

# *JOURNAL OF SPORT & EXERCISE PSYCHOLOGY*

**NASPSPA  
2015 Conference  
Abstracts**



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# JOURNAL OF SPORT & EXERCISE PSYCHOLOGY

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The *Journal of Sport & Exercise Psychology (JSEP)* is a peer-reviewed publication designed to stimulate and communicate research theory in all areas of sport and exercise psychology. The *Journal of Sport & Exercise Psychology* emphasizes original research reports that advance our understanding of human behavior as it relates to sport and exercise. Comprehensive reviews employing both qualitative and quantitative methods are also encouraged as well as brief reports of soundly designed research studies that are of special interest or importance. Areas of interest include research in social, clinical, developmental, and experimental psychology, as well as psychobiology and personality. Moreover, the terms sport and exercise may pertain to either the independent or dependent variables. Generally speaking, work on motor control processes, studies of sport as a social institution, or broader social issues are beyond the scope of *JSEP*. A wide variety of methods are acceptable for studying sport and exercise psychology topics.

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# JOURNAL OF SPORT & EXERCISE PSYCHOLOGY

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Portland, Oregon

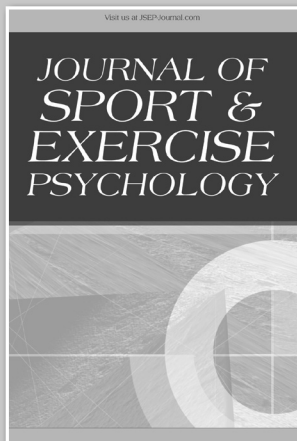
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## Human Kinetics Lecture

### Sport smarts and empty minds: Radical enactivism and highly skilled performance

Jesús Ilundáin-Agurruza; Linfield College

*When you have exclusively learned the various practices and techniques and made great efforts in disciplined training, there will be actions in your arms, legs, and body but none in your mind. . . . Training is done for the purpose of reaching this state. With successful training, training falls away.*  
—Yagyū Munenori

Expert performers fascinate us. Whether it is Nadal and Djokovic volleying cannon-like shots, Usain Bolt dashing like a cheetah, Missy Franklin gliding on water, Ronaldo and Messi finding impossible spaces among a wall of defenders, or Musashi Miyamoto's victorious 60 deadly sword duels, such performances defy belief and beg for explanation. Expertise is explored from many perspectives in sport psychology, cognitive science, and sport philosophy. For all the dissimilarity between Newell and Simon's (1972) information-processing model, Anders Ericsson's (2003) deliberate practice account, Hoffman's (1992) computer-based approach, Beilock's (2008) endorsement of embodied cognition, and Jeannerod's (1997) advancement of a neuroscience of action, they all have in common one vital element: representation. At some level or another, expert performance is tied to representations in their view. There is one alternative to representational accounts—whether these be propositional and computational or embodied—that is worth exploring. What does this alternative offer instead of representations? Nothing.

A radically enactive model advances basic minds *without* content instead of a representational and contentful cognition: “it is not knowledge (embodied know-how) that gives perceptual experiences their intentionality and phenomenal character; rather, it is the concrete ways in which organisms actively engage with their environments” (Hutto & Myin, 2013, p. 30). This enactive account is incorporated into a comparative East–West framework (Ilundáin-Agurruza, 2015a, 2015b) that shows how, phenomenologically, expert performers rather than coping mindlessly and automatically (Dreyfus & Dreyfus, 1986), act mindfully and spontaneously (Zhuangzi, 1968; Nishida, 1987). Superb performers are not encumbered at any moment with *re*-presentations, rules, calculations, or *any* kind of content; they “simply” exercise their capacities to effect spontaneous action. Risk activities, where rapid response to challenges is vital, best show this. There we see how “knowledge” disappears in the legs and arms. This does not mean that there is no room for deliberation, articulation, and representation. But these come later, built atop basic, empty minds (a holistic, situated, and scaffolded model underlies this). In short, the argument is that experts' full-bodied sport smarts are built on empty minds.

### Note

The epigraph is from Munenori's swordsmanship treatise. Thin on actual techniques but rich and complex in its analysis of performance, it comes from the pen of a man who singlehandedly killed six skillful enemy samurai who attacked his lord.

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## Keynote Presentations

### Motor Learning and Control

#### Behavioral dynamics of locomotion: From stepping to swarming

William H. Warren; Brown University

Locomotion is hierarchically organized, from an individual's step cycle to the collective behavior of swarms. A *behavioral dynamics* approach argues that at each level, stable adaptive behavior is self-organized, emerging from the dynamics of the agent–environment system and exploiting both physical and informational constraints. At the gait level, a stable step cycle emerges from the passive gait dynamics and is modulated online by visual information to adapt gait to the terrain (Matthis & Fajen, 2013). At the pedestrian level, the locomotor trajectory emerges from the agent–environment interaction, without appealing to an internal model or explicit path planning. At the collective level, global crowd behavior emerges from local interactions between pedestrians. I will describe a *pedestrian model* of steering, obstacle avoidance, and pedestrian interactions based on experiments in virtual reality. Basic behaviors are modeled as nonlinear dynamical systems, which can be linearly combined to predict more complex behavior. This perceptually grounded model reproduces patterns of crowd behavior that we observe in several scenarios: (a) *Grand Central*, in which individuals criss-cross the room, (b) *Swarm*, in which participants veer left and right while staying together as a group, and (c) *Counterflow*, in which two groups pass through each other. In each scenario, individual trajectories and crowd dynamics can be simulated with just a few basic behaviors. Thus, at each level, locomotion can be understood as emergent self-organized behavior, modulated by perceptual information to yield stable and adaptive action.

### Developmental Perspectives—Motor Control/Coordination/Rehabilitation

#### Learning to move

Karen E. Adolph; New York University

Children learn to move in the context of continual development. I argue that a fruitful way to study this process is to consider learning as *embodied* in the reality of children's growing and changing bodies, *embedded* in the practical exigencies of an ever-expanding physical environment, and *enculturated* by social interactions and culturally determined childrearing practices (Adolph & Robinson, 2015). To illustrate embodied movement, I focus on the developmental transition from crawling to walking. I show that this transition instigates a cascade of beneficial developmental changes. Compared with crawling, walking infants cover more distance faster, experience richer visual input while on the move, spend more time accessing and engaging with objects far afield, capitalize on new ways of sharing objects with others, and elicit new forms of verbal input from caregivers. In short, I suggest that infants transition to walking after they have already mastered crawling because upright locomotion allows them to go more, see more, play more, and interact more.

To illustrate embedded action by focusing on infants' behavior at the edge of a drop-off. To cope with the novelty and variability endemic in the physical environment, infants must learn to perceive the relations between their own physical characteristics and features of the environment. I show that infants learn to perceive affordances for locomotion through immense amounts of everyday locomotor experience. Learning does not transfer from earlier to later developing forms of locomotion because the relations between self and environment are altered. Thus, novice crawlers and walkers plunge headlong over the brink of impossibly large drop-offs, but experienced infants gauge affordances with impressive accuracy. To illustrate enculturated interaction, I focus on social and cultural influences on motor learning and development. I show that experienced walking infants use unsolicited social information to guide actions adaptively only when perceptual information gleaned from their own exploratory movements is ambiguous. Cross-cultural work calls attention to the disturbing fact that most of what we know about development derives from a limited sample of the world's population. For example, cultural differences in toileting affect the quantity and quality of infants' movements. The *gahvora* cradle—widely used in Central Asia—constrains infants' movements for large portions of the 24-hr day. More hours in the cradle are associated with delays in postural and locomotor milestones and less-mature crawling and walking gaits. Similarly, in our own culture, wearing diapers impairs infant walking. *NICHD R37-HD03348*

## Sport and Exercise Psychology

### Self-regulation and sports: Perseverance, peak performance, problems, and choking under pressure

Roy F. Baumeister, Florida State University

This talk will provide an overview of my research relevant to sports performance. Self-regulation is the process by which people override and alter their own responses. It can improve sports performance by maintaining effort despite fatigue or low morale, by effectively trading off speed against accuracy, by keep distracting thoughts away, and by managing emotion. It can, however, impair performance, such as when the conscious mind seeks to take over skilled execution that normally proceeds by automatic process. The latter accounts for why people choke under pressure. Self-regulatory capacity fluctuates in ways that indicate the gradual depletion of energy, so understanding and managing self-regulatory capacity can be an important key to success. Self-focused attention contributes to choking and can be stimulated by a supportive audience, so that, ironically, people sometimes perform worse when loved ones are watching. Narcissists regulate their energy according to perceived opportunities for glory, so their performance levels may depart from their ability level more than for other people.

## Senior Lectures

### Motor Learning and Control

#### The quiet eye: Origins and future directions

Joan Vickers; University of Calgary

The origins of the quiet eye (QE) date back to my early years playing, teaching and coaching sport, as well as doctoral studies at the University of British Columbia. Cognitive science was emerging as a dominant field, yet research in our field was firmly entrenched in behaviorism and the use of simple tasks that failed to identify information critical in motor performance. Excellent professors in cognitive science opened the door to study the role of the gaze and visual attention in everyday actions. The QE is recorded, *in situ*, using a mobile eye tracker and coupled external motor camera(s). During the QE, a fixation or tracking gaze is maintained on a specific location or object in the task space within 3 degrees of visual angle or less (foveal vision) for more than 100 ms (min. for awareness). Onset of the QE occurs before observable movement, and offset when the gaze deviates off the location by more than 100 ms. A longer duration QE has been shown to be a consistent characteristic of elite performers in 30 motor tasks to date; QE training has proven to be effective in 11, with new studies emerging daily. The first studies were carried out in sport; indeed, I do not believe the QE would have been discovered except in sport, due to competitive statistics confirming some athletes were more elite level than others, including teammates who experienced the same playing conditions. Recently, QE research has been extended to military and law enforcement tasks, laparoscopic and open surgery, surgical knot tying, illusions, equestrian jumping, methods of training, equipment design, child development, and research in disabilities. Despite extensive research, the underlying reasons for the quiet eye are unknown. In my talk I will touch on the notion an earlier and longer duration QE is needed to plan and organize the neural networks underlying the optimal control of actions. In particular, the dorsal-parietal-frontal network, promotes automaticity, biomechanical efficiency and precision, while reducing anxiety and distractions that can arise from the ventral-temporal network.

### Sport and Exercise Psychology

#### Stress and adaptation in sport and exercise: Does coping matter?

Peter R.E. Crocker, University of British Columbia

Engagement in sport and exercise can often be stressful. From a more comprehensive perspective, stress is part of an adaptation process in which athletes and exercisers need to continually regulate to shifting demands and develop skills and resources to manage future demands (Tamminen & Crocker, 2014). Coping is one process that can facilitate adaptation in sport and exercise (Lazarus, 2000). In this presentation, I will highlight several key issues about how researchers have attempted to examine the complexity of the coping process. I will focus on research from our laboratory, but also recognize the significant work of others, that considers conceptual and methodological issues related to investigating coping in sport and exercise setting. Using both qualitative and quantitative methods, our research findings reveal that people use a variety of cognitive and behavioral strategies to manage demands and emotions. Yet we still have a poor understanding of why people cope the ways they do. The presentation will consider recent longitudinal work with athletes. Work by McDonough et al. (2013), involving interviews with competitive youth swimmers before and after swim meets across a season, suggests that it might be possible to develop profiles of how athletes manage stress. A season-long study among high performance curlers revealed that interpersonal emotional regulation might be a key feature of facilitating team's performance (Tamminen & Crocker, 2013). I will also highlight recent prospective and longitudinal quantitative studies that examine the mediating effects of coping in personality-athletic outcomes relationships (Schellenberg et al., 2013; Riendeau et al., in progress). This inquiry in the areas of passion and perfectionism might point to promising areas of research in both sport and exercise. Lastly, I will discuss how the current research and other key areas related to interpersonal emotional regulation and communal coping have important implications for understanding the adaptation process in sport and exercise.

## Developmental Perspectives: Motor Control/Coordination/Rehabilitation

### **I want it all and I want it now!: How the first generation of pediatric mobility technology could change rehab across the lifespan**

James C. (Cole) Galloway; University of Delaware

Is moving anywhere, anytime with anyone without restriction an expectation of life? If so, then mobility is a human right. Achieving this daily “life dosage” of mobility also offers a gold standard to judge the effectiveness of mobility technology. Medical pediatric devices such as wheelchairs and walkers—which commonly suffer from a pseudo-design process of “shrink it & pink it” that produces high stigma/high cost, low dose/low aesthetic devices—fail rather dramatically. Interestingly, mobility-related nonmedical pediatric devices (aka “toys”) are increasing in type and variety while decreasing in age and cost. I will discuss a new generation of developmentally inspired, toy-inspired technology that emerges from a child/family-centered research and design process. This R&D process requires new terminology, materials, team members, funding strategies, and dissemination outlets. I will focus on the three categories of interest to *Go Baby Go!* project leaders: wheeled environments, Functional Fashions, and body weight support systems. Each of these categories illustrate the beginning of what we hope is a lasting paradigm shift in design, fabrication, funding, and accessibility. Moreover, I will argue that this shift can and should deeply involve clinicians, researchers, and families in collaboration with industry. My goal is to inspire you to both advocate for this paradigm shift and feel empowered to participate in the creation of devices that provide life dosages of social mobility.

## Early Career Distinguished Scholar Lectures

### **Acute exercise makes you smarter: What, how, and why?**

Yu-Kai Chang; National Taiwan Sport University

Research on exercise and cognition has received dramatic attention in many academic fields, including epidemiology, gerontology, neuroscience, sport medicine, and rehabilitation, and has been recognized as one of the hottest topics within exercise psychology. The emergence of this interest is partially attributed to the importance of cognitive functions in daily life and well-documented declines in cognitive functions with age. The development of cognitive functions begins in infancy, and starting at around 20 years of age cognitive functions such as information processing speed, reasoning, and memory begin to suffer from age-related decline. This process accelerates between 50 and 80 years of age. Interestingly, the cognitive development and decline across a lifespan have recently been proved capable of being moderated by various factors, such as previous experience (e.g., education levels) or living a healthy lifestyle (e.g., exercising, having positive social interactions). Exercise is particularly significant because of its additional benefits to physical and mental health; conducting exercise is a highly rewarded investment. The purpose of this talk is to introduce previous and current understandings of acute exercise, also known as a single bout of exercise, and cognitive functions, the foundation of what is commonly known as being “smart.” Specifically, this presentation will overview pioneer works and provide updated knowledge from our group on a) *what* acute exercise impacts cognitive function: various exercise types, the nature of cognitive functions, current research conclusions, and limitations; b) *how* to maximize the effects of acute exercise on cognitive functions: exercise prescription; and c) *why* acute exercise impacts cognition, as evidenced in cognitive neuroscience approaches employing neuroelectric and neuroimaging methods. These findings offer robust evidence for positive acute exercise effects on cognitive functions, and provide insights for future research while contributing to the scientific foundations for this field of investigation.

### **Reflecting upon the past . . . while shaping the future: Early movement experiences that support positive developmental trajectories**

Leah E. Robinson; University of Michigan

Lolas E. Halverson was a motor behaviorist who made outstanding contributions to our field. It is easy to reflect how Halverson's work has shaped and continues to guide my research. The overarching goal of my work is to promote movement while motivating children to be physically active and to support key aspects of child development. One of Halverson's pearls of wisdom that serves as the foundation of my research inquiries, is the "need for carefully developed environmental situations in which the child is challenged enough to grow in motor maturity and skills, but not frustrated by over-challenge" (Halverson, 1966). Halverson also stressed that children need "environmental settings which will either bring out the movement responses for the first time or help change overt responses easily and naturally" (Halverson, Robertson, & Harper, 1973) and that "children have the opportunity to progress at his or her own rate" (Halverson, 1963). Based on Halverson's pearls of wisdom, I strive to implement well-designed motor skill and physical activity programs for children who are at risk of developmental delays. These programs align with a mastery motivational climate that promotes positive outcomes and places importance on the process of learning. Findings from work conducted within my lab support that these programs are effective in promoting motor skills, self-perceptions, and physical activity in young children. As I move my research agenda forward, emerging evidence indicates a connection between motor skills, physical activity, cognition, and other indicators for healthy development. My long-term goal is to obtain a more comprehensive understanding of this intervention approach with other aspects of child development, such as school readiness and physical health. The significance of this line of inquiry could encourage the development of early childhood education policies that require early, high quality movement and physical activity programs to ensure that children enter kindergarten healthy, active, and ready to learn.

## **The NASPSPA Outstanding Student Paper Award Recipients**

### **Motor Control and Learning**

#### **Dopaminergic interactions between anxiety and processing of the environment in PD**

*Kaylena A. Ehgoetz Martens, Colin G. Ellard, University of Waterloo; Quincy J. Almeida, Wilfrid Laurier University*

Recent research has suggested that anxiety influences gait in PD, with an identified dopa-sensitive gait response in highly anxious PD. Sensory-perceptual deficits have been suggested to underlie gait impairments in PD; thus, it may be that in threatening situations anxiety acts like a dual task limiting one's ability to process information about the environment. The current study aimed to (i) evaluate whether anxiety influences information (visual) processing in PD while walking in threatening situations, and (ii) examine whether dopaminergic medication modulates anxiety's influence on information processing. Forty-eight participants (24 HC; 12 Low Anxious [LA-PD], 12 Highly Anxious [HA-PD]) were asked to walk across a plank in virtual reality that was located either on the ground (LOW) or above a deep pit (HIGH). The plank varied in size from 60 to 100 cm, and after participants crossed the plank they were asked to judge the width of the plank they had just walked across. Both ON and OFF medication states were evaluated in PD, and judgment error as well as self-reported anxiety levels were measured. Overall PD had similar judgment error as HC. However, when examining the PD groups across both medication states, a condition  $\times$  plank size interaction was found for constant error ( $p = 0.011$ ), revealing that all PD participants judged the narrowest plank more accurately when walking across the HIGH plank (compared to LOW). The opposite was observed when PD participants walked across the widest plank; that is, participants overestimated the plank size after they had walked across the HIGH plank (compared to the LOW). Finally, medication state did not influence judgment error. In conclusion, the current study did not find evidence that dopamine modulates the influence of anxiety on processing aspects of the environment, nor was there evidence to suggest that anxiety interferes with accurate perception of the plank size in PD. Instead, the current findings suggest that anxiety enhances threat-relevant processing when walking in extremely threatening situations.

## Developmental Perspectives

### End-state comfort across the lifespan: A cross-sectional investigation of how the mode of action execution influences motor planning in an overturned glass task

Sara M. Scharoun, David A. Gonzalez, Eric A. Roy, University of Waterloo; Pamela J. Bryden, Wilfrid Laurier University

Exemplified by the end-state comfort effect (ESC), young adults plan actions in advance to minimize the cost of movement (Rosenbaum et al., 1990). In children, the development of general cognitive control processes lead to improvements in anticipatory planning that forms the foundation for adult-like reaching by age 9 to 10 (Wunsch et al., 2013). Observing the other end of the lifespan, to our knowledge ESC has not been explored in older adults. The overturned glass task (Fischman, 1997) was used to investigate ESC with 5- to 12-year olds, young ( $M_{\text{age}} = 24.38$ ) and older ( $M_{\text{age}} = 72.50$ ) adults ( $N = 116$ ). Engagement of participants in this study was in compliance with ethical standards. Participants picked up a glass as if to pour water in pantomime without a stimulus, pantomime using an image/glass as a guide and actual grasping. Five- to six-year-olds displayed less ESC than older age groups. Seven- to eight-year-olds displayed less ESC than young adults, who approached ceiling. These findings support adult-like patterns of ESC by age 9 to 10 (Wunsch et al., 2013). Interestingly, 5- to 6-year-olds displayed the most ESC in pantomime without a stimulus. It is argued that familiarity with the task influences planning. Pretend play is prominent between ages 3 and 5 (Singer & Singer, 1992); therefore, children may be more familiar with planning to re-orient a glass in pantomime (i.e., pretend) compared to actual grasping. Beyond familiarity, age-related improvements in ESC can be attributed to the development of overall proficiency in state estimation (King et al., 2012). For older adults, more ESC was observed in actual grasping than pantomime without a stimulus. It can be argued that older adults are reliant on feedback to continuously and consciously modify movements to meet action requirements (Roy et al., 1996); therefore, physical interaction with an object is required to plan according to ESC. An advantage for tool use is consistent with differences in healthy aging and disorders like apraxia. Overall, findings have implications for understanding the development course of ESC.

## Sport and Exercise Psychology

### Effects of performance feedback on self-efficacy and exercise performance are moderated by self-control strength depletion

Jeffrey D. Graham and Steven R. Bray, McMaster University

Self-control is a key determinant of physical endurance. According to control theory (Carver & Scheier, 2011), performance feedback influences self-control such that when people underperform they increase effort, while those who overperform withdraw effort. This perspective clashes with social cognitive theory (Bandura, 1997), which proposes that positive performance increases self-efficacy and leads to better performance. The main purpose of this study was to investigate the effects of performance feedback on self-efficacy and performance of a muscular endurance task. A secondary objective was to investigate the effects of feedback under conditions of self-control strength depletion (Baumeister, 2014). A single blind, randomized, 2 (depletion/no depletion)  $\times$  3 (no/positive/negative feedback) design was used. Participants ( $N = 79$ ) performed two isometric endurance handgrip trials separated by a congruent (no depletion) or incongruent (depletion) Stroop task. After the Stroop task, participants received positive or negative normative feedback or no feedback (control) about their endurance performance. A 2  $\times$  3 ANOVA of the change in performance from Trial 1 to Trial 2 produced several significant effects. Of primary interest, there was a significant interaction between feedback and depletion ( $p < .001$ ). In the no depletion conditions, positive feedback led to lower self-efficacy and negative performance change whereas negative feedback led to increased self-efficacy and performance. However, in the depletion conditions, the reverse was seen with regards to self-efficacy and change in performance. Results support the effects of positive vs. negative performance feedback on effort allocation and performance drawn from control theory. Results also support social cognitive theory, as self-efficacy acted as a motivator and positively influenced subsequent behavior. The unique contribution of these findings relate to how positive vs. negative performance feedback influences self-efficacy and physical endurance performance differently when in a depleted state vs. not.

# The Franklin Henry Young Scientist Award Winners From the Canadian Society of the Psychology of Sport and Psychomotor Learning (SCAPPS)

## Sport and Exercise Psychology

### Psychosocial predictors of adolescent girls' physical activity and dietary behaviors after completing the Go Girls! group-based mentoring program

A. Justine Dowd, University of British Columbia, Vancouver, and University of British Columbia, Okanagan; Michelle Y. Chen, Toni Schmader, University of British Columbia, Vancouver; Mary E. Jung, University of British Columbia, Okanagan; Bruno D. Zumbo, Mark R. Beauchamp, University of British Columbia, Vancouver

Social cognitions targeted within a group-based mentoring program for adolescent girls were examined as predictors of physical activity (PA) and dietary behavior (separately) 7 weeks after program completion. Data were collected from 237 participants at the end of, and 7 weeks after, completing the program. Multilevel structural equation modelling was used to assess both psychosocial (measured post program) and behavioral variables (measured 7 weeks post program) among program participants. Analyses revealed that 36.5% and 31.2% of the variance in postprogram PA and dietary behavior was explained by affective and instrumental attitudes, self-regulatory efficacy (SRE), and intentions. Intentions partially mediated the effects of SRE, affective and instrumental attitudes on PA behavior. Similarly, in relation to dietary behavior, intentions partially mediated the effects of SRE, affective and instrumental attitudes. These findings highlight psychological factors that predict adolescent girls' health-enhancing PA and dietary behaviors after completing a group-based mentoring program.

## Motor Learning and Control

### Self-controlled feedback is effective if it is based on the learner's performance: A replication and extension of Chiviawsky and Wulf (2005)

Michael J. Carter, Anthony N. Carlsen, Diane M. Ste-Marie; University of Ottawa

Self-controlled feedback schedules are more effective for motor learning compared to yoked schedules. These advantages have been attributed to motivational and/or information-processing activities with many researchers adopting the motivational perspective in recent years. Chiviawsky and Wulf (2005) found that feedback decisions made before (Self-Before) or after a trial (Self-After) resulted in similar skill retention, but superior skill transfer was demonstrated by the Self-After group. Chiviawsky and Wulf concluded that motivational factors may have resulted in the similar retention performance, but the learning advantages of deciding after a trial as evidenced in transfer were hypothesized to emerge from information-processing activities such as error estimation. Here, we revisited Chiviawsky and Wulf's design to investigate the learning benefits of self-controlled feedback schedules. We replicated the Self-Before and Self-After groups, but added a Self-Both group that could request feedback before a trial, but could then change or stay with their original choice after the trial. Importantly, we included corresponding yoked groups for the self-controlled groups to address a methodological limitation in Chiviawsky and Wulf (2005) and a measure of error estimation was included. Participants practiced a target aiming task whereby a slider was propelled down a track to a goal distance using their non-dominant hand. The Self-After and Self-Both groups demonstrated similar accuracy in performance and error estimation scores in retention and transfer, and both groups were significantly more accurate than the Self-Before group and their respective Yoked groups ( $p$ 's < .05). The Self-Before group did not differ significantly from their yoked counterparts. We suggest that these findings further indicate that informational factors associated with the processing of feedback for the development of one's error detection and correction mechanism, rather than motivational processes are more critical for why self-controlled feedback schedules optimize motor learning.

## Preconference Workshops

### A Didactic Introduction to Latent Variable Modeling

**Organizers: Brian F. French, Washington State University; Holmes Finch, Ball State University**

Brian F. French, Washington State University; Holmes Finch, Ball State University

This two-part workshop will provide an introduction to the use of latent variable modeling (e.g., factor analysis, structural equation modeling) for examining learning and performance outcomes. The focus will be to provide persons who are interested in such techniques, but new to thinking about latent variables, with a general overview of the area and ideas about the types of questions that can be answered within a latent variable framework. The target audience is graduate students and faculty new to this area with a desire to be oriented to current trends in data analysis using this modeling framework. The workshop will involve two 2-hr sessions. The first 2-hr session outlines the use of this modeling framework and its advantages compared to observed variable models. Participants will be introduced to basic models in measurement such as confirmatory factor analysis, multiple indicators–multiple causes models, latent mean comparisons, and full structural equation models. Examples of these models will be shared with associated resources to conduct such analyses. The second 2-hr session will introduce more complex models for expanding the types of questions that can be answered. Topics will include measurement invariance models, multigroup models for analysis of data from experiments (e.g., RCTs, quasi-experimental designs), item response theory, and latent class analysis. Example software code for analyses covered in both sessions will be shared with all participants. This is for examples and computers are not required for the workshop. Participants can select one or both of the sessions, and will leave with a basic understanding of latent variable modeling, including how such models are used to answer various research questions, and resources for learning more about these techniques and others. The participants will receive access to sample software code, datasets, output with interpretation, and sample readings to facilitate the learning process. The prerequisite knowledge for workshop attendees is multiple regression techniques.

### How'd They Do That?: Entering the Funding Game at Mid or Late Career

Organizer: Alan L. Smith, Michigan State University

Alan L. Smith, Michigan State University; Daniela Corbetta, University of Tennessee; Deborah L. Feltz, Michigan State University; Frank M. Perna, National Cancer Institute; Catherine Sabiston, University of Toronto

With the maturation of kinesiology and the evolving landscape of higher education, expectations have increased for securing funding to support research programs in developmental perspectives, motor learning/control, and sport and exercise psychology. Government grants are particularly coveted, yet competition for funding is fierce and success requires unique skills and knowledge. Being an excellent scholar is just part of the success equation. Moreover, many in our scholarly society seek to enter the funding arena at mid or late career, having pursued their doctoral training at a time when funding pressures were less salient. This can be daunting and poses unique challenges, yet these challenges can and have been overcome to push forward important research programs. The goal of this pre-conference session is to share stories of success in securing funding at mid and late career, highlight funding opportunities in Canada and the United States, and overview how government grants are administered and reviewed. The presenters include NASPSPA members who have secured funding from agencies such as the Canada Foundation for Innovation, Canadian Institutes of Health Research, National Institutes of Health, National Space Biomedical Research Institute, Social Sciences and Humanities Research Council of Canada, and the U.S. Department of Education. They will share their pathway to supporting their research programs, including mistakes made, lessons learned, and how their workflow changed while both seeking and after receiving funding. A presenter from the National Cancer Institute, with doctoral training in sport and exercise psychology, will share funding opportunities for physical activity researchers and offer “behind the curtain” insights on how successful grant proposals move through the submission, review, selection, and management stages. Following the presentations, large group discussion and small group activities will allow for dialogue and networking among participants.

## Thursday, June 4

### Special Symposium

#### Things We Have Learned in Group Dynamics (So Far): A Tribute to Dr. Bert Carron

Symposium organizer: Mark Eys; Wilfrid Laurier University, Canada

Symposium discussant: Deborah Feltz; Michigan State University, USA

Dr. Bert Carron was a longstanding member of NASPSPA and an internationally renowned sport and exercise psychology researcher. Collectively, his contributions to NASPSPA from 1979 to 2014 were 51 communications, participation on five program committees, the 2003 Senior Lecture, and service on the *Journal of Sport Psychology* (renamed as the *Journal of Sport & Exercise Psychology*) editorial board. For this longstanding dedication to the organization and the field, he received the society's Distinguished Scholar Award in 2007. Carron was instrumental in forwarding our understanding of group dynamics in sport and exercise, and his work generated multiple lines of research on this topic. The objectives of this special symposium are to (a) reflect on his contributions as they underpin important variables contributing to the group's environment, structure, and processes and (b) highlight recent advances and future research directions in these areas of study. Accordingly, four presentations plus an expert reaction form the symposium. The first presentation will highlight current understanding of the home advantage, a critical group environment variable, in relation to a proposed conceptual model (Carron, Loughead, & Bray, 2005). The second will outline role perceptions as important contributors to the psychological structure of the group (Carron & Eys, 2012), with a specific focus on recent conceptualizing of role acceptance. Processes related to team building in sport and exercise will constitute the third presentation. These processes will incorporate additional group variables (e.g., psychological climate) that build upon more traditional conceptions of team building (Carron, Spink, & Prapavessis, 1997). The fourth will emphasize Carron's contributions across contexts by discussing group dynamics as they influence physical activity interventions. Using the group as an agent for and target of change to achieve positive psychological, physical, and functional outcomes will be stressed. Finally, a discussant will offer reactions and final thoughts about Carron's impact on NASPSPA and the field of sport and exercise psychology.

#### “Simple is better”: The game location framework of home advantage in sports

Bray, Steven R.; McMaster University

The homefield advantage has been a phenomenon of interest to sportspersons, statisticians, odds-makers, and sports science researchers for several decades. In 1992, Courneya and Carron devised a model that served as a framework to assist them in organizing their review of the diverse home advantage literature undertaken to that point in time. Their conceptual model also served as a guide for researchers, highlighting potential factors associated with game location that might exert effects on the psychological and behavioral states of the participants involved. Following a review of the available evidence, Carron, Loughead and Bray “updated” the model in 2005. Our goal was to have the model continue to serve as a catalyst for research attempting to build a better understanding of the home advantage phenomenon. In this presentation, I will discuss the game location model as an example of Dr. Carron's approach to systematically organize complex concepts to allow his students and other researchers to see the pieces of the puzzle as well as the whole picture. I will review selected evidence illustrating various components of the model and comment on how researchers have benefited from the guidance it provides. Some of the challenges associated with evaluating the model's components as well as additional factors such as the role of officiating behaviors that are not accommodated by the 2005 model will also be discussed.



**“What to expect when you’re expecting” . . . athletes to fulfill their role responsibilities**

Eys, Mark A.; Wilfrid Laurier University

The examination of athletes’ role perceptions was an ongoing interest for Dr. Carron’s research pursuits. Through the inclusion of several role concepts within the Team Climate Questionnaire (Grand & Carron, 1982), involvement in enhancing our understanding of role efficacy (Bray, Brawley, & Carron, 2002), and contributing to the conceptualization and measurement of role ambiguity (Eys & Carron, 2001; Beauchamp, Bray, Eys, & Carron, 2002), Carron had a consistent and strong influence in this area of study. The general purpose of this presentation is to highlight our current understanding of role perceptions that has evolved through Carron’s encouragement to study this structural component of groups. First, a brief review of cognitive, affective, and behavioral components of athletes’ role involvement will be provided as summarized by Carron and Eys (2012). Second, a specific focus on the concept of role acceptance/commitment will be based on recent qualitative investigations with athletes and coaches, as well as the integration of an established model of commitment from the organizational psychology domain (Meyer & Allen, 1991; Jackson et al., 2014). The approach undertaken in examining this cognition follows from Carron’s insistence on the development of a strong theoretical base and the consideration of literature derived from related areas that study group dynamics. Finally, future research directions will be provided that convey the potential importance of understanding both formal and informal role development processes, measurement issues pertaining to role components, and applied practices for effectively communicating role expectations in a sport environment. Overall, one can expect that the transmission of role expectations is a complicated group process, and that perceptions held by athletes regarding their role have an effect on individual and group outcomes.

**Through the cohesion looking glass and what Bert saw**

Spink, Kevin S.; University of Saskatchewan

A number of studies have emerged confirming the relationship between perceptions of cohesiveness and a range of individual (e.g., adherence, satisfaction) and group outcomes (e.g., team success, collective efficacy) within activity settings. While Dr. Carron recognized the need to establish relationships between this key group construct and these important outcomes, like pioneers before him (Lewin’s action research agenda, 1946), he was just as motivated about practical applications. In peering through the looking glass, Carron realized that there was an equally important question for cohesion researchers interested in behavior change. How may the cohesiveness of the group be enhanced? One established group-based intervention currently used by coaches and exercise leaders to enhance cohesion is team building. While team-building programs exist in exercise and sport settings, they typically target different group processes (Lewin, 1935): sport focuses on locomotion (improved group effectiveness) and exercise on maintenance (adherence). While multiple frameworks have been used in the sport setting (Martin et al., 2009), one model serves as the underpinning for numerous interventions conducted in the exercise setting. It is the four-stage team-building model (Carron & Spink, 1993) co-developed by Carron that uses the exercise leader as the agent of delivery. The efficacy of this model has been demonstrated across many exercise settings and age groups that range from adolescents to the elderly. The purpose of this presentation is to acknowledge Carron’s contribution to this model. This will include a focus on the development of the model, the initial testing of the model to determine if cohesion in exercise classes could be enhanced using the principles of the model, examining the relationship between the mechanisms in the model and cohesion, and extension of the model to examine other important outcomes in different populations. Future directions for the model will be presented including possible enhancements and team building for psychological climate.

**The group as a medium for influencing physical activity intervention**

Brawley, Lawrence R.; University of Saskatchewan

Cartwright (1952), in a classic article on the application of group dynamics for change, envisioned the group as both a target of change and an agent of change. This perspective characterizes the different group influence approaches to application that have been undertaken by behavior change scientists when intervening in various physical activity contexts. These approaches range from team building for exercise groups to group-environment and process-strategy approaches to fostering group motivation for community-based intervention to group-mediated, cognitive-behavioral (GMCB) intervention. Some basic differences between these intervention approaches will be contrasted with the GMCB intervention to clarify their differences. Consistent with Dr. Carron’s argument that groups are powerful social entities that influence change, evidence will be presented from these approaches that supports the use of the group as an agent for positive change. As well, the effects of the GMCB intervention over multiple studies will be summarized to illustrate its generalizability across various settings. Part of Carron’s legacy was to suggest research directions for the future. The presentation will close with challenges for the upcoming generation of new interventions.

## Developmental Perspectives

### Moving on With Assessment Methods of Motor and Perceived Competence in Children

Organizer: An De Meester, Ghent University

Discussant: Nancy Getchell, University of Delaware

#### **Moving on with assessment methods of motor and perceived competence in children to be able to more accurately evaluate relationships with these constructs and children's physical activity and sport participation: Overview**

De Meester, An, Ghent University; Robinson, Leah E., University of Michigan; Barnett, Lisa M., Deakin University; Logan, Sam W., Oregon State University; Nesbitt, Danielle R., University of South Carolina

Valid assessment methods of children's actual motor competence (MC) are essential to screen for movement difficulties, to determine children's MC levels, and to evaluate the effects of MC interventions. Similarly, measures of perceived MC need to be valid and reliable to be able to quantify the relationship with actual MC. However, despite the variety of existing assessment methods to measure both actual and perceived MC, the convergent and developmental validity of these instruments has not been thoroughly studied. Moreover, assessment methods of perceived MC often involve a comparative framework and may therefore not be objective. It is therefore necessary to evaluate, compare, and address validity of assessment methods that measure actual and perceived MC in children and youth in order to develop new assessment methods that address the existing shortcomings. This symposium will explore issues concerning a range of existing assessment methods and will challenge conventional thinking about assessing actual and perceived MC. The first two presentations include a range of actual MC assessments methods (TGMD-2, GSGA, product scores and STS-time) and focus on convergent and developmental validity. The two following presentations are about assessing perceived MC. The factorial validity of the Pictorial Scale of Perceived Movement Skill Competence is discussed in one presentation while the second presentation focuses on the development and reliability of a video-based movement demonstration instrument designed to assess perceived MC in children. The final presentation examines the relationship between actual and perceived MC with several health-related outcomes such as sports participation and motivation towards sports. The discussant will focus on the advantages and disadvantages of the presented measures in light of the interpretation of findings of past research, and the opportunities and recommendations for future research.

#### **Validity of the Pictorial Scale of Perceived Movement Skill Competence**

Barnett, Lisa M., Deakin University; Vazou, Spyridoula, Iowa State University; Robinson, Leah E., University of Michigan; Ridgers, Nicola D., Salmon, Jo, Deakin University

**Objectives:** The Pictorial Scale of Perceived Movement Skill Competence (PMSC) assesses young children's perceptions of movement skill competence: 12 perceived Fundamental Movement skills (FMS; based on the Test of Gross Motor Development, 2nd edition) and six Active Play activities (e.g., cycling). The purpose of this investigation was to explore how well children's movement perceptions fitted within the constructs of FMS and play activities. **Design:** Validation study. **Methods:** Participants for this study were part of the 5-year follow-up of the Melbourne Infant Feeding, Activity and Nutrition Trial (InFANT) Program. The latent structure of the PMSC responses was tested through confirmatory factor analysis (CFA). Cronbach's alpha was conducted to assess internal consistency for all 18 items and factors from the final model. **Results:** The 303 children (boys 53.1%,  $n = 161$ ) used in analysis were aged 4-5 years ( $M = 4.7$ ,  $SD = 0.46$ ). The final model produced an 18-item three-factor solution with good fit indices. Factors were Active Play (Bike, Board Paddle, Climb, Roller Skate/Blade, Scooter, and Swim), Object Control – Hand Skills (Bounce, Catch, Hit, Throw), and FMS skills with a leg action (Gallop, Hop, Jump, Leap, Run, Step Slide, Kick, Roll). Cronbach's alpha for all items was 0.84. **Conclusion:** Young children could distinguish between movement perceptions. The factors reflect the hypothesized structure in terms of FMS being distinguished from Active Play. Further research should investigate how and if these constructs change in children overtime.

### Comparison of performances on process- and product-oriented motor assessments

Logan, Samuel W., Oregon State University; Robinson, Leah E., University of Michigan; Barnett, Lisa M., Deakin University; Goodway, Jacqueline D., Ohio State University; Stodden, David F., University of South Carolina

**Objectives:** Fundamental movement skills (FMS) include locomotor (e.g., jumping, hopping, and running) and object control (e.g., throwing, kicking and striking) skills. Valid and accurate assessments of FMS are essential to screen for movement difficulties, determine competence levels, evaluate the effectiveness of interventions and understand their predictive utility for health. Fundamental movement skills are assessed using various process- (movement patterns) or product-oriented (outcome/performance) approaches. Limited research has examined performances between process- and product-oriented assessments, with results indicating low-to-moderate positive correlations. The purpose of this study is to examine associations among three motor assessments (Test of Gross Motor Development-2nd edition [TGMD-2]; Get Skilled: Get Active protocol [GSGA] and Product scores) of three FMS in typically developing children. **Methods:** Participants included 170 children between 4 and 11 years old (84 boys; 86 girls). Performance of the jump, hop, and throw was assessed by the process-oriented TGMD-2 and the GSGA. A product-oriented approach was also used to assess jump length (as a percentage of height), hop stride length (as a percentage of height), and throw (velocity in miles per hour). Spearman's correlations of raw scores were used to examine relationships between assessments. **Results:** Jump (TGMD-2 to GSGA = .54; TGMD-2 to Product = .53; GSGA to Product = .52); Hop (TGMD-2 to GSGA = .68; TGMD-2 to Product = .59; GSGA to Product = .69); Throw (TGMD-2 to GSGA = .79; TGMD-2 to Product = .70; GSGA to Product = .68). All correlations were significant at the .01 level. **Conclusion:** This study demonstrated moderate-to-strong associations between process- and product-oriented assessments of three FMS and provides support for convergent and developmental validity of all three assessments. Incorporating both product and process assessment approaches may be beneficial to provide more effective predictive utility in examining relations between FMS and health.

### Development and reliability testing of a video-based instrument designed to assess perceived motor skill competence in children

Robinson, Leah E., Palmer, Kara K., University of Michigan; Carter, William M., Dennis, Abigail L., Ward, Jeffery K., Davis, Shelby L., Auburn University

**Objectives:** Self-perceptions of motor competence have a direct effect on children's motivation to participate in various forms of movement and physical activity (Robinson, 2011). Several scales (i.e., Harter and Pike's Pictorial Scale of Perceived Competence and Acceptance for Young Children and Barnett's Pictorial Scale of Perceived Movement Skill Competence) have been developed to assess perceived motor competence in young children. The purpose of this study is to determine the reliability and internal consistency of a video-based movement demonstration instrument designed to assess children's perceived motor skill competence. **Methods:** The instrument was based on the 12 fundamental motor skills (FMS) from the Test of Gross Motor Development-2nd Edition (Ulrich, 2000) with a similar layout and item structure to Pictorial Scale of Perceived Movement Skill Competence (Barnett et al., 2014). Participants were 3rd graders ( $n = 28$ ; 57% boys) aged 8–10 years ( $M = 8.4$  years,  $SD = .56$ ) and 4th graders ( $n = 26$ ; 46% boys) aged 9–10 years ( $M = 9.2$  years,  $SD = .42$ ). **Results:** Using a one-way random effects model, intra-class correlations (ICC) and internal consistency (i.e., Cronbach's alpha) were conducted for the total FMS along with the 2 subscales: locomotor (LOCO) and object control (OC). Third graders reported excellent ICC (Total = 0.84, LOCO = 0.74, OC = 0.86) and internal consistency (Total = 0.84, LOCO = 0.77, OC = 0.86). Fourth graders demonstrated outstanding ICC (Total = 0.82, LOCO = 0.76) and internal consistency (Total = 0.81, LOCO = 0.76) for Total and LOCO skills. However, their ICC (OC = 0.69) and internal consistency (OC = 0.69) for OC skills only demonstrated acceptable/good agreement. **Conclusions:** Findings provide evidence that supports the reliability of the video-based perceived motor skill competence instrument and warrants future investigation between the instrument to actual FMS competence and other health measures in children.

### Actual and perceived motor competence assessment in relation to children's motivation towards sports and community sports participation

De Meester, An, Pion, Johan, Ghent University; Stodden, David F., University of South Carolina; Cardon, Greet, Lenoir, Matthieu, Haerens, Leen, Ghent University

**Objectives:** The reciprocal relation between motor competence (MC), physical activity and sports participation is the subject of various studies but the role of motivation within this context has been understudied. It remains furthermore unclear how children's actual MC relates to their perceived MC. Therefore, the purpose of the present study is 1) to investigate the relation between children's actual and perceived MC and 2) to examine how children's actual and perceived MC relate to their quality of motivation for sports and their community sports participation. **Methods:** 144 pupils (56.9% boys; age =  $9.84 \pm 2.10$  years) from 13 classes from the 3rd to 6th grade completed validated questionnaires to assess motivation towards sports (Sebire et al., 2013), community sports participation, and perceived MC (Harter et al., 2012). Actual MC was assessed with the Körperkoordinationstest für Kinder test battery during school hours (Kiphard & Schilling, 1974, 2007). Multilevel regression analyses were conducted. **Results:** Pupils' actual MC was positively related to their perceived MC [ $\beta = 1.01$ ,  $SE = .26$ ,  $\chi^2(1) = 14.49$ ,  $p < 0.001$ ]. After controlling for age and sex, it was furthermore found that pupils' perceived MC was positively related to their quality of motivation towards sports [ $\beta = .07$ ,  $SE = .02$ ,  $\chi^2(1) = 21.20$ ,  $p < 0.001$ ] and their community sports participation [ $\beta = .17$ ,  $SE = .05$ ,  $\chi^2(1) = 13.51$ ,  $p < 0.001$ ]. Pupils' actual MC was not significantly directly related to either one [ $\beta = .02$ ,  $SE = .01$ ,  $\chi^2(1) = 1.72$ ,  $p = .19$  and  $\beta = .00$ ,  $SE = .00$ ,  $\chi^2(1) = 0$ ,  $p = 1$  respectively]. Mediation analyses indicated a mediation-effect of perceived MC on the relation between actual MC and sports motivation (100%) and on the relation between actual MC and community sports participation (43.9%). **Conclusion:** Even though the positive relation between children's actual and perceived MC indicates that children are able to correctly assess their own MC, the current results suggest that perceived MC is a more important factor with regard to children's quality of motivation towards sports and their community sports participation.

### Feasibility of supine-to-stand time as a measure of lifespan motor competence

Nesbitt, Danielle R., University of South Carolina; Phillips, David S., Southern Utah University; Stodden, David F., University of South Carolina

**Objectives:** Motor competence (MC) is assessed using a variety of product- and process-oriented test batteries, most of which have been developed to assess children's movement competence. Limited studies have addressed lifespan trajectories of MC. Supine-to-stand (STS) time is used to assess functional capacity and health in elderly populations, but very little is known about how it relates to the movement processes of STS and other MC measures and health in children. The purpose of this study is examine the associations between STS time, STS component sequences and other measures of MC (TGMD-2, kicking, throwing, and standing long jump performance) and the Fitnessgram Pacer test in preschool aged children. **Methods:** A convenient sample of 41 (males = 20) 4- to 5-year-old children participated in the study. Average STS time were correlated with modal component developmental sequences, TGMD-2 standard scores, kicking and throwing speed and standing long jump distance. Children also performed the 15-m PACER test (accompanied by an adult lure). Data was analyzed using Pearson (quantitative) and Spearman's (ordinal) bivariate correlations with an alpha of 0.05 to determine significance (IBM SPSS version 22). **Results:** Results demonstrated moderate correlations between STS and axial ( $r = -.39$ ,  $p < .01$ ) and upper extremity ( $r = -.39$ ,  $p < .01$ ) component sequences, but STS time was not correlated with lower extremity components. Results also demonstrated a moderately high inverse correlations between STS time and PACER laps ( $r = -.66$ ,  $p < .01$ ), standing long jump distance ( $r = -.61$ ,  $p < .01$ ) and kicking speed ( $r = -.52$ ,  $p < .01$ ). Finally, results demonstrated moderate correlation between STS time and throwing speed ( $r = -.45$ ,  $p < .01$ ) and TGMD-2 standard scores ( $r = -.33$ ,  $p < .01$ ). **Conclusion:** Based on the moderate to moderately strong correlations between STS time, STS component sequences and a variety of other process- and product-oriented measures of MC, STS time may be a useful and developmentally valid measure of global MC/functional capacity and health across the lifespan.

**Friday, June 5**

## **Sport and Exercise Psychology**

### **Promoting Children's Physical and Mental Health Through the Lens of Developmental Circus Arts**

Organizer: Spyridoula Vazou, Iowa State University

Discussant: Jacqueline L. Davis, University of British Columbia

#### **Promoting children's physical and mental health through the lens of developmental circus arts: Overview**

Vazou, Spyridoula, Iowa State University

The presentations in this symposium focus on research studies and empirical cases that have examined the role of developmental circus arts in children's physical and mental health. The predominant vehicle for physical activity (PA) among children is youth sport and physical education. This symposium will highlight the theory and practice of using circus activity to promote positive youth development in various PA environments and the associated benefits on both physical and mental domains. The first presentation will describe a conceptual framework of developmental circus arts and how participation in youth circus arts may foster physical, socio-emotional, and cognitive skills. The second presentation will share results from a 3-month intervention in physical education, which examined the effects of circus instruction on children's physical literacy. The third presentation will describe associations between youth circus participation, need satisfaction, affect, and other positive youth development outcomes among youth through a range of youth circus programs. The fourth presentation will provide qualitative phenomenological findings on youth circus training and the fifth presentation will describe case histories that illustrate the therapeutic impact of youth circus education in children with diverse special needs. Collectively, the symposium will elicit discussion on how circus could represent a new PA paradigm that addresses multiple outcomes simultaneously and can fit in school programs as an alternative to traditional physical activity.

#### **Supporting children's physical, socio-emotional and cognitive growth: A theoretical framework for developmental circus arts**

Davis, Jacqueline L., University of British Columbia

The objective of this presentation is to propose a theoretical framework for the study of circus-based physical activity as a vehicle for the health and well-being of individuals and of groups across diverse social contexts. The developmental circus arts (DCA) theoretical framework holds that participation in community-based, person-centered circus arts training concurrently addresses multiple aspects of human development. This presentation spotlights DCA pertaining to children and youth. The DCA framework hypothesizes that circus participation promotes (a) physical fitness and motor proficiency, (b) cognitive development, and (c) social and emotional learning. The physical skills that are particular to circus (e.g. juggling, acrobatics, balancing, aerials, clowning) serve as the bedrock from which (a), (b), and (c) arise. Learning these skills improves physical fitness (e.g., strength, flexibility) and motor proficiency (e.g., eye-hand coordination, balance) which in turn engenders confidence and self-efficacy. Acquiring skills and preparing performances necessarily tax, and thus strengthen, participants' cognitive capacities, particularly executive function (e.g., focused attention, working memory, and cognitive flexibility). Finally, through DCA processes participants gain social and emotional competencies such as self-awareness, self-management, social awareness, relationship skills, and responsible decision-making. The DCA framework asserts that these processes and their impact on the developmental aspects outlined here are essentially the same across contexts. Circus is currently used as an educational and/or therapeutic modality in physical education and afterschool contexts, with special needs populations, youth in challenging contexts (the homeless and incarcerated), and with patients and clients in hospitals and in out-patient occupational therapy. Empirical evidence supporting DCA theory is beginning to emerge suggesting that circus may belong among the traditional physical activity options (e.g., sports, dance) as a vehicle for positive youth development.

### **Bridging the gap between relatedness and physical activity through youth circus participation**

Vazou, Spyridoula, Iowa State University; Davis, Jacqueline L., University of British Columbia; Agans, Jennifer, Tufts University; Jarus, Tal, University of British Columbia

Based on self-determination theory (SDT), relatedness, autonomy, and competence are three basic psychological needs which, when met, contribute to healthy psychological development and, when hindered, can bring about ill-being. SDT is increasingly used as a valuable framework to understand people's enjoyment of and persistence at various physical activity (PA) settings; however, very little empirical research using the SDT framework exists in the emerging field of youth circus (YC). The purpose of this study was to examine whether YC participation satisfies the three psychological needs and how they relate to other indicators of positive youth development (PYD). One hundred eleven youth ages 10–21 ( $M = 15.77$ ;  $SD = 3.53$ ) responded to a cross-sectional survey administered through the American Youth Circus Organization. Participants' circus experience spanned from 6 months to 17 years across a range of youth circus programs (e.g., afterschool, summer camps, and clubs). The survey assessed circus participation patterns, psychological need satisfaction, intrinsic motivation, concentration, positive and negative affect, PYD, and grit. Results showed high scores on all three psychological needs. Hierarchical regression analyses, controlling for age and gender, showed that intrinsic motivation and positive affect were positively predicted by the needs for relatedness and competence, whereas negative affect was negatively predicted by the needs for relatedness and autonomy. For affect, relatedness was the strongest predictor. Our results show that young people in youth circus programs experienced high levels of relatedness that strongly predicted intrinsic motivation and affect. Considering the consistent absence of strong associations between relatedness and exercise behavior, the current findings contribute to our understanding of youths' sense of belonging in organized PAs and suggest that youth circus could be a means to fostering relatedness in PA contexts.

### **Youth circus training at the Fern Street Circus: Making the ordinary extraordinary and letting the extraordinary be ordinary**

Ott, Doyle; Sonoma State University

This study provides evidence for development of multiple intelligences through circus arts training. Employing a qualitative phenomenological methodology, participants in the Fern Street Circus program were interviewed over the course of several years to create a dense set of statements about the meaning of circus training. The transcribed data were then coded to establish types of responses that were given by all participants in the study. In analyzing the data of the study, a number of patterns emerged, all fitting well into the framework of development of the whole individual through addressing multiple intelligences as theorized by Howard Gardener and others. The "big tent" of the circus allows individuals with different strengths and affinities to find expression together in a place that allows them to utilize their strongest assets while addressing areas where they may need or desire development. The unifying physicality of circus training provides (often literal) grounding for the development of the individual. Due to this physicality, kinesthetic intelligence is often foregrounded in participants' responses, but almost always in conjunction with inter- and intrapersonal skill and artistic intelligence. This appeal to a particular blend of intelligences is unusual if not unique in sport and arts related activities and may help to explain some of the efficacy of circus training indicated in subsequent studies.

### **Case histories in youth circus education**

Montgomery, Jo; School of Acrobatics and New Circus Arts

Children with physical and/or cognitive disabilities suffer disproportionately from chronic health problems, leading to reduced physical activity and downward spirals to further decline in function. They also encounter barriers that limit their access to opportunities and resources for maintaining or improving their health and psychosocial development. Effective strategies need to be identified for improving the well-being of this population that include access to adaptable and prosocial physical activities. The use of circus arts interventions with special needs children has been increasing recently in special education, social work and occupational therapy. The purpose of this presentation is to illustrate the therapeutic impact of circus arts participation on children with diverse special needs. Individual cases are presented from the School of Acrobatics and New Circus Arts (SANCA) whose mission includes improving the mental and physical health of children of all ages and abilities. Working over several years in balancing, acrobatics, trapeze, and/or trampoline has been noted to improved strength, coordination, and self-confidence in children with spina bifida, hemiparesis (from a stroke at birth), and visual impairment. Children with autism spectrum disorder and social issues at school have responded positively to the creative, improvisational aspects of circus including clowning. From these accounts of individual cases, a broader picture emerges of circus as an adaptable therapeutic modality that can address multiple physical and psychological diagnoses.

### **Circus as a physical literacy approach in PE in grades 4 and 5**

Kriellaars, Dean, Kiez, Tia, Aubertin, Patrice; University of Manitoba

Social circus is an approach that uses circus instruction to aid in the healthy development of children at risk. Circus instruction is wholly consistent with physical literacy in the cognitive, physical, and social domains. The benefits of circus instruction to children in PE class have not been previously evaluated in an experimental trial. This study compared the impact of circus instruction in the physical literacy of children in grades 4 and 5. Three schools using circus in PE class (PECIRCUS) were compared to three control schools (PE) matched for socioeconomic level in Montreal, Canada. Physical literacy was assessed at baseline and after 3 months. The PLAY tools (Physical Literacy Assessment of Youth, [physicalliteracy.ca](http://physicalliteracy.ca)) were employed to obtain: 1) an assessment of physical literacy (motor competence, movement vocabulary, confidence and comprehension), 2) the child's self-report of physical literacy, 3) the teacher's surrogate assessment of the child, 4) the parental assessment of the child, and 5) an inventory of the child's activities. A total of 211 children aged 8 to 11 were assessed at each time period. Circus instruction was provided in PE class by instructors which were trained at the National Circus School (Montreal) or through the Cirque du Soleil, Cirque du Monde programs.

## **Developmental Perspectives**

### **Psychometric Data for the Test of Gross Motor Development–3rd Edition From a Transnational Cohort**

Organizer: E. Kipling Webster, University of Michigan

Discussant: Jacqueline D. Goodway, Ohio State University

#### **Test of Gross Motor Development – 3rd edition**

Ulrich, Dale A., University of Michigan

Burton & Miller (1998) proposed a taxonomy of movement skills consisting of six main components. One component that serves as the underlying foundation for the Test of Gross Motor Development-3 (TGMD-3, Ulrich, 2015) is fundamental motor skills (p. 58). The TGMD-3 is a popular fundamental motor skill assessment used throughout the world as a research tool to examine the movement patterns displayed by children between the ages of 3 and 10.9 years. The TGMD-3 is a norm-referenced assessment that is updated every 15 years to coincide with changes in the United States census data to ensure a representative sample is available for making valid decisions. An updated version of this popular assessment is currently underway, with several changes that were made in an effort to improve the quality of this test. This symposium will provide a detailed description of the changes that have been made in the third edition, along with a transnational effort to collect normative data from several countries to ensure more appropriate comparisons and analyses can be made. Specifically, this symposium will cover: 1) a summary of changes and clarifications to items to the third edition; as well as psychometric properties generated from cohorts in the 2) United States, 3) Brazil, and 4) Germany.

#### **Revisions for the third edition of the Test of Gross Motor Development**

Webster, E. Kipling, Webster, Elizabeth K.; University of Michigan

Objective: To discuss and clarify the changes and additions for the latest edition of the Test of Gross Motor Development–3rd edition (TGMD-3). Methods: Through feedback from researchers and teachers over the past 10 years, revisions were made from the TGMD–2nd edition to create the TGMD-3. Results: One of the primary changes for the TGMD-3 includes the addition of three new skills, which include the skip, one-hand strike, and underhand throw and the removal of the skills leap and underhand roll. Additionally, the subscale “object control” has been renamed “ball skills” to provide clarity for practitioners. There are several changes to the performance criteria to clarify scoring criteria and hopefully bolster improved understanding of the movement components that are being observed. Additionally, several performance criteria have been clarified in terms of the wording to reduce confusion. Also, all performance criteria that included a specific number of repetitions of a skill required to get credit for the performance criterion (e.g., Hop 3 consecutive times) were changed to 4 repetitions to maximize consistency across skills. A few performance criteria that have created frequent questions from researchers who use the test, will be demonstrated in an effort to improve the scoring and training of research staff. Conclusions: By integrating feedback compiled over 10 years, the TGMD-3 will be released in the fall of 2015, with several improvements that aim to promote clarity and functionality of this direct observation assessment tool and new national norms.

**Test of Gross Motor Development–3rd edition: Psychometric properties for a Brazilian cohort**

Valentini, Nadia C., Federal University of Rio Grande do Sul; Webster, E. Kipling, Ulrich, Dale A.; University of Michigan

Objective: To assess the psychometric properties (content, criteria, and construct validity and reliability) of the Test of Gross Motor Development–3rd edition (TGMD-3) in a cohort of children from Brazil. Methods: Translators, experts, physical educators, health professionals, and 235 children were included in this preliminary study ( $M_{\text{age}} = 7.51$  years, DP age = 2.02; 46% male). Thirteen fundamental motor skills were assessed using video cameras to further interrater reliability analysis. A subsample of this population ( $n = 20$ ;  $M_{\text{age}} = 7.45$  years) was retested within a 7- to 10-day interval to assess test–retest reliability. Results: Language clarity and pertinence of the TGMD-3 were confirmed. Test–retest ( $r$  values from 0.89 to .94) and inter- and intrarater reliability ( $r$  values from 0.90 to 0.96) were found. Internal consistency reliability, using Cronbach's alpha, indicated that the test might be used with confidence for the locomotor ( $\alpha = 0.70$ ) and ball skills ( $\alpha = 0.73$ ) subtests, as well as for the gross motor quotient ( $\alpha = 0.82$ ). Appropriate indices of the confirmatory factorial validity (RMSEA = 0 .06; CFI = 0 .83; TLI = 0 .78; NFI = 0 .07; GFI = 0.93; AGFI = 0.90) confirmed appropriate construct validity. Conclusion: The preliminary data suggested that the TGMD-3 is a valid and reliable instrument for assessing fundamental motor skills in Brazilian children.

**Psychometric properties for a United States cohort for the Test of Gross Motor Development–3rd edition**

Webster, E. Kipling, Pitchford, E. Andrew, Ulrich, Dale A.; University of Michigan

Objective: To assess the psychometric properties based on the item analysis portion of the Test of Gross Motor Development–3rd edition (TGMD-3) in a cohort of children from the United States. Methods: Thirteen fundamental motor skills were assessed via direct observation per test guidelines; 351 children were included in this analysis ( $M_{\text{age}} = 6.05$  years; 52.7% male). Internal consistency was assessed for reliability, whereas item difficulty and factor analysis were conducted to determine construct validity. A subsample of this population ( $n = 30$ ;  $M_{\text{age}} = 6.37$  years) was retested at least 1 week after the first administration ( $M = 13.2$  days) to assess test–retest reliability. Results: Internal consistency procedures indicated that the test was reliable and that results may be used with confidence for the locomotor ( $r = 0.92$ ) and ball skills ( $r = 0.95$ ) subscales, as well as for the gross motor quotient ( $r = 0.96$ ). Additionally, test–retest analyses found high intra-class correlations (ICC) for locomotor (ICC = 0.97), ball skills (ICC = 0.95), and total TGMD-3 (ICC = 0.97). Item difficulty was appropriate for each age group (ages 3–10) with a range from 0.17 to 0.85. Subscale and total TGMD-3 averages also had appropriate difficulty levels of 0.59 (locomotor), 0.55 (ball skills), and 0.57 (total). Factor analysis confirmed skill assignments to two subscales (locomotor and ball skills), with eigenvalues at 6.32 and 1.19, respectively, confirming appropriate construct validity. Conclusion: The psychometric properties from the item analysis portion of the TGMD-3 were similar to or better than previous editions, indicating the TGMD-3 is a reliable and appropriate measurement tool for assessing fundamental motor skills in young children. Unfortunately, with the current sample, girls continue to display inferior performance in ball skills compared to their male peers, which could place them at increased risk of reduced physical activity and increased risk for unhealthy growth.

**Reliability and validity of the Test of Gross Motor Development-3 (German version): Results**

Wagner, Matthias O., University of Konstanz; Webster, E. Kipling, Ulrich, Dale A.; University of Michigan

Objective: To assess the psychometric properties of the German version of the Test of Gross Motor Development 3 (TGMD-3). Methods: Performances of 117 typically developed children (58 boys; 18 kindergarten and 99 elementary school children;  $M_{\text{age}}$ : 7.99 years,  $SD = 1.98$  years) as well as 10 children with developmental coordination disorder (DCD; 8 boys;  $M_{\text{age}}$ : 7.88 years,  $SD = 1.57$  years) on 12 gross motor tasks were analyzed on the basis of the respective video recordings. Results: Results indicate an excellent 2-week test–retest ( $N = 69$ ; total: ICC = .983\*\*; locomotor skills: ICC = .941\*\*; ball skills: ICC = .977\*\*), interrater- (2 raters;  $N = 30$ ; total: ICC = .960\*\*; locomotor skills: ICC = .884\*\*; ball skills: ICC = .973\*\*) as well as intrarater- ( $N = 30$ ; total: ICC = .988\*\*; locomotor skills: ICC = .972\*\*; ball skills: ICC = .991\*\*) reliability. Internal consistency of the two subscales ( $N = 110$ ; locomotor skills: Cronbach's  $\alpha = .744$ ; ball skills: Cronbach's  $\alpha = .890$ ) ranges between acceptable and good. Confirmatory factor analysis provides evidence for the postulated two-factor model ( $N = 110$ ; CMIN = 54.83;  $df = 53$ ;  $p = .405$ ; CMIN/ $df = 1.04$ ; CFI = .997; RMSEA = .018; SRMR = .049). Substantial correlations between the TGMD-3 and the M-ABC 2 subscales ( $N = 110$ ) indicate the presence of convergent (TGMD-3 locomotor skills  $\times$  M-ABC 2 balance:  $r = .467$ \*\*); TGMD-3 ball skills  $\times$  M-ABC 2 aiming and catching:  $r = .436$ \*\*) or divergent (TGMD-3 locomotor skills  $\times$  M-ABC 2 aiming and catching:  $r = .334$ \*\*); TGMD-3 ball skills  $\times$  M-ABC 2 balance:  $r = .339$ \*\*) validity, respectively. Indications for concurrent validity can be found in the relationship between the TGMD-3 and the German youth games total score ( $N = 91$ ;  $r = .337$ \*\*) in elementary school. Performance differences between children with and without DCD (total:  $F = 3.72$ ;  $df = 1$ ;  $p = .035$ ; part.  $\eta^2 = .171$ ; locomotor skills:  $F = 4.52$ ;  $df = 1$ ;  $p = .024$ ; part.  $\eta^2 = .201$ ; ball skills:  $F = 2.50$ ;  $df = 1$ ;  $p = .066$ ; part.  $\eta^2 = .122$ ) support the clinical validity of the TGMD-3 in this subgroup. Conclusion: Our findings provide evidence for the reliability and validity of the German version of the TGMD-3.



## Saturday, June 6

### Sport and Exercise Psychology

#### Attentional Focus in Endurance Performance

Organizer: Linda Schücker, University of Münster

Discussant: Keith R. Lohse, Auburn University

##### Attentional focus in endurance performance: Overview

Schücker, Linda; University of Münster

A majority of studies in motor learning and motor control point to an advantage of an external focus of attention. These studies mainly concentrate on discrete motor tasks. However, dating back more than 35 years, there is another body of research that looks at attentional focus effects concentrating on endurance activities. Even though these fields of research use the same language (an internal vs. external focus of attention) the concept in endurance activities differs, notably it is more expansive and encompasses a range of different targets of attention (e.g., an internal focus encompassing all bodily processes and an external focus including any distraction from physical activity). Findings of attentional focus effects on endurance performance are inconsistent. Problems in this research area are the broad definition, the use of a range of different measures, and a lack of understanding of the underlying mechanisms of how attentional foci affect endurance performance. The overall goal of this symposium is to look at attentional focus effects in endurance activities from different theoretical and methodological perspectives. The symposium will begin with a brief overview of previous research (definitions, measures, and manipulations). The first presentation will look at the attentional focus concept in endurance activities from a metacognitive perspective based on semistructured interviews in elite runners. The second presentation is taking a mindfulness perspective of attentional focus and looks at its relationship with endurance performance. The third presentation examines the role of competitors in affecting focus of attention during cycling time trials. The final talk looks at attentional focus effects on the physiological parameter of movement economy in cycling, manipulating four different attentional foci. The discussant will then summarize and compare the different talks, giving his own perspective on the subject and leading the overall discussion.

##### Metacognitive processes in the self-regulation of performance in elite endurance runners

Brick, Noel, MacIntyre, Tadhg, Campbell, Mark; University of Limerick

Introduction: The study of attentional focus in endurance activity has operated on a largely atheoretical basis since its inception almost four decades ago. While subsequent research has progressed our understanding of how cognitive orientations impact endurance performance (e.g., Brick, MacIntyre, & Campbell, 2014, *International Review of Sport and Exercise Psychology*, 7, 106–134), the need for a comprehensive conceptual framework still exists. One framework that may address this concern is the metacognitive approach (e.g., Efklides, 2014, *Psychological Topics*, 23, 1–30). The present study sought to investigate the dynamics of attentional focus and cognitive control during endurance activity from a metacognitive perspective. The study also intended to examine the situational factors that may influence cognitive strategy use by elite endurance runners. Method: Semistructured qualitative interviews were utilized with 10 elite-level endurance runners to explore retrospectively their attentional focus and cognitive strategy use during endurance running. Each interview was digitally recorded and transcribed verbatim. The data was subsequently analyzed using a content analysis. Results: The findings revealed that metacognitive strategies such as planning, monitoring, reviewing and evaluating, and metacognitive experiences were fundamental to cognitive control and cognitive strategy use in elite endurance runners. The findings also added to the array of active self-regulatory strategies previously reported in the literature. Conclusions: These results suggest that metacognitive processes are central to effective cognitive control in elite endurance athletes during running. The findings allowed for the development of an integrative metacognitive framework, which incorporates dimensions of attentional focus. This model may better represent the processes that underpin cognitive control and determine cognitive strategy use in elite athletes during endurance running.

### **The effects of mindfulness on endurance**

Godwin, Maurice M., Auburn University; Rietschel, Jeremy C., Veteran's Health Administration; Dyke, Ford B., Auburn University; Rietschel, Carly H., University of Maryland; Jha, Amishi P., University of Miami; Miller, Matthew W., Auburn University

Endurance is crucial for performance on many physical tasks. It has been theorized that endurance on a task is related to one's ability to focus attention to the task, but investigations of this theory have yielded mixed results. This discrepancy may be due to an inadequate conceptualization of focused attention. It has recently been posited that "mindfulness" could encapsulate the concept of focused attention as it relates to endurance; this is because a core component of mindfulness is focusing attention to the present moment, which could involve maintaining focus on an endurance task currently being performed. Yet, the relationship between mindfulness and endurance has not been thoroughly investigated. Thus, the present study investigated this relationship. Specifically, the effects of brief mindfulness induction and dispositional mindfulness on an endurance task were examined. Participants were assigned to either a brief "guided" or "unguided" mindfulness induction treatment group, or to a control group. All participants sat in a room for 8 min. The guided group received instructions to focus attention to their breath and were reminded of the instructions every 40 s; the unguided group was given the same instructions but without reminders; and the control group was instructed to wait. The endurance task asked participants to exert a submaximal force on a handgrip dynamometer for as long as they could, and endurance was operationalized as the duration for which the force was maintained. Participants completed the task both before (pretest) and after (posttest) treatment. Finally, participants completed a questionnaire to assess dispositional mindfulness. Results revealed dispositional mindfulness was positively associated with endurance gain score (posttest – pretest score;  $p = .007$ ), and the guided mindfulness induction enhanced gain score exclusively for participants low in dispositional mindfulness ( $p = .007$ ). This suggests endurance performers can increase their mindfulness to enhance their ability to focus attention to their task, thus improving performance.

### **Competitor presence and exercise intensity mediate attentional processes during endurance exercise**

Williams, Emily; Jones, Hollie; Marchant, David; Sparks, Andy; Bridge, Craig; Midgley, Adrian; McNaughton, Lars; Edge Hill University

**Introduction:** Previous investigations have shown that a reduction in internal attentional focus inhibits the rise in perceived exertion during performance in the presence of competitors. Additionally, exercise intensity has been proposed as a mediator of attentional focus. What is currently unknown is whether the magnitude at which a competitor is performing is also a mediator of attention. This study investigated the influence of a competitor on attentional focus during cycling time trials (TT) and whether the magnitude of this performance was a mediator of attention. **Methods:** Ten trained cyclists performed four 16.1-km TTs in which during three they were instructed to mirror the pace of a visual avatar during the initial 4 km. Following a self-paced baseline TT (BL), cyclists mirrored a 95%, 100%, and 105% representation of their BL performance. The direction of attentional focus and ratings of perceived exertion (RPE) were measured every 4 km and additional measures of RPE were recorded every 1 km in the initial 4 km. Retrospective attention was assessed posttrial for each distance quartile. **Results:** During the initial 4 km, internal focus was significantly greater ( $p = 0.003$ ) and RPE was significantly lower ( $p = 0.03$ ) in BL than 100%. Posttrial internal attention and RPE were both higher in 105% than 95% ( $p < 0.001$ ). **Conclusion:** In cycling TTs performed at the same intensity (BL and 100%), the presence of a competitor lowers perceptions of exertion and reduces internal attention. This supports previous findings demonstrating that the presence of a competitor provides an external distraction. A faster competitor (105%) and accompanying increase in intensity, however, was insufficient to draw attention externally and failed to prevent a rise in perceived exertion. Both intensity and competitor presence mediate attentional focus during exercise, but the influence on these processes is affected by the magnitude of the competitor's performance and should therefore be considered for future applications.

### **Effects of attentional focus instructions on cycling economy**

Schücker, Linda; Fleddermann, Marie-Therese; de Lussanet, Marc; Elischer, Jannik; Böhmer, Christopher; Zentgraf, Karen; University of Münster

Inconsistent results and different terms (Brick et al., 2014) emphasize the controversial research on focus of attention in endurance sports. Schücker et al. (2009) showed higher movement economy for a distracting environmental focus of attention compared to two bodily-related foci in submaximal running. In this study, we transfer these findings to cycling where movement execution is more constrained. The aim is to investigate the effects of four different foci of attention on cycling economy at submaximal intensity. Twenty-five trained cyclists completed  $4 \times 6$ -min time trials at an individualized submaximal intensity on an ergometer under four attentional conditions. Attentional focus was manipulated via instructions before and during the condition and checked for compliance. The conditions were divided in (1) a task-irrelevant, but body-related condition (head position), (2) an environmental, task-irrelevant condition (video), in (3) a task-relevant condition (force production of quad muscles) and in (4) a second task-relevant condition, which is often used in cycling (smooth and circular step-cycle). Dependent measure for cycling economy was oxygen consumption assessed by spiroergometry. The main finding of a repeated measure ANOVA showed a significant effect of attentional focus on relative oxygen consumption,  $F(1, 23) = 6.22, p = .02, \eta^2 = .21$ . Post-hoc comparisons showed that oxygen consumption in condition (2, “video”) was significantly lower than in condition (4, “smooth and circular”). The results of the study show that a distracting, task-irrelevant focus of attention is beneficial for cycling economy at a submaximal intensity compared to the task-relevant condition “smooth and circular step-cycle.” No differences were found for other conditions. Better cycling economy is inferred from lower oxygen consumption at the same cycling intensity. Further studies are needed to evaluate why and whether the “step-cycle” focus is detrimental or the video focus is beneficial to performance.

## **Motor Learning and Control**

### **The Role of Attentional Focus and Motor Behavior**

Organizer: Louisa D. Raisbeck, Michigan Tech; Christopher K. Rhea, University of North Carolina at Greensboro

Discussant: Arya Alami, La Grange College

#### **The Role of Attentional Focus and Motor Behavior: Overview**

Raisbeck, Louisa D., Michigan Tech; Rhea, Christopher K., University of North Carolina, Greensboro

The effects of focus of attention on motor performance have been well documented. Evidence exists demonstrating performance differences between an internal focus of attention compared to an external focus of attention (Wulf, 2013). Wulf, Höß, and Prinz (1998) brought attentional focus to the forefront by explicitly defining internal and external focus and demonstrating the different effects on learning and performance. Much of the early work on the focus of attention investigated how various attentional components influenced motor performance and learning. These early studies established that an external focus of attention was more effective for performance and learning relative to an internal focus of attention. Since then, a number of studies have investigated the effectiveness of attentional focus across a variety of domains and skills using varying methods to manipulate instructions and feedback. Newer studies have delved further to determine how attentional focus affects movement accuracy and kinematics. More recently, the effects of the type of attentional focus instructions are of interest as we begin to develop a clearer understanding for a more permanent use for attentional focus. This symposium will explore how attentional focus is used to enhance motor behavior.

### The effects of attentional focus instruction on postural sway

Diekfuss, Jed A., Rhea, Christopher K., University of North Carolina, Greensboro; Fairbrother, Jeff, University of Tennessee, Knoxville; Raisbeck, Louisa D., University of North Carolina, Greensboro

The effects of focus of attention on motor performance have been well documented (Wulf, 2013). However, the majority of attentional focus research has been concentrated on the effects on instruction with a young, healthy population. The purpose of this study was to examine if similar effects are observed in older adults during a series of balance challenges. Young ( $n = 20$ ,  $23.0 \pm 3.7$  years) and older ( $n = 15$ ,  $60.9 \pm 13.8$  years) healthy adults completed 26 trials of quiet standing balance under eight conditions. Participants were instructed to stand on a hard (H) or foam (F) surface while focusing internally (IF) or externally (EF). Further, a curtain was placed approximately 1 m in front of the participants during half of trials to act as a postural stabilizer when being touched. In the IF condition, participants were instructed to keep either their feet (no curtain [NC]) or their feet and fingertips (curtain [C]) still. In the EF condition, participants were instructed to keep the floor (NC) or the floor and curtain (C) still. Center-of-pressure displacement (COPd) and velocity (COPv) in the anterior-posterior (AP) and medial-lateral (ML) directions were obtained through a force plate collected at 100 Hz. Older adults had significantly higher mean AP and ML COPv during F-EF-C compared to F-EF-NC ( $p = .005$ ,  $p = .001$ , respectively), and significantly higher ML COPd standard deviation during F-EF-C than F-EF-NC ( $p = .005$ ). Also, mean AP COPv was significantly higher during F-EF-C than during F-IF-NC ( $p = .002$ ). The overall effects of attentional focus were only present for young adults in the AP direction. Specifically, young adults had significantly greater COPd standard deviation in IF conditions compared to the EF conditions ( $p = .03$ ). These results suggest that young adults may be more sensitive to the effects of an internal focus of instruction, but older adults may be more sensitive to external foci of attention if there are multiple cues to attend. The data show that instructing older adults to focus on multiple external cues may be detrimental to their balance control.

### Clinical applications: Do the effects of attentional focus apply to prosthesis users with unilateral leg amputation?

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According to Wulf (2007), an internal focus of attention is defined as attending to one's body movements while performing a motor skill, whereas an external focus of attention consists of focusing on the effects of one's movement. Within the clinical population, persons with lower leg amputation lose somatic afferent neurons that provide exteroceptive and proprioceptive information to the central nervous system. From a functional standpoint, many patients use prostheses to meet the functional requirements once performed by their missing limb. While using a prosthesis, the contact and interaction between the prosthesis and residual limb creates both friction and pressure that elicit static and dynamic sensations for the user known as *extended physiological proprioception* (Doubler, 1984; Simpson, 1973, 1974). The purpose of this study was to investigate the effects of attentional focus cues on movement performance and production of the prosthesis in patients with unilateral leg amputation. Specifically, how does attentional focus strategy affect performance when patients are asked to increase their base of support in response to a perturbation while standing? It was hypothesized that the external focus condition would enhance both movement production and outcome measures. Patients with two levels of function were included in the study and were based on their need to use a walking device while ambulating. Using a within-participant design, participants were asked to stand and respond to a vibratory stimulus placed on their prosthesis by moving their prosthetic-side laterally to increase their base of support. Results revealed that the internal focus of attention demonstrated faster reaction times than external focus, whereas the external focus of attention demonstrated faster movement times than the internal condition. Response times for external focus were faster than internal focus. Results of the study will be discussed in terms of movement production quality and the constrained action hypothesis.

### **The effects of focus of attention on visual behavior and movement automatization**

Porter, Jared, Southern Illinois University, Carbondale; Makaruk, Hubert, Starzak, Marcin; Josef Pilsudski University of Physical Education

According to the constrained action hypothesis, an external focus of attention is beneficial for motor learning due to improvements in movement automaticity, whereas directing attention internally interferes with automatization. In addition to movement automatization effects, some researchers have suggested that the use of vision may play a critical role in how attention is allocated. Alternatively, others have suggested that perhaps the reason why an external focus of attention is so effective is because it directs the learner to look at more valuable cues for motor skill execution. There were multiple aims to the present study. First, we sought to investigate the performance and learning effects of changing focus of attention within a population practicing a well-learned rope-jumping skill. Second, using a dual-task paradigm we investigated how visual behavior changed as participants were instructed to focus their attention internally, externally, or neutrally (i.e., control condition). Third, we wanted to evaluate how the error, speed, and rhythmic performance of a complex continuous skill changed as a result of focusing attention compared to a control condition. To investigate these issues, we examined the effects of attentional focus on kinematics and visual control (i.e., length and number of fixations) during practice and post-testing. Highly skilled participants ( $N = 54$ ) practiced the rope-jumping task over 5 days of acquisition, which was followed by a delayed retention and transfer test. The findings indicated that the learning of the task was improved and participants in the external focus condition increased movement automaticity compared to participants in the internal focus and control conditions. In addition, the findings of this study indicated that visual attention as a function of attentional focus had a greater influence on motor performance rather than motor learning. Moreover, vision did not appear to be a mitigating factor in the focus of attention effect.

### **Retention and transfer of balance control following training with external and internal attentional focus cues.**

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Instructions directing participants to focus their attention externally are thought to facilitate motor performance (Wulf, 2013). Although evidence suggests that the benefit extends to balance control, little is known about the learning effects of such instructions. Establishing how attentional focus instructions affect balance during retention and transfer tests will shed light of effective approaches to readily applicable training interventions designed to improve clinical outcomes in populations at risk for falls. The purpose of the present study was to examine the effects of attentional focus instructions on the performance and learning of postural and suprapostural balance tasks (cf. McNevin & Wulf, 2002). Participants ( $N = 18$ ;  $M = 26.22 \pm 11.00$  years) in external focus (EF), internal focus (IF), and control (CTRL) conditions completed eight blocks of training to implement specific focus instructions during postural and suprapostural balance tasks. Participants wore an APDM inertial measurement unit positioned in the lumbar region. Acceleration signals were used to calculate distances, velocities, root mean square sway in the ML and AP directions and total sway area. Results indicated significant differences between conditions ( $p < .05$ ). The EF condition displayed higher values than the IF and CTRL conditions for AP velocity, AP Distance, and AP RMS Sway for the suprapostural task during both retention and transfer. These results indicated that instructions to direct attention externally during training on a suprapostural task alters balance performance during delayed assessments. Moreover, the higher values observed under the EF condition were not consistent with traditional notions of enhanced postural control. Nevertheless, the EF condition's performance may have reflected an exploration of a larger area within the base of support at a higher rate, which could potentially facilitate an adaptive response to perturbation.

## Developmental Perspectives

### Measuring Issues in Motor Assessments

Organizer: Till Utesch, Nadja Schott, and Maike Tietjens, University of Münster

Discussant: Dale A. Ulrich, University of Michigan

#### Measuring issues in motor assessments: Overview

Utesch, Till, University of Münster; Schott, Nadja, University of Stuttgart; Tietjens, Maike, University of Münster

Motor development plays an important role in children's overall health. Therefore, movement assessments are frequently used in motor development research, physical activity or physical education. Different aspects need to be considered in assessment selection, such as the need of process or product orientated testing. Therefore, it is important to clarify measuring issues concerning motor assessments. In general, conclusions can only be as valid as the theoretical assumptions that are proposed. This symposium integrates different studies from the field of motor development. The aim of the symposium is to unravel measurement issues concerning the latent traits in motor assessments and their stability over time. The four contributions bring together findings from research groups in Australia, Belgium, and Germany. This symposium will address significant questions in motor development across childhood. It will highlight benefits of movement assessments in the research field of motor development and give theoretical as well as practical perspectives. The first study examines the dimensionality of the latent concept of motor competence, which is indicated in motor assessments every time a composite score is built. Using a Rasch measurement approach, a wide variety of motor skills (MOT 4-6) is analyzed. The second presentation investigates comparability of motor competence between continents. Children from Australia and Belgium are studied using the KTK. In the third talk, the stability of motor abilities of children with a low motor competence is investigated with regard to their risk persistency in coordination problems, obesity, physical activity, and so on, using the Environmental Stress Hypothesis framework. The fourth study focuses on the longitudinal stability of motor skill development across childhood. Dale Ulrich will summarize the findings and highlight possibly for further studies.

#### Using Rasch measurement to investigate the construct of motor competence in preschool children

Utesch, Till, University of Münster; Bardid, Farid, Ghent University; Huyben, Floris, Vrije Universiteit Brussel; Strauss, Bernd, Tietjens, Maike, University of Münster; De Martelaer, Kristine, Vrije Universiteit Brussel; Seghers, Jan, University of Leuven–KU Leuven; Lenoir, Matthieu, Ghent University

**Introduction.** One of the most sensitive developmental periods is preschool age, when motor assessments help to describe motor development. The purpose of this study was to investigate the construct of motor competence, which is defined as the ability that underlies the performance of a wide variety of motor skills (Haga, Pedersen, & Sigmundsson, 2008). In motor tests, a composite score, built out of different motor skills (Burton & Rodgerson, 2001), often indicates this construct. **Methods.** Using the MOT 4-6 (Zimmer & Volkamer, 1987), data were collected in 1467 children (aged 3–6 years) in Flanders, Belgium. The MOT 4-6 is a frequently used test assessment in preschool and consists of 17 items (3-level categories). **Results.** Detailed analyses using the partial credit model and mixed Rasch model revealed a one-dimensional structure ( $CR = 1.964$ ,  $pCR = .06$ ;  $P-X^2 = -.227$ ,  $pP-X^2 = .24$ ). Due to unordered threshold parameters, five items were excluded. These items have the same scoring system counting zero, one or more successful trials, which deviates from the other items. The remaining items attain the requirements of objective measurement provided by Rasch measurement and therefore can be accumulated to one composite score. **Conclusion.** The study shows item and person homogeneity within a validated composite score for the MOT 4-6, using 12 instead of 17 MOT 4-6 items. Thus, it provides evidence in terms of a single latent construct (i.e., motor competence) that underlies the performance of motor skills in preschool children. Furthermore, it shows that some scoring systems are less suitable in motor competence assessment.

### Cross-cultural comparison of motor competence in children from Australia and Belgium

Bardid, Farid, Ghent University; Rudd, James, Victoria University; Lenoir, Matthieu, Ghent University; Polman, Remco, Victoria University; Barnett, Lisa, Deakin University

**Background.** Motor competence in childhood is an important determinant of PA and physical fitness in later life; however, childhood competence levels in many countries are lower than desired. Due to the many motor skill instruments in use, it is unclear how children's motor competence across countries can be compared. The purpose of this study was to evaluate the motor competence of children from Australia and Belgium using the Körperkoordinationstest für Kinder (KTK). **Methods.** The sample consisted of 244 (43.3% boys) Flemish children and 252 (50.0% boys) Australian children, aged 6 to 8 years (Australian  $7.6 \pm 0.7$  and Flemish  $7.3 \pm 0.9$ ). **Results.** ANOVAs revealed that Flemish children performed significantly better than Australian children on jumping sideways ( $p = 0.004$ ;  $\eta^2_p = .016$ ), moving sideways ( $p < 0.001$ ;  $\eta^2_p = 0.084$ ) and hopping for height ( $p < 0.001$ ;  $\eta^2_p = .022$ ) but not for balancing backwards ( $p = 0.221$ ;  $\eta^2_p = .003$ ). Moreover, a chi squared test revealed significant differences between the Flemish and Australian score distribution with 21.3% Flemish and 39.3% Australian children scoring "below average" ( $p < 0.001$ ; Cramér's  $V = 0.22$ ). **Conclusion.** The very low levels reported by Australian children may be the result of cultural differences in physical activity contexts such as physical education, active transport and organized sports.

### Elaboration of the environmental stress hypothesis: Results from a population-based 6-year follow-up

Wagner, Matthias, University of Konstanz; Jekauc, Darko, Humboldt University Berlin; Worth, Annette, University of Education Karlsruhe; Woll, Alexander, Karlsruhe Institute of Technology

**Objective.** The aim of this paper is the longitudinal elaboration of the environmental stress hypothesis (Cairney et al., 2013) on the basis of the MoMo study (Wagner et al., 2013). We assume that, in comparison to their typically developed peers, children with potential developmental coordination disorder (DCD) show a higher risk for persistent gross motor coordination problems (H1), overweight and obesity (H2), physical inactivity (H3), peer-relationship (H4) as well as internalizing (H5) problems in adolescents. **Methods.** MoMo (a) started with a population-based representative sample of 4,529 German children and adolescents aged between 4 and 17 years at baseline (2003–2006), (b) continued with a first follow-up (2009–2012) and (c) includes standardized motor tasks, a physical activity questionnaire, as well as various health-measures. We focus on children between 6 and 10 years at baseline ( $N = 1,674$ ;  $M_{age} = 8.26$ ,  $SD = 1.48$ ; 50.6% boys) who were reexamined between the ages of 12 and 16 years ( $N = 929$ ; response rate: 55.5%;  $M_{age} = 14.36$ ,  $SD = 1.45$ ; 49.0% boys). Children in the longitudinal sample diagnosed as having potential DCD at baseline ( $N = 111$ ; 49.5% boys) were identified on the basis of three common gross motor coordination tasks using the age- and gender-specific 15th percentile cutoff. Data were analyzed with binary logistic regressions including the stability of the respective dependent variable. **Results.** In comparison to their typically developed peers, children with potential DCD show a higher risk for (i) persistent gross motor coordination problems ( $OR = 7.66$ ,  $p < .01$ ), (ii) overweight and obesity ( $OR = 1.78$ ,  $p < .05$ ), (iii) physical inactivity ( $OR = 7.31$ ,  $p < .05$ ), (iv) peer-relationship ( $OR = 1.48$ ,  $p < .05$ ) as well as (v) internalizing ( $OR = 1.53$ ,  $p < .05$ ) problems in adolescents. **Conclusion.** Our results provide evidence for the developmental impact of childhood DCD. Subsequent analysis will be focused on the mediating and moderating role of personal and social resources using the data of two subsequent survey waves (2014–2016; 2018–2020).

### The relation between cognitive and motor skill performance: A latent variable approach

Holfelder, Benjamin; Schott, Nadja; University of Stuttgart

**Background.** It is well known, that for learning, planning and performing such complex motor skills (FMS) as throwing, catching, or kicking a ball, cognitive abilities like executive functions (EF) are required. The main objectives of this study are (1) the investigation of age- and gender-specific courses of development of qualitative and quantitative parameters of FMS and for EF as well as (2) testing the interrelations between and the predictive power of FMS and EF among each other. **Methods.** This 1-year longitudinal cohort study included 156 children (aged  $8.01 \pm 1.18$  years at baseline, 6 to 10 years). Motor skills were assessed using a performance- and process-based approach (throwing and kicking speed, number of successful catching trials; video-based component analysis). The EFs were tested computer-assisted with a Go/NoGo task and a Flanker task. **Results.** The results of the qualitative and quantitative parameters of the motor skills as well as the EF increase with class level, while boys outperform girls in all FMS (with only small differences for catching). Furthermore, subjects exhibit a significant improvement for both dimensions across the school year. The structural equation model shows a significant relationship between FMS and EF ( $r = -.58$ ,  $p < .001$ ) at t1. Both domains proved to be stable from t1 to t3, which is reflected by high correlations for FMS ( $r = .96$ ,  $p < .001$ ) and EF ( $r = .69$ ,  $p < .001$ ). Testing the predictive power of FMS and EF among each other, both paths are nonsignificant. Finally, the factor gender was included as a moderator, but the model comparison showed no significant differences ( $\Delta\chi^2 = 9.28$ ,  $df = 6$ ,  $p = .159$ ). **Conclusion.** The results did not confirm the suggested bidirectional relationship between FMS and EF. Although many questions are not clarified yet, the current state of knowledge and actual practical experiences—used to implement specific interventions in everyday school life and at sports clubs in an early stage of development—seems promising to promote the development of FMS and EF.

## Motor Learning and Control\*

### Planning of a manipulative action in children with coordination development disorder

Martins, Raquel de Melo; Papst, Josiane Medina; Camata, Thiago Viana; Costa, Marcelo Alves; Marques, Inara; Universidade Estadual de Londrina

*End-state comfort* (ESC) is a widely used paradigm in research on action planning and suggests that subjects select the most appropriate position of the hand to grasp an object in order to obtain the highest articular comfort at the end of the action. This effect is confirmed in most studies in adults; however, the results have been controversial in investigations of action planning in children with developmental coordination disorder (DCD). The objective was to investigate the action planning capacity of children with DCD and verify whether ESC is enhanced with practice. The study included 32 children with DCD (10 of 5-6 years, 17 of 7-8 years and 5 of 9-10 years old). The task consisted in grasping, transport and fitting of a wooden beam (25 cm long and 3 cm in diameter), placed horizontally on a black-colored wooden support (10 cm in height). The bar was colored red in one extremity and yellow in the other, and should be inserted into one of the targets positioned on each side of the support, with four bar insertion possibilities: yellow in yellow, yellow in red, red in red and red in yellow. The task was performed in a condition with lower attention precision (bar extremity and target were cylindrical) and a condition of higher attention precision (bar extremity and target were semicylindrical) 20 trials were randomly performed in each task condition, divided into 5 blocks, totaling 40 trials of practice. The data were analyzed using the percentage of ESC in each trial block, regardless of the task starting conditions (cylindrical or semi). Friedman's test and Wilcoxon's signed-rank post hoc test were used to compare the blocks of trials, followed by the Bonferroni correction ( $p < 0.001$ ). The results indicate differences between blocks ( $\chi^2(9) = 20.965, p < 0.01$ ), the post hoc found that participants improved from the first block ( $M = 37.50\%$  [25.00 to 50.00]) to the ninth block ( $Md = 62.50\%$  [50.00 to 75.00]) ( $z = 3.449, p = 0.001$ ). Thus, we found that children with DCD were able to improve their ESC, demonstrating that the children showed behavioral changes.

### An internal focus of attention impairs dynamic balance performance of children

Abdollahipour, Reza; Psotta, Rudolf; Palacky University in Olomouc; Wulf, Gabriele, University of Nevada, Las Vegas

Research has shown that concentrating on body movements (internal focus of attention) impairs motor performance or learning relative to concentrating on the intended movement effect (external focus). Yet, only a few studies have examined both movement outcome and movement quality (form) as a function of attentional focus. In the present study, we examined the effects of attentional focus instructions on both aspects of performance in children ( $M_{age}$ : 8.0 years,  $SD$ : .46; 16 girls, 8 boys), using a dynamic balance task. Participants were asked to walk as fast and accurately as possible across a foam balance beam that was placed on the ground (height: 2.5 cm). The walking distance, indicated by yellow start and finish lines on the beam, was 4 m. All participants performed 5 trials in each of 3 conditions that were presented in a counter-balanced order: Internal focus (IF) ("concentrate on your feet while walking"), external focus (EF) ("concentrate on the beam while walking"), and control (C) (no focus instructions) conditions. Movement time served as a measure of movement outcome. Movement quality was assessed by expert ratings. Scores were given based on the extent to which the feet touched the floor: Small error (.1), medium error (.3), large error (.5), or completely stepping off the beam (1). A composite score (movement time + error score) served as overall performance measure. Data were analyzed in a 3 (attentional focus)  $\times$  5 (trials) repeated-measures ANOVAs. Participants generally adhered to the external (78%) and internal (82.5%) focus instructions. Children walked faster in the C (3.15 s) than the EF (3.33 s) and IF (3.45 s) conditions. There were fewer performance errors in the EF (.018) relative to the IF (.141) and C (.178) conditions, which did not differ from each other. In terms of overall performance, there were no differences between C (3.34) and EF (3.33) conditions, but both were more effective than the IF condition (3.59). Thus, instruction directing attention to body movements (feet) was detrimental to dynamic balance performance in children. *Supported by the Internal Grant Foundation of the Palacky University in Olomouc [IGA-FTK-2015001]*

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\*The abstracts are alphabetically arranged by the first author's surname within each of the three sections—Motor Learning and Control, Developmental Perspectives: Motor Control/Coordination/Rehabilitation, and Sport and Exercise Psychology. A funding source, if provided, is given in italics at the end of an abstract.



### **Influence of internal versus external focus of attention on catching in children**

Abdollahipour, Reza; Psotta, Rudolf; Palacky University in Olomouc; Wulf, Gabriele; University of Nevada, Las Vegas; Agricola, Adrian; Valtr, Ludvik; Palacky University in Olomouc

The performance benefits of adopting an external relative to an internal focus of attention have been demonstrated for many different motor tasks. Yet, most studies have examined attentional focus effects for closed motor skills. Also, the majority of studies used adult participants. In the present study, children (mean age: 8.75 years, *SD*: .79; 15 girls, 9 boys) performed a catching task under different focus conditions. Participants were asked to stand behind a yellow line (5 × 100 cm), placed at a distance of 15 m from a tennis ball throwing machine (Lobster Elit Grand 4; Lobster Sports, Inc. USA) and to be prepared to catch the ball. In a within-participant design, participants performed 10 trials each under internal focus (“concentrate on your hands”), external focus (“concentrate on the ball”), or control (no focus instructions) conditions. The order of conditions was counterbalanced. Performances were scored as follows: 2 points were awarded for catching the ball with both hands; 1 point was given when the ball was touch with the hand(s) but not caught; and 0 points were given for a complete miss. Performance data were analyzed in a 3 (attentional focus) × 10 (trials) analysis of variance with repeated measurement on both factors ( $\alpha = .05$ ). Catching performance was more effective in the external (1.53) than internal focus (1.39) condition, while both were not significantly different from control conditions (1.49). There was no difference between control and external focus conditions. Questionnaire results revealed a relatively higher rate of adherence to the external (88.3%) and internal focus (81.6%) instructions. In the control condition, most participants focused on the ball (75%), fewer on their hands (16.6%), or on ball and hands (8.4%). Thus, when left to their own devices (control), most children adopted an external focus to perform this open skill. The results also highlight the negative consequences of instructions promoting an internal focus for motor performance in children. *Supported by the Internal Grant Foundation of the Palacky University in Olomouc [IGA-FTK-2015001]*

### **Stress-related increases in effort does not facilitate motor learning**

Aiken, Christopher A.; Van Gemmert, Arend W.A.; Louisiana State University

Stress has been shown to have positive and negative effects on motor performance (Van Gemmert & Van Galen, 1997). One perspective is that stress increases effort (Hockey, 1997) which as a result could benefit motor learning (Lee et al., 1994). The purpose of this experiment was to examine the effects of two stressor types (Cognitive and Physical) on motor skill learning. Forty-eight participants learned to draw a line from one target to another in exactly 2000 ms while avoiding two stationary barriers. Participants performed the task without (CTL) or with an additional physical (PS) or cognitive (CS) stressor. Participants in PS listened to white noise at 80 dB while participants in CS performed a secondary arithmetic task. Acquisition consisted of 60 trials, followed by 6 retention trials. Following retention, participants performed 6 trials with no additional stressor (transfer). The dependent variables (DVs) of interest were duration errors (i.e., deviation from the 2000 ms duration goal); absolute, constant, and variable error. In addition, we analyzed reaction time (RT), average and peak velocity (AV; PV), average and peak acceleration (AA; PA), and normalized jerk (NJ). Separate ANOVAs were applied to assess acquisition and retention effects on each DV. One-way ANOVAs were applied to each DV to measure transfer. ANOVAs revealed significant improvements from the first to last trial block and retention for all DVs ( $p < .05$ ) except RT ( $p > .05$ ). CS performed significantly worse than both PS and CTL for each DV ( $p < .05$ ) except PV and PA. During transfer, no significant differences were found ( $p > .05$ ). These results suggest that both cognitive and physical stress do not affect motor learning. However, performance, as shown by the results in acquisition and retention, is negatively affected by cognitive stress but not physical stress. In conclusion, the increase in effort from additional stress does not facilitate motor learning. *LSU Graduate School*

### **Effects of instruction on self-efficacy during self-controlled learning**

Aisner, Tyler; Mora, Erika G.; Becker, Andrea; Barros, Joao A.C.; California State University–Fullerton

Instructional language has been shown to impact self-efficacy during the acquisition of motor skills (Hooyma et al., 2014). It is possible then that the instructions provided to participants might be used to explain at least in part results observed in the self-controlled feedback literature. Unfortunately, the specific instructions provided to participants in these studies are rarely included in the description of methods (Sanli et al., 2013). Therefore, the goal of this study was to investigate the effects of different instructions on self-efficacy scores during the acquisition of a timing task. For that, 42 college-aged volunteers were assigned to either instruction condition: NEED ( $n = 21$ ) or WANT ( $n = 21$ ). Participants in the NEED condition were prompted to “ask for feedback whenever they need it” while participants in the WANT condition were prompted to “ask for feedback whenever they want it.” It was suggested that the word need implied the idea of obligation (Wilensky, 1978) thus being less autonomy-supportive. The task consisted of pressing five computer keys sequentially in exactly 1200 ms. Feedback comprised of sequence and constant errors. Participants completed 50 trials. At the end of practice participants were asked to rate from 0 to 10 how confident they were in their ability to get a perfect score if they had 50 additional trials. An independent sample *t*-test was used to compare self-efficacy scores between instruction conditions. The result did not reveal a significant difference ( $p = .278$ ). Additionally, repeated-measures block by instruction condition ANOVAs did not indicate instruction condition effects ( $p > .05$ ) or instruction condition by block interaction ( $p > .05$ ) for CE, AE, and VE. These findings do not match previous literature (Hooyma et al., 2014). It appears that instruction conditions alone were not enough to influence self-efficacy or performance of a motor skill.

### Do young and old adults exhibit different temporal control of gross and fine motor tasks? Evidence for dissociable timing mechanisms

Alphonsa, Sushma; Cummins, Daisha L.; Myers, Kodey; Skabelund, Zach T.; Studenka, Breanna E.; Utah State University

Previous studies have shown that individual timing variability is correlated across similarly controlled tasks. More specifically, discretely produced tasks exhibit individual difference correlations (Zelaznik & Rosenbaum, 2010). Similarly, tasks that are either discretely or smoothly produced show different timing behavior (Huys et al. 2010). The purpose of the current study was to understand if young and old individuals showed different timing behavior for discrete and smooth gross and fine motor tasks. In order to understand whether a specific type of movement had an effect on the type of timing, the timing variance of four different motor tasks was decomposed into clock and motor variance. Subjects in two groups: young and old, performed four types of movements (gross: walking and cycling, fine: tapping (unimanual and bimanual) and circle drawing) to a metronome for 10 s and then without a metronome for 20 s. Each block consisted of 10 trials with a total of 50 trials. Clock variance was higher for smooth movements (cycling and circle drawing) for the young group compared to the old. However, clock variance for the discrete movements (walking and tapping) was less variable in the young group compared to the old. The young group had less motor variance for smooth movements (cycling and circle drawing) compared to the old. However, the motor variance was greater in the discrete tasks (walking and tapping). Additionally, the variance was higher in the older group compared to the young. These results show opposite behavior of the clock and motor variances based on the type of task and age. Our findings show that, with age, motor variance for discrete movement increases. However, this effect is not seen for the temporal control of smooth movements from which we conclude that older individuals do not exhibit deficits in controlling smooth movements.

### Effects of feedforward video self-modeling on bilateral transfer of a rugby passing skill

Anderson, David I.; Keaney, Brian; San Francisco State University

The current study examined whether a video recording of a rugby player's dominant side passing could be used as a feedforward self-model to facilitate non-dominant side passing. Twenty-four collegiate male rugby union players passed a size 5 rugby ball for maximum velocity and separately for accuracy toward a target (a car tire: 0.65 m internal diameter, 0.20 m rim) suspended so that its center was 1.2 m above the ground at a distance of 5 m and 10 m from the player. Velocity was measured with a radar gun and accuracy was scored using a 4-point system. Players were videotaped during a pretest in which 5 passes were made with each side from 5 m, 10 m, and for maximum velocity, for a total of 30 trials. The best pass by the dominant side for each condition for each player was copied and spliced into a video clip that presented each pass in real time, slow motion, then real time again. For the Experimental group, the videos were flipped so that the dominant side pass appeared to be a non-dominant side pass. For the Control group, the clips were not modified. The clips were uploaded to YouTube and players were asked to watch them for 5 min on 5 separate days prior to returning a week later for a posttest. Players also rated their confidence in their ability to pass the ball through the targets prior to the pretest, immediately after the pretest, and immediately prior to the posttest. As expected, players were more accurate,  $F(1, 23) = 7.7, p < .05$ , more confident,  $F(1, 23) = 90.4, p < .05$ , and passed with greater velocity,  $F(1, 23) = 16.5, p < .05$  during the pretest with their dominant side. Contrary to expectations, the Experimental group did not show greater improvement from pretest to posttest than the Control group for passing accuracy, confidence, or velocity, as revealed by non-significant interactions between Group and Test, nor did the Experimental group show superior performance on the posttest. Further study is warranted to determine whether parameters can be modified to make this type of feedforward video self-modeling more effective.

### Acute exercise and visuomotor adaptation in children

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Physical exercise in children as a preventive and therapeutic tool has become the focus of recent research. Previous researchers suggest physical exercise prepares the brain to facilitate cognitive function and learning. Even acute bouts of exercise have also been proven to provide cognitive enhancement and motor-perceptual learning in adults. However, it is not known to what extent the benefit of acute physical exercise is applicable to motor-perceptual skill learning in children. Therefore, this research seeks (1) to examine the impact of an acute bout of intense endurance exercise (iEE) on motor-perceptual learning in children, and (2) to assess whether the length of exercise matters. Thirty-three children ( $8.9 \pm 0.7$  years) were randomly allocated into three groups: no exercise (CON,  $n = 11$ ), iEE Short (EX-S,  $n = 13$ ), and iEE Long (EX-L,  $n = 9$ ). All participants undertook five blocks of task practice: one block of trials without rotation to define baseline performance (BA); one adaptation block where the on-screen feedback of the joystick movement was rotated 60 degrees clockwise (AD); and three retention blocks with the same rotation at 1 hr (RT1), 24 hr (RT24), and 7 days (RT7) after adaptation. EX-S performed a 5-min iEE after the baseline block, while the length of the iEE was 13 min for EX-L group. Root mean square error (RMSE) was measured for each trial in all blocks. Data were analyzed using a 3 (Group)  $\times$  5 (Block) ANOVA with block as a within factor. Results showed a significant block effect with lower RMSE during the retention blocks, RT1, RT24 and RT7, compared to AD in all groups. In addition, a tendency to a significant group by block interaction was found suggesting lower RMSE in the retention blocks of the EX-L and EX-S groups compared to the CON group ( $F(8,120) = 2.03, p = 0.08, \eta^2_p = 0.12$ ). These results indicate that a relatively short bout of intense exercise prior to the adaptation phase enhances learning of a visuomotor transformation task in children. Furthermore, the duration of the intense exercise could be as short as five minutes.

**External focus distance and level of expertise in kayak sprinting**

Banks, Stephen; Higgins, Peter; Sproule, John; University of Edinburgh; Wulf, Gabriele, University of Nevada

Research has reliably demonstrated a benefit to motor performance or learning with an external focus of attention. The impact of focus distance on continuous skills, and the potential role of the performer's level of expertise, has not been evaluated. Two experiments investigated the impact of these factors on sprinting performance in kayaking on placid water. In both experiments a within-participant design was used, and a distal external focus ("Focus on the finish") was compared to a proximal external focus ("Focus on the boat") as well as to a control condition. Vision was controlled by providing a fixed point to observe during all trials. In Study 1 using a surf ski sprint of 75 m, experienced kayakers ( $n = 20$ ) were faster with the distal focus (29.75 s) compared with the proximal focus (32.37 s) or the control condition (30.95 s) ( $ps < .001$ ). Also, they were faster in the control condition than in the proximal focus condition ( $p = .003$ ). The effect size was large ( $\eta^2_p = .55$ ). In Study 2, youth racers ( $n = 16$ ) performed 100 m sprints in K1 kayaks. The control condition (28.96 s) was significantly faster than the proximal focus condition (29.83) ( $p = .028$ ); the effect size was large ( $\eta^2_p = .23$ ). There was no significant difference between the distal focus (29.03 s) and the other two conditions. Thus, the proximal focus on conjoined equipment (the boat) was non-optimal for either experienced (Study 1) or highly skilled kayakers (Study 2). Yet, the instructed distal focus on the finish improved the performance of experienced kayakers (Study 1), whereas the control condition without a prescribed focus was the best condition for the trained racers (Study 2). The findings suggest that the performance of experienced, but non-expert, performers can be enhanced by instructions promoting a distal external focus. In contrast, for expert kayakers the distal focus instruction was not helpful, as those performers may already have optimized their attentional focus.

**Forward thinking: When a distal focus makes you faster**

Banks, Stephen; Sproule, John; Higgins, Peter; University of Edinburgh; Wulf, Gabriele, University of Nevada

Research has consistently demonstrated a benefit to performance and learning of an external focus of attention. However, the impact of focus distance on open, continuous skills has not been investigated. Skilled river kayakers ( $n = 27$ ) were tested in a wild water racing sprint of 100 m on Class 2 water. Using a within-participants design a distal external focus ("Focus on the finish") was compared to a proximal external focus ("Focus on the paddle") as well as to a control condition. Vision was controlled by providing a fixed point to observe during all trials. The distal focus (30.63 s) significantly surpassed the proximal (32.07 s) and the control (31.96 s) conditions ( $ps < .001$ ). The effect size was large ( $\eta^2_p = .53$ ). There was no significant difference between the proximal and control condition ( $p > .05$ ). Interestingly, participants' judgments of their performance in each condition and their condition preferences did not correspond to their actual performance. The findings indicate that the distance of an external focus can have a significant influence on performance. Focusing proximally on conjoined equipment (the paddle) did not result in optimal performance. Also, performer-selected focal points (control condition) were non-optimal, despite performers' relatively high skill level. The instructed distal focus on the finish yielded the fastest racing times. The distal focus may have directed attention to a task-relevant point thus minimizing cognitive competition, distraction and attentional switching which might undermine skilled performance.

**Effects of self-controlled feedback on the acquisition of a balance task**

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Self-controlled feedback schedules have been shown to facilitate acquisition of motor skills compared to yoked feedback schedules (Wulf, 2007). This manipulation has informational and motivational effects on performance and learning (Wulf et al., 2010; Sanli et al., 2013). In this study, we aimed to provide further insight into the motivational effects of self-controlled feedback by minimizing the informational value of the feedback provided. Specifically, we investigated the effects of self-controlled feedback on the learning of a balance task where extrinsic feedback was largely redundant. For that, 30 college-aged volunteers were assigned to self-controlled feedback (SC) or yoked (YK) group. Participants had no experience in the experimental task or tasks perceived to improve balance (e.g., skateboarding). Groups were yoked in terms of sex and footedness. The task involved balancing for 30 s on a stabilometer (Lafayette Instruments). Acquisition consisted of 10 trials. SC participants were able to ask for feedback after each trial. YK participants received feedback according to their SC counterparts. Immediately after acquisition, participants rated their perceived self-efficacy and motivation. Retention consisted of two trials without feedback. Performance was analyzed via separate repeated measures group by trial ANOVAs for acquisition and retention. Independent  $t$ -tests were conducted for self-efficacy and motivation scores. The ANOVAs indicated an effect for trial ( $p = .00$ ) during acquisition and no significant effects ( $p > .05$ ) during retention.  $t$ -Tests did not reveal significant differences ( $p > .05$ ) between groups in terms of self-efficacy or motivation. In this case, self-controlled feedback did not enhance the acquisition of a motor skill, self-efficacy or motivation scores. Since feedback here was largely redundant, it is possible that self-control benefits come mainly from the information provided to the learner rather than the perception of control as argued by Hartman (2007).

### The influence of cognitive load and sensory cues on visual attention in freezers

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Freezing of gait (FOG) is an abrupt interruption to gait, which often occurs in narrow spaces (sensory demand) or while performing dual-tasks (attentional demand). While it is well known that visual cues can alleviate FOG, it is not clear if this is through a sensorimotor or attention-driven mechanism. By investigating gaze behaviour, this study aimed to determine: (i) whether freezers (Fs) and non-freezers (NFs) look to narrow spaces differently, (ii) how a dual-task influences this behaviour and (iii) how visual cues influence where Fs and NFs look. Fs ( $n = 14$ ) and NFs ( $n = 17$ ) walked towards a narrow doorway in two conditions: 1) No Dual-Task (-DT) and 2) Dual-Task (+DT) with (+VC) or without visual cues (-VC). Percentage of total fixation duration (PTFD) was measured on pathway, doorway and through doorway. In -DT-VC, Fs displayed greater PTFD on the pathway ( $p = 0.044$ ) and less PTFD on the doorway ( $p = 0.0087$ ) than NFs ( $p = 0.021$ ). +DT-VC produced a change (compared to -DT-VC) in the NFs only; resulting in increased PTFD on the pathway ( $p < 0.02$ ) and decreased PTFD on the doorway ( $p < 0.034$ ; i.e., NFs performed similar to Fs). When visual cues were present (-DT+VC), both groups behaved similarly. Although with a dual-task (+DT+VC), Fs PTFD toward the pathway decreased ( $p < 0.003$ ) and toward the doorway increased ( $p = 0.023$ ) compared to -DT+VC. In contrast, NFs PTFD toward the pathway increased ( $p = 0.0017$ ). Since Fs sampled the pathway more and doorway less than NFs in -DT-VC, Fs may be attempting to decrease their view of the perceived upcoming threat of the doorway, thereby decreasing the demand on processing resources. In support of this, since NFs displayed similar gaze behavior with dual-task, greater demand may place similar limitations on processing resources. When visual cues were present, behavior was similar between groups (i.e., when processing demands were not increased). However, the dual-task influenced Fs to look to the relevant threat. One explanation may be that the visual cues reduced processing demands to allow sampling of the threatening doorway.

### The effects of setting proximal and distal goals on motor learning

Becker, Kevin A.; Texas Woman's University; Fairbrother, Jeff T., Sollenberger, Lacey P., University of Tennessee; Fisher, Kevin M., Central Michigan University

Recent research has highlighted the importance of considering the role of psychosocial variables in motor learning (e.g., Wulf, Chiviacowsky, & Lewthwaite, 2010). One such variable that has received little attention in motor learning literature is goal setting. Although goal setting has received much research attention (see Locke & Latham, 1990), few studies have tested the direct effects of goal setting on motor learning. Related research found that setting proximal goals led to higher productivity in a toy making task compared to distal goals (Latham & Sejts, 1999), but it is yet to be determined if this benefit would generalize to the learning of a novel motor skill. The purpose of the present study was to examine the effects of proximal and distal goals on the learning and performance of a novel motor task. Participants ( $N = 24$ ) were randomly assigned to either a proximal goal group (PG) or a distal goal group (DG) and then learned to balance on a stabilometer. Acquisition consisted of 15 trials, each lasting 20 s. The PG group set a goal for every 5 trials while the DG group set one goal for the entire practice phase. All participants returned 24 hr later for a five-trial retention test. In addition, participants' self-efficacy was measured prior to the start of acquisition, twice during acquisition, and once before the start of retention. Results showed that the PG group had lower root mean square error scores than the DG group during both acquisition ( $p = .048$ ) and retention ( $p = .012$ ). There were no group differences in self-efficacy scores ( $p$ 's  $> .05$ ). These findings indicated that setting proximal goals facilitated both immediate performance and longer-term learning. Although the effect was likely due to psychosocial influences, no direct evidence was found for a link to self-efficacy. Additional research is needed to determine if proximal goals operate through psychological factors such as motivation or perhaps prompt different practice strategies.

### The role of corrective and confirmatory KP in learning a novel motor task

Becker, Kevin A., Texas Woman's University; Fairbrother, Jeff T., Bass, Andy D., University of Tennessee

Augmented feedback has long been recognized as one of the most valuable types of instructional assistance in motor learning (Salmoni, Schmidt, & Walter, 1984). Traditionally, feedback has been presented in a corrective mode, designed to help learners recognize errors and guide them to a correct performance. Recent research showing a learning benefit of feedback after "good" as opposed to "bad" trials suggests that feedback confirming successful movements may also facilitate learning (Chiviacowsky & Wulf, 2007). The purpose of this study was to compare the effects of knowledge of performance (KP) that confirmed correct components of the movement to those of KP that corrected errors in the movement. Participants ( $N = 24$ ) assigned to either corrective KP (COR) or confirmatory KP (CNF) conditions learned a soccer throw-in task with the goal of demonstrating correct form. Acquisition consisted of 20 trials and was followed by 24-hr retention and transfer tests. Following each trial in acquisition, participants received feedback about either their most critical error (COR) or the most critical form component performed correctly (CNF). No feedback was provided in retention and transfer. Results showed that the COR group scored higher on form than the CNF group during acquisition ( $p = .003$ ), retention ( $p = .023$ ), and transfer phases ( $p = .001$ ). The COR group also had higher self-efficacy scores than the CNF group prior to the retention and transfer phases ( $p = .043$ ). The results suggested that for learning a complex motor skill, feedback that identifies and corrects errors is superior to feedback that confirms successful movement components. This finding provided support for the traditional view of feedback, and is not consistent with the learning benefit found by Chiviacowsky and Wulf (2007).

**Motor-evoked potentials in the lower back, using TMS, correlate with visually perceived lifted weight**

Behrendt, Frank; de Lussanet, Marc; University of Münster; Zschorlich, Volker; University of Rostock

Background: The visual perception of human movements activates a complex cortical network that involves visual processing regions as well as motor and somatosensory representations in the brain. Facilitation of the primary motor cortex (M1) during the mere observation of an action was found to be highly congruent with the observed action itself. Changes in the corticospinal excitability are specific for the muscles involved in the observed movement and revealed a temporal coding between execution and observation of the same action. It has been shown that the muscle-specific facilitation of the observer's motor system reflects the degree of muscular force exerted in an observed hand action. Here we investigated whether the cortical representation area in M1 that control specific back muscles are also facilitated due to the observation of a lifting movement. Methods: Fourteen healthy subjects (24.5 years; 3 females) were tested using transcranial magnetic stimulation to measure the corticospinal excitability in the back area. The subjects observed the lifting of boxes of different weights (3.25 kg, 12.5 kg, and 22.25 kg) from the ground depicted by point-light biological motion. Results: The repeated-measures ANOVA on the  $z$ -scores of the MEPs data revealed that the main effect (weight of the boxes) was statistically significant. Bonferroni post hoc analysis on the  $z$ -scores also showed that MEP responses were significantly higher for observing the lifting of the lightest box as compared with observing the heavier boxes being. Conclusion: In accordance to earlier results regarding hand action, the present study indicates a modulation of corticospinal excitability concerning the musculature of the lower back during the observation of lifting actions that mainly involve the according muscles—despite the relatively small M1 representation.

**Fitts's law behavior when producing rapid aiming movements with delayed visual feedback**

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Fitts's law, one of the most robust descriptions of movement behavior, states that movement time to a target is determined by the logarithmic ratio of distance ( $D$ ) and target width ( $W$ ). According to Meyer et al. (1988), a Fitts task is comprised of an initial ballistic movement towards the target center, occasionally followed by a corrective submovement, based upon visual feedback. When visual feedback is delayed, Fitts's law is observed, but movement time increases linearly with the amount of delay (Hoffman, 1992). Interestingly, the delayed nature of the movement feedback does not appear to interfere with the corrective closed-loop submovement. In this study, we further examine Fitts's law behavior with delayed visual feedback. Fifty-one college-aged students performed a series of discrete Fitts-like aiming movements using a 6-*df* Geomagic Touch haptic device to control a dot on a computer screen. A time-delay was introduced between device movement and dot movement. Three groups of participants performed the task at 0, 100, or 200 ms of visual delay for 60 trials at each index of difficulty (3.0, 4.5, and 6.0). These initial 180 trials were considered the training portion. After the training portion, participants in each group performed the same task at each ID with the three visual delays randomly changed between consecutive movements. There was a significant difference between movement times for the training condition and the randomized condition at 0 and 100 ms delays; movement time did not differ at 200 ms. We suggest that individual are adapting different ballistic strategies used based on the knowledge of the upcoming delay. When the delay was unknown, but constant (training condition), participants adapted a strategy that allowed Fitts's law to hold true similar to that reported by Hoffmann (1992). When the delay was both unknown and randomly changing with each trial, a strategy is adapted that allows participants to compensate for unknown delays; however, there was no longer a linear increase in movement time with time-delay. *NSF*

**Plyometric catch training causes redistribution of neuromotor effort from compensatory to anticipatory control in catching**

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Catching relies on anticipatory and compensatory neuromotor control. Load uncertainty increases anticipatory and compensatory muscle activity in the catching of weighted balls. We studied the effect of load uncertainty in plyometric catch training on the redistribution of neuromotor effort between anticipatory and compensatory control in catching. We hypothesized that load uncertainty training would cause a shift in the relative distribution of effort from compensatory to anticipatory control in catching. The experiment involved 3 groups of men ( $M_{\text{age}} = 21$ ), A) load knowledge training ( $n = 14$ ), B) load uncertainty training ( $n = 13$ ), and C) control ( $n = 14$ ). Training involved 3 sessions/wk for 6 weeks using 4 single-arm plyometric catching exercises with 1- to 9-lb. balls. Sets involved 16 reps of 4 ball weights (30, 53, 78, and 100% of participant's max.) presented randomly. Group A had knowledge of ball weight, whereas Group B did not (balls were visually identical). Pre/posttests involved recording EMG integrals in 6 muscles (anterior deltoid, biceps, triceps, wrist flexors, and bilateral lumbar erector spinae) during a 64-trial ball-catching task, and computing changes in the proportion of anticipatory (0.6 s prior to catch) and compensatory (0.6 s after catch) neuromotor effort. Percent change in the proportion of anticipatory neuromotor effort was analyzed using one-way ANOVAs. On average, Groups A and B increased anticipatory effort in catching, whereas the control did not,  $F(2,38) = 3.24$ ,  $p = .011$ . The biceps, triceps, wrist flexors, and lumbar erector spinae non-catching side muscles showed this same pattern of results. Although Groups A and B did not differ significantly, there was a trend of load knowledge training producing greater redistribution of effort from compensatory to anticipatory control. Deltoid and lumbar erector spinae catching side muscles were unaffected. In summary, plyometric catch training caused a shift in neuromotor effort from compensatory to anticipatory control. Contrary to our hypothesis, load uncertainty training did not amplify the redistribution. *Miami University*

### **Preparation of bimanual reaching movements: Contributions from directions and amplitudes**

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Bimanual reaching movements with asymmetric directions or asymmetric amplitudes have longer reaction times than their symmetric counterparts. The interaction between asymmetric directions and amplitudes, however, has not been fully explored. We predicted that asymmetric directions would have larger costs than asymmetric amplitudes due to simultaneous activation of non-homologous muscles by opposite arms in the former. Two experiments tested bimanual reaching movements on a button box with five rows and two columns of buttons. The middle row was the home position for the left and right hands, and the other buttons were potential targets. Participants were instructed to make bimanual reaching movements as quickly and as accurately as possible. In Experiment 1, the simultaneous illumination of two targets served as the go signal. There were significant costs for asymmetric directions and asymmetric amplitudes, and the cost for asymmetric directions was significantly larger than the cost for asymmetric amplitudes. The costs for asymmetric directions and amplitudes were also compared in Experiment 2. On each trial, four targets were precued (two on each side). There were different types of precues that could, for example, precue directions or amplitudes. This experiment was a bimanual version of Rosenbaum (1980) and Goodman and Kelso (1980). If asymmetric directions have larger costs than asymmetric amplitudes (Exp. 1), then precuing directions should reduce reaction times more than precuing amplitudes. Precuing directions produced significantly shorter reaction times than precuing amplitudes. Therefore, both experiments suggested that directions have a larger contribution than amplitudes to the preparation of bimanual reaching movements. We are currently investigating whether attentional factors affected the results in Experiment 2. *NSERC*

### **Optimizing high ID performance: The role of the tracking template**

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A recent experiment by Boyle, Kennedy, and Shea (2012) demonstrated that practice tracking a template created from a sine wave results in enhanced performance and transfer on a difficult (ID = 6) Fitts task. To further these findings, an experiment was conducted to determine if a template constructed from recorded ID = 6 Fitts kinematics would provide the same benefit. To create the templates, a master-yoked pairing design was utilized. Participants were assigned to one of four groups (Fitts-Master, Fitts-Yoked, Sine-Master, and Sine-Yoked). Following 44 acquisition trials in the Fitts-Master (reciprocal motion between targets at ID = 6) or Sine-Master conditions (reciprocal motion tracking a sine wave), respective visual templates were constructed for the Fitts-Yoked and Sine-Yoked conditions. The templates were generated from the unique displacement data of the Fitts and Sine Master participants on each trial. These custom 44 trials made up the visual training template for the Fitts and Sine-Yoked participants. Following all acquisition trials, all participants were asked to perform 9 test trials under their respective acquisition conditions (Test 1) and 9 test trials under normal Fitts task conditions (Test 2). Results indicated faster movement times in the sine wave training group on Test 2 compared to both Fitts groups (Master and Yoked), with no differences seen between Sine conditions (Master or Yoked) pairings on any test or kinematic variable. No differences were detected between Fitts-Master & Fitts-Yoked pairings on any measure except significantly lower dwell time in the Fitts-Yoked group on Test 2. These results indicate that the presentation of a tracking template can promote changes in kinematic variables, in this case lower dwell times in the Fitts-Yoked pairing on Test 2. However, the conclusions formed from this experiment points to the need to have the template guide the movement in a way that promotes an equal acceleration/deceleration profile paired with smooth target reversal. *Texas A&M University College of Education & Human Development, Sydney & JL Huffines Institute for Sports Medicine and Human Performance*

### **The role of cognitive effort and error processing in the contextual interference effect during perceptual-cognitive skills training**

Broadbent, David P., Liverpool John Moores University; Williams, A. Mark, Brunel University; Causer, Joe, Ford, Paul R., Liverpool John Moores University

The contextual interference (CI) effect shows that motor skills practiced in a random order leads to superior learning compared to a blocked order. This is explained by greater cognitive effort due to task switching occurring during random practice, although greater cognitive effort due to error processing may provide an additional explanation. Furthermore, CI has rarely been investigated for perceptual-cognitive skills, such as anticipation. We examined the CI effect for anticipation in tennis in conjunction with theoretical explanations related to cognitive effort. In two experiments, novice participants anticipated three different tennis skills shown as life-sized video in either a random or blocked order. Anticipation performance was recorded during a pretest, three practice sessions, retention test, and a transfer test to a different practice order. In Experiment 1, cognitive effort was examined using a secondary choice reaction time task, involving responses to tones, separately in the preparation and feedback phase of a trial. In Experiment 2, two additional practice order groups had the Stroop test inserted during the inter-trial interval to increase cognitive effort. The CI effect was found in both experiments as the blocked groups made more accurate anticipation judgments during practice, whereas the random groups were superior on the transfer test. Cognitive effort during practice was greater in the random compared to blocked practice group in Experiment 1. In Experiment 2, the additional cognitive effort between trials promoted learning for the blocked practice group, but reduced it for the random group. Following errors, the random practice groups exhibited greater cognitive effort in the preparation phase (Experiment 1) and inter-trial interval (Experiment 2) compared to correct trials, whereas there was no difference for blocked groups between correct and error trials. Cognitive effort is not only associated with more task switching during random compared to blocked practice, but also with greater error processing, leading to the CI effect.

**Bimanual coordination dynamics under social pressure**

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The current study examined the impact of social performance pressure on the coordination dynamics of bimanual in-phase (IP) and anti-phase (AP) coordination. In-phase and anti-phase bimanual coordination patterns are characterized by a high degree of stability and automaticity. The primary hypothesis was that social pressure would produce self-regulation of these patterns in the form of frequency and amplitude modulations. This was observed. The issue was whether or not this self-regulation would improve or degrade performance. Improvement would emerge in the form of increased stability of coordination and reduced error, whereas degradation would emerge in the form of decreased stability and increased error. There were four groups: 1) IP pressure; 2) IP no-pressure; 3) AP pressure; and 4) AP non-pressure. Three blocks of five trials were performed by each group. During the first block, all groups were informed that performance was good. During the second block, no information on performance quality was provided. At the end of the 2nd block, those in the pressure conditions were informed their performance was not good, and that a panel of experts would watch them perform the 3rd trial block. After each trial in the 3rd block, a panel member informed the experimenter to tell the participant to improve performance. Those in the non-pressure conditions were told their performance was good at the end of the 2nd block. A panel did not watch the non-pressure groups during the 3rd block. The 2nd and 3rd blocks were the same bimanual pattern (IP or AP) within a group. Overall, IP was more stable than AP in all four groups and absolute error was smaller when producing IP compared to AP. Performance stability improved from block 2 to block 3 in the pressure groups. The no pressure groups were characterized by a small increase in variability from block 2 to 3. The AP pressure group also showed a decrease in error between blocks 2 and 3. Contrary to some research, the current findings show that pressure does not degrade very stable/automated motor skills.

**Examining sensory recalibration during blind-walking using a continuous pointing task**

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The congruent information typically experienced through visual and proprioceptive inputs during sighted-walking consequently allows for accurate representations of distance traveled during blind-walking (e.g., Philbeck et al. 2008). However, the extent of visual-proprioceptive congruence can be altered by prolonged exposure to sensory conflict (e.g., changing the visual gain during walking). This results in blind-walking extents that are undershot following exposure to high visual gains (HVG) and overshot following exposure to low visual gains (LVG; Rieser et al., 1995). This type of sensory recalibration has generally been examined using discrete measures of end point error. Recently however, Campos et al. (2009) introduced a continuous pointing task that uses arm azimuth angle (i.e., limb rotation about the vertical body axis) to calculate perceived distance traveled and perceived self-velocity during entire sighted- and blind-walking trajectories under congruent sensory conditions. The purpose of the current study is to extend what is known about the dynamic changes that occur during sensory-motor recalibration during walking by adopting this novel continuous pointing measure. Thus, participants in the current study performed the continuous pointing task during 4 m of blindfolded walking before and after 10-min sensory adaptation periods. Participants walked on a treadmill at a rate of 1.2 m/s while being presented with a virtual hallway through which they moved visually at a rate either congruent or incongruent with the speed of the treadmill. In the incongruent conditions, the visuals either moved at a speed of  $0.5\times$  (LVG) or  $2\times$  (HVG) the treadmill (i.e., proprioceptive) speed. As predicted, during post-adaptation responses, the perceived distances of the walked responses in the LVG condition were greater than those experienced in the HVG condition. Given that perceived self-location and self-velocity was captured during the entire walking extent, these data will also be discussed in the context of the online error correction mechanisms regulating human movement.

**Eliminating the learning benefits of self-controlled knowledge of results (KR) schedules: The importance of information-processing activities during the KR-delay interval**

Carter, Michael J.; Head, Anna; Puvendran, Piragas; Ste-Marie, Diane M.; University of Ottawa

Several studies have shown that self-controlled knowledge of results (KR) schedules optimize motor learning compared to yoked KR schedules. This optimization has been attributed to error estimation processes occurring during the KR-delay interval which allows the learner to request KR only when a comparison between perceived and actual error would maximize the informational value of the KR received. The present experiment tested this assumption using an attention-demanding interpolated activity during the KR-delay interval. Participants practiced a waveform tracing task in either a Self-controlled, Self-controlled-Interpolated, Yoked, or Yoked-Interpolated group. Testing occurred on two consecutive days with performance accuracy in movement timing and amplitude measured across both days. Day one consisted of 60 practice trials (6 blocks of 10 trials) with the relative frequency of KR restricted to 30% per block to avoid any potential learning differences between groups resulting from discrepancies in the amount of KR received during practice. Learning was assessed on day two using delayed no-KR retention and transfer tests (1 block of 10 trials each). Retention and transfer data showed typical learning advantages for the Self-controlled group relative to their Yoked counterparts. With the interpolated activity however, these learning benefits were eliminated as the Self-controlled-Interpolated group did not outperform the Yoked-Interpolated group. Importantly, the Self-controlled group was significantly more accurate than the Self-controlled-Interpolated group and no significant differences were found between the two yoked groups. These combined results suggest that the interpolated activity interfered with information-processing activities specific to self-controlled KR schedules that occur during the KR-delay interval. Such findings add to the growing evidence that highlights informational factors associated with the KR decision as an important explanatory mechanism for the optimization of motor skill retention and transfer from self-controlled KR schedules. *Natural Sciences and Engineering Research Council of Canada*

### **Sensory motor rhythm/theta ratio differences between good and poor putting performance in skilled golfers**

Chang, Yi-Ting; Wang, Kuo-Pin; Cheng, Tai-Ting; National Taiwan Normal University; Huang, Chung-Ju, University of Taipei; Hung, Tsung-Min, National Taiwan Normal University

Ability to sustain attention is very important in precision sports. Previous studies have investigated the psychophysiological processes, EEG power variation in particular, during the pre-shot period. Sensory motor rhythm (SMR) is an EEG component that has been related to the automaticity process of attention. Furthermore, SMR/theta ratio has been used to investigate attentional performance. Research has shown that a greater SMR/theta ratio represents a decrease in somatosensory and motor interference in basal ganglia/thalamocortical circuits, indicating better attention maintenance in children with attention deficit-hyperactivity disorder and microsurgical skills. However, studies of SMR/theta ratio in the context of precision sport performance that also heavily demands sustained attention, are limited. Therefore, this study aims to investigate SMR/theta ratio between best and worst putting performance in skilled golfers. Methods: 33 skilled golfers were recruited in this study. The participants were requested to perform 40 putts and were informed of their individual putting accuracy while EEG was recorded. The 2 s of EEG segment prior to putting for good and poor putts were selected to derive a SMR/theta ratio. A 2 (good vs. poor performance)  $\times$  2 (T1 vs. T2) ANOVA with repeated measures on both factors was employed. Results: A significant performance by time interaction was observed. Follow-up simple main effect analysis revealed that a higher SMR/theta ratio was observed on both T1 and T2 for the good than for the poor performance. Moreover, SMR/theta ratio of the good performance demonstrated a significant decrease from T1 to T2 whereas SMR/theta ratio of the poor performance remained unchanged. Discussion: This study found that better golf putting performance was preceded by higher SMR/theta ratios. Higher SMR/theta ratio has been an indication of inhibition of afferent and task irrelevant input prior to skill execution. Successful inhibition results in better performance.

### **Effect of self-regulated and progressively increasing difficulty practice schedules on whole body motor skill learning**

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The use of self-control has been suggested as the better way to organize the schedules of practice because the learners could regulate the criticality of skill acquisition in the process of learning. To investigate this theoretical assumption, the presented study examined the effect of self-regulated and progressive increase in difficulty on learning a whole body motor skill. The task was to ride a bike with power crane on the roller training plate. The difficulty of the task was manipulated by changing the gear and goal speed in various combinations from the easiest to the most difficult. Twenty-four male college students were recruited and divided randomly into self-regulated difficulty (SRD) or progressive increase difficulty (PID) group. After pretest, the participants practiced ten blocks (one per day) of riding within each 30 trials. The posttest and delay posttest were implemented at the end of practice and a week after practice session. The results showed that although the PID group got the higher difficulty level than the SRD group during practice, no difference in the post and delay posttest was found. In general, the SRD had significant higher successful rate (SR) than the PID group. For daily practice, the SR for SRD group was around 50% while that for PID was decreased as the task difficulty increased. No transition of performance was found during the process of learning implicated that the new parameter was scaling along task difficulty changed instead of new movement coordination been formed. In conclusion, the effect of self-regulated and progressive increase in difficulty practice schedules was similar for learning the cycling skill in this study. However, the former had higher successful rate, which might be positive of motivation and confidence for learners to challenge further difficulty.

### **Examining the locus of offline enhancement for pre-structured motor sequences**

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Motor sequence and skill learning can be enhanced with a period of sleep rather than wake. This offline benefit is associated with the formation of motor chunks. Wright et al. (2010) offered data congruent with this claim but suggested other features of motor sequences benefit from sleep. Recent work using an unstructured discrete sequence production task (Abrahamse et al., 2013) provided some support for this proposal but this assessment was hampered by difficulties ascertaining how learners segmented the unstructured motor sequences making it impossible to determine the specific benefit from consolidation. To solve this problem the present study used a pre-structured sequence created by using a temporal pause during the presentation of certain sequence stimuli during presentation (Abrahamse et al., 2013). This approach has been shown to be effective in dictating how learners segment motor sequences. For example, in a six-element sequence, used in the present work, placing a random duration pause prior to the presentation of the stimulus for 4th element of the sequence, forces the task to be treated as one with two three element parts or chunks. When tasks are segmented this way, it has been argued that there are three independent contributions to motor sequence production. Namely, (a) sequence initiation, (b) concatenation of the motor chunks, and (c) execution of the chunks. The present work required individuals to learn a motor sequence that consisted of either three 2-element chunks (2-2-2) or two 3-element chunks (3-3). Using the 2-2-2 and 3-3 versions of the six-element sequences allowed a change in the relative involvement of the three components of a motor sequence described earlier. Following training individuals were then tested either immediately (IMM) or 12 hr later (12H). The 12-hr interval included overnight sleep. The 12H condition exhibited offline enhancement as expected but gain was not restricted to just concatenation of motor chunks. These data will be discussed with respect to the memory benefits from consolidation.



**The motivational role of feedback in motor learning: Information resulting in low success experience degrades learning**

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Recent findings have provided converging evidence for the motivational role of feedback in the learning process. For example, feedback highlighting successful performance (e.g., Chiviawosky & Wulf, 2002, 2007) or suggesting better-than-average performance (e.g., Wulf, Chiviawosky, & Cardozo, 2014) has been found to increase learners' perceptions of competence or self-efficacy, and enhance learning. In the present study we asked whether thwarting learners' need to feel competent by setting a relatively high criterion for "good" performance, thereby reducing their experience of success, would degrade learning. Participants practiced a coincident-anticipation timing task and received error feedback after every other trial (50%) during the practice phase. One group (low success or LS) was informed before the beginning of practice that an error of 4 ms or less would be considered a good trial, whereas another group (high success or HS) was told that an error of 30 ms or less would be considered good performance. A third (control) group was not given a performance criterion. During practice, participants in the LS and HS groups experienced good performance (i.e., were within their criterion range) on 6.3% and 57.8% of the feedback trials, respectively. On retention and transfer (non-dominant hand) tests without feedback one day after practice, absolute errors of the HS and control groups were significantly lower than those of the LS group. Participants in the HS group reported higher levels of self-efficacy than LS and control group participants. The results demonstrate that reducing learners' opportunities to experience success during practice degraded learning. Thus, the present findings add to the mounting evidence that, in addition to providing error information, feedback can have an important motivational function that impacts learning.

**The effect of driving speeds and practice conditions on the movement performance of the table tennis forehand drives**

Chuang, Kuo-Liang, Liu, Yeou-The; National Taiwan Normal University

The table tennis forehand drive is a fast interceptive action that plays an important role of attacking-to-score in table tennis games. For table tennis training, although the rally drill of the forehand drive is closer to the game situation, coaches also use a multi-ball drill where a number of balls are fed to the player consecutively to practice forehand drives. For an effective scoring forehand drive, the speed of the driving movement becomes the most important factor. However, increasing the movement speed will result in an increase of movement variability. According to the movement speed-accuracy relationship in space-time (Hancock & Newell, 1985), increasing the movement speed by increasing the movement amplitude may be the best strategy for maximizing movement accuracy. Therefore, the purpose of the study was to examine the movement performance of the table tennis forehand drive using different movement speeds in different practice conditions. Eight male collegiate division B table tennis players participated in this study. Two high-speed cameras (200 fps) and the Known 3D motion digitizing system were used to capture the ball/racket kinematic data. All participants performed the forehand drives with two driving speeds under the rally drill and the multi-ball drill conditions; 30 strokes were analyzed in each speed/condition. The results showed that the movement amplitude of the multi-ball condition was significantly longer than that of the rally condition, and the MT of the high-speed condition was significantly shorter than that of the normal-speed condition; the landing locations of the high-speed strokes were less accurate than those of the normal-speed strokes. All movement times of the forehand drives were under 200 ms, and the movement times of the high-speed strokes were even under 100 ms. The performance accuracy may be improved if the increase of driving speed can be achieved by increasing the movement amplitude instead of decreasing the MT. The results of the study provide practical implications to table tennis training programs.

**The impact of state anxiety on the use of contextual information during anticipation: A test of attentional control theory**

Cocks, Adam J.; Jackson, Robin C.; Bishop, Daniel T.; Williams, A. Mark; Brunel University London

The assumptions of attentional control theory (Eysenck et al., 2007) were studied by testing the impact of state anxiety on anticipation during a dynamic, time-constrained task. Moreover, we examined the involvement of high- and low-level cognitive processes in anticipation and how their importance may interact with anxiety. Skilled ( $n = 12$ ) and less-skilled ( $n = 12$ ) tennis players anticipated opponents' shots under low- and high-anxiety conditions. Three different video stimuli were shown, each presenting various degrees of contextual information (postural cues only, shot sequencing and court positioning with no postural cues, and postural cues, shot sequencing and court positioning all presented). A four choice response of ball bounce location was required following the point of video occlusion at ball-racquet contact. Response accuracy was used as a measure of performance effectiveness, whereas response accuracy divided by the corresponding mental effort rating was used as a processing efficiency quotient. Skilled players recorded higher response accuracy and at a reduced cost to processing efficiency than their less-skilled counterparts. Processing efficiency significantly decreased under high- when compared to low-anxiety, although no difference in performance effectiveness emerged. When analyzing the directional errors made, anxiety was most detrimental to performance in the condition conveying only contextual information, suggesting that anxiety may have a greater impact on high-level (top-down) rather than lower-level (bottom-up) cognitive processes, potentially due to a shift in attentional control. Our findings provide partial support for attentional control theory, with anxiety eliciting greater decrements in processing efficiency than performance effectiveness due to predominance of the stimulus-driven attentional system.

### **Internal focus cue specificity: Are the benefits of an external focus a function of a misdirected internal focus?**

Coker, Cheryl A.; Plymouth State University

Porter et al. (2010) and Wu et al. (2012) demonstrated superior standing long jump (SLJ) performance when participants directed their attention externally instead of to their leg action (internally). Through kinematic analysis, Ducharme et al. (2012) attributed this finding to the more optimal projection angle achieved as a result of adopting an external focus. Given that Wen-Lan et al. (2003) identified “the selection of optimum takeoff angle and technical use of the arms [as] two of the most important methods that promote the jumping performance” (p. 186), the question remains whether changing the nature of the internal focus cue to direct performer’s attention on the arm action of the jump would elicit a projection angle and outcome similar to that of the external focus. Using a counterbalanced, within participant design, 21 volunteers performed two SLJs for maximum displacement in each of four experimental conditions. In the Control condition, no attentional focusing cues were provided. The Leg condition instructions directed participants to focus on extending their knees as rapidly as possible while the Arm condition prompted participants to focus on swinging their arms forward as rapidly as possible. Finally, in the External condition, participants were to focus on jumping as close as possible to a cone placed 3 m directly in front of them. While significantly farther jumps were recorded when an arm focus was adopted vs. attending to the action of the legs, findings were also consistent with the literature in that instructions that induced an external versus internal focus of attention were superior. Interestingly, the takeoff angle data did not follow suit. A significant difference in takeoff angle was found between the Arm (40.7 degrees) and Leg (42.7 degrees) conditions but no significant differences were observed in projection angle for the external and internal focus conditions. These results further demonstrate that subtle changes in verbal cues can affect skill performance and raises additional questions about mechanisms underlying focus of attention strategies. *PSU RAC*

### **Hysteresis and motor planning in children with autism spectrum disorder**

Cummins, Daisha L.; Myers, Kodey; Studenka, Breanna E.; Utah State University

Studies have found that children with autism spectrum disorder (ASD) have a rigidity of motor plans and difficulties planning and executing movements (Eigsti et al., 2013). Children with ASD also exhibit repetitive behaviors such as nail biting and rocking back and forth. When planning for movements, repetitive behaviors might manifest as difficulty in formulating new or switching between different motor plans. In typically developing individuals, sequential actions often exhibit hysteresis, which is a phenomenon that explains that the way an individual chooses a specific motor plan could be influenced by recent, similar motor actions. We sought to determine if hysteresis was stronger in children with ASD and if this was influencing the planning and execution of a motor task. A rotation motor task was created to evaluate the rigidity of motor planning capabilities and hysteresis of five children with ASD (7–9 years old). A control group, consisting of 5 age-matched participants was also tested. The participant sat across from the researcher. A stick was placed in different orientations around a circle grid system containing 24 positions. The researcher would move the stick counterclockwise or clockwise in these positions, reveal the position to the participant, and ask them to return it to the home position in front of them. Researchers measured the position at which the child switched grasps (e.g., from a thumb up to a thumb down grasp) in both the clockwise and counterclockwise direction. While moving the stick clockwise, the peak switch (the switch where children adopted a comfortable grasp) occurred much later for children with ASD. These children also switched their grasp positions less frequently than the control group. The results of this study suggest that changing a grasp was more costly than being comfortable while performing the action, and that hysteresis was more prevalent in children with ASD than in the control group.

### **Looking to learn: Visual guidance accelerates observational learning of the full golf swing**

D’Innocenzo, Giorgia; Bishop, Daniel; Gonzalez, Claudia C.; Williams, A. Mark; Brunel University London

Researchers have shown that experts exhibit more efficient gaze behaviors than their less-skilled counterparts. This finding is consistent with the information-reduction hypothesis, which proposes that people learn through experience to select and process information that is task-relevant, and to ignore redundant information. Accordingly, the question arises as to whether guiding novices to focus on task-relevant regions, as per the gaze patterns of experts, might result in improvements in performance. Recently, several researchers have employed perceptual training comprising visual guidance based on experts’ gaze in an attempt to improve novices’ anticipation and decision making with mixed success. Considering the inherent idiosyncrasy of individuals’ eye movements, to achieve the same end a generic training strategy may be preferable to such methods. We test this latter hypothesis with regard to observational learning of the golf swing. Golf novices ( $N = 21$ ) took part in one of three conditions: viewing a video of a skilled golfer performing 10 swings, (FV group); viewing the same video with visual guidance, (i.e., translucent dots superimposed on key anatomical areas, VG group); or viewing a video about the history of golf (Control group). It was predicted that, after the intervention, the VG group would show greater overt visual attention to task-relevant regions, enhanced pattern recognition for the golf swing, and improved swing kinematics relative to the FV group. Our findings revealed that, postintervention, VG participants spent more time looking at the cued areas even when the guides had been removed, indicating that these guides were successful in directing attention. There were no differences in pattern recognition between groups. Preliminary analysis of the kinematic data revealed that after the intervention, contrary to the FV and control groups, the VG group showed significant improvements in several kinematic measures. Thus, visual guidance may prove to be an efficient method for accelerating observational learning of novel complex motor skills. *Brunel University London*

### Effect of precision demand on the end-state comfort of children with developmental coordination disorder

De Melo Martins, Raquel; Papst, Josiane Medina; Costa, Marcelo Alves; Camata, Thiago Viana; Marques, Inara; Universidade Estadual de Londrina

The precision hypothesis predicts that an action is preplanned when subjected to the condition where there is an increase in the precision of the task. Thus, it is expected that children with DCD plan their actions using the end-state comfort more often when the task requires greater precision. The aim was to compare the frequency of end-state comfort between the conditions of lower and higher demand of precision. Thirty-two children with DCD (10 of 5-6 years, 17 of 7-8 years, and 5 of 9-10 years old). The task consisted in grasping, transporting and fitting of a wooden beam (25 cm long and 3 cm in diameter), placed horizontally on a black-colored wooden support (10 cm in height). The bar was colored red in one extremity and yellow in the other, and should be inserted into one of the targets positioned on each side of the support, with four bar insertion possibilities: yellow in yellow, yellow in red, red in red and red in yellow. The task was performed in a condition with lower attention demand (bar extremity and target were cylindrical) and a condition of higher attention demand (bar extremity and target were semi-cylindrical) 20 trials were randomly performed in each task condition, divided into five blocks, totaling 40 trials of practice. Friedman's test was used to compare the percentage of end-state comfort in each task condition, and Wilcoxon's signed-rank test was used to compare the conditions of lower and higher precision demand. The results show that children had higher end-state comfort frequency (Md = 55.00% [40.00–75.00]) compared to end-state discomfort (Md = 20.00% [10.00–38.75]) on the cylindrical condition ( $z = 4.124, p < 0.01$ ), as well as finished their actions more comfortably (Md = 60.00% [41.25–75.00]) than uncomfortably (Md = 15, 00% [5.00–33.75]) on the semi-cylindrical condition ( $z = 4.478, p < 0.01$ ). These results confirmed the end-state comfort effect in children with DCD, considering the higher frequency of comfort achieved in both precision demands of the task. Thus, these children planned this manipulative action. *Capes*

### Focus of attention and cue quantity: A simulated shooting experiment

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Evidence exists showing performance benefits of using an external focus of attention (FOA) compared to an internal FOA for both performance and learning (see Wulf, 2013). The literature, however, is unclear whether the quantity of FOA cues (CQ) has an effect on the motor learning process. Furthermore, little research has examined participants' subjective perceptions of cognitive workload and its relationship with performance and learning. To examine this, participants ( $n = 35$ ) completed a simulated handgun shooting task; FOA and CQ were manipulated during handgun instruction. For the internal FOA conditions (IF), participants were told to focus on aspects of movement (e.g., hand, arm, wrist); whereas the external FOA conditions (EXF) were told to focus on the effects of one's movement (e.g., gun, gun barrel, gun stock). To manipulate CQ, participants received FOA instruction guided toward one aspect of movement/effect of movement or three aspects of movement/effect of movement. Shooting performance was assessed at baseline, acquisition and at two separate retention phases (immediate, delayed) that included transfer tests. Participants completed the NASA Task Load Index (TLX) to assess subjective perceptions of cognitive workload following all trials. Performance results indicated that, regardless of FOA instruction, participants who received one cue performed significantly better during acquisition, immediate retention, immediate transfer, delayed retention, and delayed transfer than those receiving three cues (all  $ps < .05$ ). Results from the TLX demonstrated a significant negative relationship between perceived cognitive workload and shooting performance during immediate retention,  $r(35) = -.33, p = .05$ . The current study demonstrates the importance of CQ when providing instructions. To most effectively learn a novel motor task, learners should be instructed to focus on one cue. Subsequently, this study establishes the importance of utilizing a psychometric tool of cognitive workload when assessing performance and learning.

### Loading the head reduces head-pitch attenuation of center of mass oscillations during walking and running gait in soldiers

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Soldiers are required to locomote various distances while carrying substantial loads on their head and torso. During gait, the center of mass (COM) vertically oscillates, and in order to keep one's eyes on a target to achieve the required visual acuity, these rhythmic oscillations must be attenuated at other joints or segments of the body. While head vertical motion is coupled to COM motion, changes in head pitch can mitigate the deleterious effects of these oscillations. The purpose of this study was to determine the effects of head load on dynamic visual acuity and coordinative dynamics during gait. Twelve male Army ROTC cadets volunteered for the project. Participants walked and ran on a large (1.8 m × 2.5 m) treadmill while holding a mock rifle with a 4-button keypad attached on the thumb side of the trigger hand. A monitor was positioned at eye level 2 m away and presented Landolt C optotype images in one of four orientations and ranged in size from 20-10 to 20-35. Participants were instructed to respond to each optotype orientation as quickly and accurately as possible by depressing the corresponding button on the keypad. Participants experienced four head manipulations: unloaded, 1.7 kg helmet only, helmet with .68 kg night vision goggles (NVGs), and helmet with NVGs and .68 kg counterweight at the posterior helmet. Visual acuity performance was assessed by the percentage of correct responses and timing of responses. Cross-correlation analysis was performed between the head pitch angle and the COM vertical position. Manipulating head load did not lead to differences in visual task performance ( $p > .05$ ). A main effect of load was observed for the zero-lag correlation ( $p = .005$ ), whereby the unloaded condition had significantly greater mean negative correlations (−.43) compared to the other three conditions (−.12, −.03, −.03, respectively). These findings suggest that loading the head reduces its ability to attenuate COM motion, possibly requiring other components of the system, such as the trunk or eyes, to compensate in order to maintain performance. *Army Natick Soldier Research Development and Engineering Center (NSRDEC)/Naval Health Research Center (NHRC) W911QY-12-C-0006*

### **Spatiotemporal coupling of periodic finger tapping with saccades, and their correlation to reading comprehension**

Duncan, Laura J.; Richardson, Brian A.; Lyons, James L.; Kuperman, Victor; McMaster University

Reading-disabled children often present with deficits in motor coordination (Wolff et al., 1990). More recent studies with non-reading impaired university students also revealed correlations between motor proficiency and reading ability (Ally, 2013). In this latter case, the variance of the unimanual inter-response interval (varIRI) in finger tapping correlated to reading ability. The importance of oculomotor control in reading warrants consideration that a common sensorimotor basis might exist for explaining the apparent association between reading and motor actions. This study aimed to further explore this idea by examining eye and hand movements in an oculomanual task as measured by a battery of tests. Standardized reading measures included the Grey Oral Reading Test, fourth edition, Author and Magazine Recognition, Orthographic Segmentation, and Test of Word Reading Efficiency, second edition. The oculomanual task replicated the eye-hand spatial magnet effect revealed by Richardson et al. (2013), wherein series of reciprocal horizontal saccades paired with unimanual finger tapping (750 ms intervals) cause the finger trajectory to deviate in the direction of the paired saccade. Considering the correlation of tapping varIRI to reading ability, and the spatial interference between saccades and finger tapping, we hypothesized that the magnitude of eye-hand spatial interference would also correlate to reading ability. Although we replicated the eye-hand spatial entrainment effect, the data did not reveal a correlation between tapping varIRI and reading ability. However, our results revealed a significant correlation between tapping varIRI and the magnitude of eye-hand spatial interference. Together these results suggest that oculomanual interference also manifests temporally, thus modulating the variability structure of response timing such that it becomes uncorrelated to reading ability. Future studies should question whether this is a function of saccading in synchrony with tapping, or broader generalization of coordinated response

### **Dopaminergic interactions between anxiety and processing of the environment in PD**

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Recent research has suggested that anxiety influences gait in PD, with an identified dopa-sensitive gait response in highly anxious PD. Sensory-perceptual deficits have been suggested to underlie gait impairments in PD; thus, it may be that in threatening situations anxiety acts like a dual task limiting one's ability to process information about the environment. The current study aimed to (i) evaluate whether anxiety influences information (visual) processing in PD while walking in threatening situations, and (ii) examine whether dopaminergic medication modulates anxiety's influence on information processing. Forty-eight participants (24 HC; 12 Low Anxious [LA-PD], 12 Highly Anxious [HA-PD]) were asked to walk across a plank in virtual reality that was either located: on the ground (LOW) or above a deep pit (HIGH). The plank varied in size from 60 to 100 cm, and after participants crossed the plank they were asked to judge the width of the plank they had just walked across. Both ON and OFF medication states were evaluated in PD, and judgment error as well as self-reported anxiety levels were measured. Overall PD had similar judgment error as HC. However, when examining the PD groups across both medication states, a condition  $\times$  plank size interaction was found for constant error ( $p = 0.011$ ), revealing that all PD participants judged the narrowest plank more accurately when walking across the HIGH plank (compared to LOW). The opposite was observed when PD participants walked across the widest plank; that is, participants overestimated the plank size after they had walked across the HIGH plank (compared to the LOW). Finally, medication state did not influence judgment error. In conclusion, the current study did not find evidence that dopamine modulates the influence of anxiety on processing aspects of the environment, nor was there evidence to suggest that anxiety interferes with accurate perception of the plank size in PD. Instead, the current findings suggest that anxiety enhances threat-relevant processing when walking in extremely threatening situations.

### **Motor contagion in single-limb stance by means of biological and non-biological point light displays**

Eils, Eric; Richter, Sascha; Kuhlmann, Hendrik; de Lussanet, Marc; Zentgraf, Karen; University of Münster

Introduction: Human beings are proficient in separating biological and nonbiological stimuli when decoding movement. Biological stimuli have been shown to take precedence, which may interfere with executed movements (Kilner et al., 2003). This study has two aims, first to investigate the replicability of this interference effect (Tia et al., 2011), and second to elucidate the modulating role of stimulus size. Methods: Two studies with 28 and 26 subjects were performed. Subjects stood in single-limb stance and observed different point-light-display conditions (PLD): a person in single-limb stance (biomotion), moving dots without biological information (non-bio) and a static control stimulus (stance). Body sway was captured by means of a force plate (100 Hz). Total sway distance of the center of pressure was used for evaluation. Size of the PLD-stimulus was approx. 50° or 3° viewing angle in study 1 and 2, respectively. A one-way repeated-measures ANOVA was used for statistical analysis. Results: The results from Tia et al. (2011; PLD-stimulus approx. 50° viewing angle) could not be replicated in study 1. Significant differences were found between conditions,  $F(2,54) = 16.10$ ,  $p < 0.001$ ,  $\eta^2 = 0.37$ , but between biomotion and stance and not between biomotion and non-bio. In study 2, significant differences,  $F(2,50) = 4.48$ ,  $p = 0.016$ ,  $\eta^2 = 0.15$ , between stance and biomotion as well as between non-bio and biomotion were found. Discussion: No motor contagion effect was found for 50° viewing angle (i.e., no increased sway in bio-motion compared to non-bio), but for 3° viewing angle. Results may be explained by differences in eye movements (e.g., occurrence of saccades) between conditions. Stimuli stay within the fovea centralis during the 3° viewing angle but are outside at the 50° viewing angle. Thus, saccades may occur within the later condition and may modulate the motor contagion effect. This issue will be addressed in further studies. References: Kilner, J.M. et al. (2003), *Current Biology*, 13(6), 522–525. Tia, B. et al. (2011), *PlosOne* 6(3):e17799.

### Interpersonal coordination in a “leader-follower” relationship during balance tasks on a balance board

Eils, Eric; Sieverding, Leonie; Bischoff, Matthias; de Lussanet, Marc; Zentgraf, Karen; University of Münster

Introduction: Joint action tasks require temporal and spatial coordination between performing partners (Sebanz et al., 2006). This study focuses on a precision task on a balance board in a “leader-follower” relationship to elucidate how both partners coordinate their movements and how visual restriction of one partner modulates the interaction. Methods: Participants (10 unisex pairs) stood pairwise on a circular plate (diameter 1.5 m) that was pivoted on a spherical joint allowing 2D-movement. The joint task was to guide a ball through a labyrinth to a goal (iPad) by jointly shifting their weight on the balance board. One subject of the pair was assigned as “leader” (“L”) and one as “follower” (“F”). In condition 1–“free”, both partners could see the labyrinth. In condition 2–“no screen (ns)”, vision to the labyrinth was obstructed for “F.” In 3–“no partner (np),” view between partners was restricted (wall). Testing order was counterbalanced. Movement of the partners was captured by using a reflective marker on the spine (C7). Three parameters were derived for analysis: time needed to complete the task, pathway of C7 (PC7), and cross-correlation between “L” and “F” (repeated-measures ANOVA, post hoc: Bonferroni–Holm). Results: Significant differences in completion time were found between conditions,  $F(2,18) = 13.05$ ,  $p < 0.001$ ,  $\eta^2 = 0.59$ ; free < ns; free < np; ns = np), but no significant differences in PC7 for either “L” or “F.” Mean cross-correlation of PC7 was not significantly different between “L” and “F” in mediolateral (ml) and anteroposterior (ap) directions ( $0.57 < r < 0.77$ ; 7 ms < lag < 232 ms). Discussion: Visual restriction of the “F” on both the computer screen and the partner leads to decreased temporal performance in the jointly executed task. Analysis of PC7 shows that movement sway of the “L” is always increased compared to the “F,” but the difference becomes significant when vision of “F” is restricted, underlining the dependence on specific visual information. Cross-correlation analysis of PC7 did not show the expected interpersonal-coordinative pattern. Reference: Sebanz, N. et al. (2006), *TiCS*, 10.

### Vision and expertise in swimming starts: Do they mix?

Farrow, Damian T.; Tor, Elaine; Glazier, Paul; Victoria University; Pease, David, Australian Institute of Sport

Vision is commonly cited as the dominant sensory modality involved in the control of many sports skills. Despite coach interest, the role of vision in a swim start and its interaction with expertise has not been established and was the purpose of the current experiment. Twelve highly skilled swimmers drawn from the Australian Institute of Sport (AIS) swimming program and 7 less skilled swimmers participated. Data collection was completed at the AIS indoor pool using the “wetplate” analysis system. This system comprised an instrumented start block with a modified Kistler force platform integrated with four synchronized machine vision cameras to capture above and below water activity to 15 m. This system provided the following dependent variables associated with swim start performance: reaction time (s); horizontal take-off velocity (m/s), water entry angle (deg), maximum start depth (m), breakout distance (m) and time (s), and time intervals at 5 m and 15 m (s). After a typical warm-up and a familiarization trial, participants were required to complete five start trials under four different visual conditions over four testing sessions. The four visual conditions were: 1) normal vision where participants wore normal swim goggles; 2) central vision only where the goggle lenses were occluded except for a 10 mm diameter circle in the center of the lens; 3) peripheral vision only where the central lens of the goggles were completely occluded; and 4) full occlusion where the goggles were completely occluded and no visual information was available. A series of Group  $\times$  Visual Condition repeated measures ANOVAs were used to evaluate any differences in performance across the four visual conditions and level of expertise. Preliminary results revealed numerous expertise differences in select aspects of start performance; however, the influence of the visual conditions was less clear. These preliminary findings suggest that, for skilled performers relative to lesser skilled performers, vision is not an essential source of sensory information used to control a swim start.

### Explicit response codes modulate the influence of emotional stimuli on approach-avoidance behavior and selectively impact subjective emotional experience

Fawver, Bradley; Beatty, Garrett F.; Hass, Chris J.; Park, Kyoungshin D.; Janelle, Christopher M.; University of Florida

The influence of emotion on motor behavior can be modulated by implicit cues such as the distance between an individual and affective environmental content. Explicit cognitive processes elicited when evaluating affective meaning can also impact the degree to which emotions impact motor actions. How implicit and explicit factors interact to influence emotional reactions and ensuing whole body movements remains unspecified. We sought to determine the impact of explicit positive (e.g., Toward) and negative (e.g., Away) instructional codes on implicit approach (e.g., forward gait) and avoidance (e.g., backward gait) behaviors made under different emotional conditions. Participants completed 28 forward and 28 backward gait initiation trials following exposure to emotional images. In two separate trial blocks, the direction of gait was instructed using Toward or Away response codes to targets located in the anterior and posterior directions. Pleasant emotional stimuli facilitated initial step velocity for gait in the forward ( $p = .042$ ) and backward directions ( $p = .025$ ). Additionally, compatibility between instruction cue and the direction walked in the first trial block (e.g., Toward, Forward-Backward) facilitated forward (both  $ps < .05$ ) and backward (both  $ps < .05$ ) step force following exposure to pleasant stimuli. Finally, participants rated all images as more arousing (all  $ps < .05$ ) and less pleasant (all  $ps < .05$ ) when there was incompatibility between instructional cue and direction of gait initiation in the last block of trials (e.g., Away, Backward-Forward). Results suggest that explicit instructional codes impact implicit approach-avoidance behavior based on compatibility with movement direction and congruence with emotional content. Furthermore, these findings provide support for embodiment perspectives, which emphasize the influence of movement on emotional processing. Theoretical and functional implications are discussed.

### Effects of motivation orientation on non-linear aspects of motor performance and retention

Ferguson, Natalie L.; Olsen, Cameron S.; Studenka, Breanna E.; Dorsch, Travis E.; Gordin, Richard D.; Utah State University

Achievement goal theory (Nichols, 1989) outlines three factors that affect motivation: goals, perceived ability, and behaviors. The combination of these factors yields two goal orientations that are subsequently used to define success and ability: task orientation and ego orientation. Those with high task orientation are intrinsically motivated (Duda & Ntoumanis, 2003). Those with high ego orientation are extrinsically motivated (Newton & Duda, 1993). Although decades of research has focused on motivational orientations as they relate to perceptions of ability and performance outcomes, there is little research investigating how motivational orientation may affect variability of motor performance during and after competition. The present study explored the relationship between motivational orientation and dynamic measures of motor variability, for performance and learning. The Task and Ego Orientation in Sport Questionnaire (TEOSQ; Duda & Nicholls, 1989) was used to assess individual's levels of task and ego orientation. Participants were placed into four categories: High Task, High Ego; High Task, Low Ego; Low Task, High Ego; and Low Task, Low Ego. Over three days, participants completed 51 trials of isometric force tracking. Day 1 involved 25 practice trials. On day 2, 21 trials were completed while competing with a confederate from the lab. Day 3 consisted of five trials to measure retention. Performance for all groups was not significantly different during competition versus practice; however, retention (learning) was poorer for the high ego, low task group. A non-linear measure (ApEn) quantifying regularity of performance also increased during competition for both groups that reported high ego orientation. The regularity of behavior during competition did not directly predict learning outcomes. Having high task orientation along with high ego orientation allows for better learning despite greater irregularity of performance during competition. Furthermore, the least adaptable motivational profile for learning was high ego paired with low task.

### Methods to improve performance and retention on a symmetric task

Ferrandino, Josie H.; Jensen, Jody; University of Texas at Austin

This was a preliminary study to show proof of concept that the instruction strategies used were additive upon each other and enhanced results. The purpose of this pilot research was to test the impact of a focus of attention manipulation on a gross motor task—a full body squat without added weight. Twenty participants (ages 18–22 years) were randomly placed into one for five conditions: (a) a Control group received no instruction, (b) the External Focus group was told to keep their body within 2 parallel lines marked on the floor; (c) the External Focus/Self-talk group was told to keep their body within 2 parallel lines and received added instruction to say “straight down”; (d) the Internal Focus group was told to place their weight evenly on the back of their heels; and the Internal Focus/Self-talk group was told to place their weight evenly on the back of their heels and received the added instruction to say “heels even.” A retention session was held following 1 week of no practice. During the retention test, no prompts were given for focus of attention or self-talk. Focus of attention was expected to reduce the asymmetry of force distribution during a body weight squat. Self-talk was expected to enhance the effects of focus of attention and further reduce the amount of asymmetry. Dependent measures were symmetry indices created for the distribution of reaction forces between the right and left foot for  $F_x$ ,  $F_y$ , and  $F_z$ . The symmetry index was defined as the average of the differences between the right and left reaction forces divided by the sum of the right and left reaction forces for each frame collected. Practice sessions were analyzed with a Condition  $\times$  Session MANOVA with repeated measures on Sessions. The retention session was analyzed using a one-way MANOVA. Preliminary results indicated increased symmetry in those conditions using focus of attention with self-talk. These results show that the combination of these two instructional strategies lead to better performance over each strategy individually.

### The number of instructional statements contributes to explicit learning decrements in a golf putting task

Fisher, Kevin, Central Michigan University; Fairbrother, Jeff, University of Tennessee

Traditional explanations of motor learning contend that skills are learned explicitly in a process in which learners accumulate declarative knowledge and progress through distinct stages (e.g., Fitts & Posner, 1967). More recently, implicit approaches to instruction have been used in an attempt to bypass accumulation of explicit knowledge. Such approaches have been shown to facilitate motor learning compared to explicit instruction by enhancing skill retention and transfer under conditions involving distraction, increased pressure, or physical stress (Masters & Poolton, 2012). One method thought to invoke implicit learning is instructional analogies (Liao & Masters, 2001). Researchers have typically compared the effects of a single analogy statement to those of explicit instructions consisting of up to 12 statements (Liao & Masters, 2001). Thus, differences between these approaches could be attributed to attentional loading. This study compared the effects of analogy instruction, traditional explicit instruction, and explicit instruction consisting of a single statement. Participants ( $n = 48$ ) practiced a 10-foot golf putt under one of four conditions: Six-Rule Traditional Explicit Instruction (TEI), One-Rule Explicit Instruction (OREI), Analogy Instruction (AI), or no instruction (CTRL). Chi-square results indicated that AI and OREI groups made more putts during acquisition and the CTRL group made fewer ( $p < .01$ ). During Retention 1 and 2, however, differences in performance were eliminated. During Transfer 1 (breaking putt), the TEI group made fewer putts, suggesting that traditional explicit instruction can negatively affect adaptation to novel task demands ( $p = .024$ ). During Transfer 2 (attentional loading), the AI group made more putts while the TEI and CTRL groups made fewer ( $p < .01$ ). These results suggest that the number of statements in explicit instructions may degrade performance under secondary-task loading. Moreover, analogy instruction may confer an additional benefit compared to an equivalent-length explicit instruction.

**Invisible and visible stimuli are processed sequentially**

Flannigan, Jenna C., University of Ottawa; Chua, Romeo, University of British Columbia; Cressman, Erin K., University of Ottawa

In the response priming paradigm, a small (prime) visual stimulus is followed by a larger visible (mask) stimulus that renders the prime invisible and specifies the target location. When the prime and mask indicate the same response (i.e., congruent), response time is faster than when they specify opposite responses (i.e., incongruent) or the prime does not specify a response (i.e., neutral). According to the rapid-chase theory (Schmidt et al., 2006), the initial direction and kinematics of the movement are influenced by the prime, but the final outcome reflects the properties of the mask. In support of this theory, it has been shown that as the time between prime and mask onset increases (stimulus onset asynchrony [SOA]), the prime influences the response for a longer period. In the current study we examined if the prime and mask are processed according to the rapid-chase theory when they are presented during an ongoing response; a task which has been suggested to lead to more dorsal stream involvement and a lower prime activation threshold compared to when the prime is presented before movement onset. We predicted that corrections to the target would occur later in incongruent trials as the SOA increased. Participants ( $N = 12$ ) initiated 540 reaches to the center target flanked by a left and right target. The prime was presented at movement onset and was followed by the mask after a SOA of 34, 51, or 68 ms. In 66% of the trials, participants pointed to the center target with a movement time goal of 400–600 ms. In the remaining trials, the left or right mask was preceded by a congruent, neutral, or incongruent prime. Results revealed that the time required to correct to the mask target occurred sooner in the congruent condition compared to the neutral ( $p < 0.001$ ) and incongruent ( $p = 0.008$ ) condition. Importantly, corrections to the mask occurred later in the 68 ms SOA condition compared to the 34 ms and the 51 ms SOA condition, both  $p < 0.001$ . Overall, the results are consistent with the rapid-chase theory suggesting that the prime and mask are processed sequentially.

**The effects of focus of attention on visuomotor performance and EMG activity in cancer patients**

French, Margaret; Belsley, Leah; Porter, Jared M.; Southern Illinois University

“Chemo-brain” or “chemo-fog” is described as difficulties with memory, focus, attention, reduced motor functioning, and difficulty executing motor skills that involve visual accuracy and tracking. Previous research has demonstrated that directing patients suffering from chemo-brain to focus their attention externally improves visuomotor tracking abilities. However, what has not been identified is what underlying performance production characteristics resulted in these behavioral differences. The purpose of this study was to further investigate focus of attention effects on continuous visuomotor skill performance in cancer patients. We hypothesized that instructions, which directed one’s attention externally, would result in better motor performance (i.e., increased time on target) and increased movement efficiency (i.e., decreased muscle activation) than instructions directing attention internally or neutrally. Using a counterbalanced within-participant design, volunteers ( $N = 13$ ) performed a rotary pursuit tracking task with their dominant arm for a total of 15 trials (i.e., 5 trials per condition) that lasted 30 s in duration. In addition, surface EMG electrodes were placed directly over the anterior and posterior deltoids of the dominant shoulder. The dependent variables were the total contact time for each 30-s trial (i.e., time on target) and the amount of muscle activation. Results indicated that the Control and External conditions had a significantly greater time on target compared to the Internal condition. Furthermore, there were no significant differences in the activity of the anterior deltoid, while the posterior deltoid was less active in the Control condition compared to the Internal and External conditions. The present findings add to a growing body of research that demonstrates utilizing an internal focus of attention negatively influences an individual’s motor ability. It is important for practitioners to avoid using verbal instructions that direct one’s attention internally.

**Role of visuospatial processes in learning from demonstration: Implications for human-robot dynamics**

Gentili, Rodolphe J.; Oh, Hyuk; Huang, Di-Wei; Katz, Garrett E.; Reggia, James A.; University of Maryland

It is widely accepted that the combination of various practice modalities (e.g., physical, mental, observational) can benefit the teaching of motor tasks. Specifically, the combination of physical and observational practice can be particularly beneficial in learning new motor skills. Consistent with this view, computational and neurophysiological studies have suggested that the fronto-parietal brain regions, which include the human mirror neuron system (MNS), are critical for learning from demonstration since they are similarly activated during both action execution and observation. Despite numerous MNS studies, and although a human can observe and reproduce a movement independently of the perspective from which it is observed, few MNS investigations have focused on the visuospatial mechanisms associated with learning from demonstrations. Here we build upon previous simulation work by studying a fronto-parietal network model that combines the frontal and parietal components of the MNS as well as parietal visuospatial processes. This fronto-parietal model was tested by using an actual humanoid robot to study the corresponding motor learning elements that would be engaged in a real world situation. Specifically, this approach allows ecological testing and verification of the main elements of our neural model of motor learning. Namely, those elements are the fronto-parietal processes during observational and physical practice to learn arm reaching movements demonstrated by humans. The results reveal that, by using a combination of observational and physical practice, this fronto-parietal architecture allows the humanoid robot to successfully learn and reproduce accurately observed arm movements under different perspective conditions. This work contributes to inform human motor learning mechanisms by improving our understanding of the role of visuospatial parietal processes during learning from demonstration, as well as by developing a platform for examining human-robot dynamics. Implications of this work for human motor performance and learning are discussed.

### **Whole-task training and progressive-part training: Effects on physical performance and mental representation of characteristics of a fast-pitch softball swing**

Gonzales, Joseph M., Chen, David D., California State University–Fullerton

The purpose of this experiment was to examine the effects of whole-task training and progressive-part training on mental retention of characteristics of a fast-pitch softball swing. Twenty-two female students between 18 and 25 years of age volunteered to participate in this university IRB-approved experiment. The participants had no previous softball training, nor had they participated in any sort of league. Half of the participants were assigned to the whole-task training group and the other half the progressive-part training group. All participants completed a pretest swing, three practice trials, and one 10-min delayed retention test swing in which they were filmed. In addition, all participants took a cognitive representation test 10 min after the physical practice and a delayed cognitive representation test 24 hr later. An ANOVA on the experts' rankings on the swing form suggested that the whole-task group performed significantly better than the progressive-part group in physical performance ( $p = .009$ ). Univariate ANOVAs on the cognitive representation of the fast-pitch swing failed to differentiate between the whole practice group and the progressive-part training group. Results are discussed with regard to the social cognitive learning theory and the ecological theory.

### **Identifying the behavioral mechanisms of the quiet eye in skilled and less-skilled archers during aiming tasks**

Gonzalez, Claudia C.; Williams, Sean; Brunel University London; Caser, Joe, Liverpool John Moores; Miall, Chris; Grey, Michael; University of Birmingham; Humphreys, Glyn, University of Oxford; Williams, A. Mark, Brunel University London

Investigations into the gaze strategies employed by athletes have determined that longer quiet eye durations (QED) are characteristic of skilled compared to less-skilled performers and may reflect a more efficient programming of a motor response (Vickers, 1996). The cognitive mechanisms of the QE are not yet fully understood and the aim of the current study was to investigate the effects of distinct cognitive programming loads on QED. Firstly, eye movement findings from 10 expert and 13 novice archers, obtained using electro-oculography (EOG), validated skill-based QED effects during a field-shooting task. Participants then took part in 2 computer-based archery tasks in which shooting was controlled with a joystick, used to maneuver the crosshairs on the screen. In experiment 1, task complexity was manipulated by implementing 2 levels (high and low) of random movement (noise) into the crosshair (joystick) position as the participants attempted to aim at the target. In experiment 2, we further manipulated task complexity by adding 3 target sizes ( $> 1^\circ$ ) and presented these in random and blocked order within the two noise conditions. Eye movements were measured using EOG (1000 Hz) and the QE was defined as fixations  $< 1^\circ$  of at least 200 ms prior to shooting. Both groups showed reduced accuracy with increasing task complexity. Experts showed longer QED compared to novices in the high-noise conditions, which may suggest superior processing efficiency and/or reduced distractor effects of the joystick's movement. Also, a linear relationship between accuracy and QED was only observed during high-noise conditions. The longer QED of the groups did not result in better performance, but may reflect the increased processing demands of the more complex task. Our results identified task complexity effects in QED and demonstrate the importance of on-line control mechanisms during the critical QE programming period. A better understanding of QE mechanisms will aid the formulation of training programs focused on the critical processes involved.

### **Scheduling concurrent visual feedback in learning a continuous balance task**

Goodwin, Jeff E.; University of North Texas

This investigation held concurrent visual feedback frequency at 50% in the acquisition phase and manipulated three different feedback schedules (fade, constant, reverse fade) while comparing those to a 0% feedback frequency. Forty-eight young adults ( $M_{\text{age}} = 23.29$  years,  $SD = 4.70$ ) participated in the investigation in exchange for course credit. Participants who volunteered had no previous experience with the task. The Biodex Balance System (Biodex Medical Systems, Inc., model #945-300, Shirley, NY) was used and consisted of a circular platform that moved in the anterior/posterior (sagittal plane) and medial/lateral (frontal plane) axes simultaneously and provided an assessment of dynamic postural stability. The fade group received 100% concurrent visual feedback (during each acquisition trial) on acquisition trials 1–4, 75% on trials 5–8, 50% on trials 9–12, 25% on trials 13–16, and 0% on trials 17–20. The reverse fade group received a concurrent feedback schedule opposite of the fade group. The constant group received concurrent feedback on every other trial in the acquisition phase. The no concurrent group did not receive any concurrent feedback in the acquisition phase. Concurrent feedback was presented as a trace of the movement pattern, and visual terminal feedback consisted of the percent time in each zone and each quadrant. The acquisition phase consisted of 20 trials and each trial was 20 s in length. A retention test of 4 trials was administered 48 hr later. Acquisition and retention results revealed the fade, constant, and reverse fade concurrent groups performed with significantly greater accuracy and stability than the no concurrent feedback group. There were no significant differences between the three concurrent feedback schedules. The results indicated that manipulating concurrent feedback scheduling did not produce similar results to those research investigations which manipulated knowledge of results scheduling.



**Effect of practice scheduling on acquisition and retention of an underhanded beanbag toss**

Goodwin, Jeff E.; DuBois, Kenneth G.; University of North Texas

The purpose of this study was to determine the effect of three different practice schedules (blocked, random-blocked, random) on the acquisition and retention of an underhand beanbag toss. Sixty undergraduate students were randomly assigned to one of three practice groups. The task required participants to toss beanbags, with their dominant and nondominant arms, to targets (2.84 m and 7.54 m) on the floor. Concentric circles of 10, 20, 30, 40, 50, 60, 70, 80, 90, and 100 were drawn around the target to assess accuracy. Participants in the blocked practice group practiced all trials on one motor skill (e.g., tossing underhand from 2.84 m with dominant arm) before moving on to practice a different motor skill (e.g., tossing underhand from 7.54 m with nondominant arm). Participants in the random-blocked practice group first practiced motor skills in a random sequence and then switched to a blocked sequence. Participants in the random practice group practiced the motor skills in a random sequence. On the first day, participants performed 120 practice trials: 30 trials from 2.84 m with dominant arm, 30 trials from 2.84 m with nondominant arm, 30 trials from 7.54 m with dominant arm, and 30 trials from 7.54 m with nondominant arm. On the second day, a retention test was administered and consisted of 20 trials: 5 trials from 2.84 m and 7.54 m and with the dominant and nondominant arms. Retention results indicated that the random practice group performed with significantly higher accuracy than the random-blocked and blocked groups. There were no significant differences between the random-blocked and blocked practice groups.

**Why self-controlled feedback enhances motor learning: Answers from electroencephalography and self-report questionnaire**

Grand, Kirk F., Auburn University; Bruzi, Alessandro T., Federal University of Lavras; Dyke, Ford B., Godwin, Maurice M., Leiker, Amber M., Thompson, Andrew G., Buchanan, Taylor L., Daou, Marcos Z., Miller, Matthew W.; Auburn University

The purpose of the present study was to test the hypothesis that learners who choose when to receive augmented feedback while practicing a motor skill exhibit enhanced augmented feedback processing and intrinsic motivation, along with superior learning, relative to learners who do not control their feedback schedule. Accordingly, participants were assigned to either self-control (SC) or yoked (Y) groups and asked to practice a non-dominant arm beanbag toss. SC participants received augmented feedback at their discretion, whereas Y participants were given feedback schedules matched ("yoked") to their counterparts in the SC group. Participants' visual feedback was occluded, and when they received augmented feedback, their processing of it was indexed with electroencephalography. Specifically, the amplitude of the feedback-related negativity (FRN) component of the event-related potential waveform was measured. Participants self-reported intrinsic motivation via the Intrinsic Motivation Inventory (IMI) after practice, and completed a retention and transfer test the next day to index learning. Results support the hypothesis. Specifically, SC participants exhibited substantially larger (more negative) FRN amplitudes ( $p = .031$ ,  $d = 0.865$ ), reported markedly higher IMI scores ( $p = .036$ ,  $d = 0.849$ ), and demonstrated moderately higher retention and transfer test scores ( $p = .026$ ,  $\eta^2_p = .138$ ). Additionally, post-hoc multiple regression analysis indicated FRN amplitude and IMI score as a set robustly predicted motor learning, as indexed by a combined retention-transfer test score ( $p = .003$ ,  $R^2 = .543$ ). Results suggest it may be prudent for motor skill instructors to develop strategies designed to enhance feedback processing and intrinsic motivation, such as self-controlled feedback schedules.

**Using vibrotactile movement guides to change technique: Case studies in quarterbacking**

Gray, Rob; Arizona State University

Making adjustments to a heavily practiced, well-established skill (i.e., a technique change) can be one of the most difficult tasks required of an experienced athlete. Although there can be several situations in sport for which this is required (e.g., rule or/and equipment changes, advancement to a higher level of play), there are a dearth of empirical studies that have examined the processes underlying successful technique change. The current line of research used an attentional control framework in which it was assumed that altering a well-established skill requires a temporary return to an internal/skill-focused attentional focus so that the motor procedures can be deconstructed. After the new technique is learned, it is further purposed that attentional control must transition back to an external/outcome focus. Based on this framework, a vibrotactile movement guide was developed that directs a performer's attention during critical phases of acquiring a new technique. This movement guide was used in 3 separate case studies involving football quarterbacks attempting to correct a flaw in their throwing mechanics—holding the ball too low before release. The results showed that (i) at the start of the intervention, participants performed poorly on a task that involved responding to the vibrotactile stimuli on their hands while throwing (<40% accuracy) and had a high incidence of poor technique (>75%), (ii) after 4 weeks, performance on the vibrotactile task improved (>80%), the incidence of low hands decreased (<30% incidence) but throwing performance suffered (20% decline in accuracy), and (iii) after an additional 2 weeks (in which the frequency of the use of the tactile guide was systematically decreased), throwing performance returned to preintervention levels with a low incidence of the old technique (<20%). These results are consistent with the idea that successful technique change requires a return to a novice stage of attentional control, which can be facilitated by vibrotactile stimulation designed to shift attentional focus.

### Perception and production of complex movement variability

Haworth, Joshua, Johns Hopkins School of Medicine; Stergiou, Nicholas, University of Nebraska at Omaha

We are interested in visual and postural system coupling in adults, particularly in the sensitivity of coupling to the statistical complexity of the motion of a point-light stimulus. Work in biomechanics has revealed that the kinematics resultant from biological sources of motion can be characterized by nonlinear measures of temporal structure of the movement variability (Stergiou et al., 2003). The health of a biological system is related to an optimal state of this variability; characterized by the presence of mathematical chaos examined in movement over time. We sought to evaluate the perception (eye tracking) and motor replication (posturography) of the motion of a visual stimulus, which was driven by chaotic and non-chaotic signals. Participants were presented with four separate conditions, each consisting of a different point-light stimulus defined to follow one of three signal structures; sine, chaos, and brown noise. Each signal was comprised of 15,000 data points at 50 Hz, providing 5 min of continuous point motion. Gaze and posture were measured at 50 Hz. Cross-recurrence quantification analysis (cRQA) was used to investigate the coupling between gaze and postural sway to the motion of the visual stimulus, to further understand sensorimotor coordination. The cRQA parameter *percent determinism* indicated similar strength of coupling of gaze with either periodic or chaotic motion structures, yet weaker coupling to aperiodic stimulus motion. The cRQA parameter *maxline* indicated subjects presented with a particular affinity toward chaotic motion. Analysis of postural coupling supports the idea that the complex periodicity of body sway affords interactivity with non-simple environmental dynamics. These results collectively strengthen the argument that chaos is an invariant and beneficial feature of biological motion, a feature that may be critical for immediate and robust coordination of the self with the environment and other environmental agents. *Autism Speaks, NASA, American Society of Biomechanics*

### The influence of skill level differences on information processing and motor performance

Helm, Fabian; Reiser, Mathias; Munzert, Jörn; University of Giessen

It is well known that the general advantage of expertise performance in sports is caused by several physiological or perceptual-cognitive features. Among others, this advantage is driven by the memorization of motor experiences and their associated internal representations. In terms of perceptual-cognitive features, findings of skill level differences for general information processing are inconsistent. The investigation of information processing during perceptual action prediction tasks could help to explain these inconsistencies. With this background, the present study examined if skill level influences the speed of information processing and movement execution in basic and unpredictable reaction time tasks in a natural environment. Twenty-two participants (11 skilled team handball goalkeepers and 11 novices) performed non-familiar simple (SRT) and two choice reaction time (2CRT) tasks, as well as a 2CRT task that was familiar only to the goalkeepers, in a block-randomized order. Reaction times for all conditions and movement times for the 2CRT task that was familiar only to goalkeepers were measured using motion capture data and analyzed by fitting the ex-Gaussian distribution to the data. Our results reveal a general advantage for the goalkeepers' performance in all conditions with respect to mean reaction and movement times. Specifically, differences in reaction and movement times of the 2CRT task that was familiar only to goalkeepers are statistically significant for the ex-Gaussian parameter *mu*, which describes the mean of the Gaussian component of the distribution. It is concluded that motor familiarity increases the speed of information processing which might result from a faster response programming. The increased speed for action execution in experts might be due to a superior movement control. Increments of speed for both movement and reaction times in experts are considered to be driven by internal motor representations for the familiar movement.

### Are experts in physical rotation better in mental rotation?

Heppe, Holger; Schumacher, Stefan; Zentgraf, Karen; University of Münster

**Introduction:** There are findings that physical training may affect cognitive performance (Hillman et al., 2011). In a study by Stegmann et al. (2011), selective benefits in mental rotation performance of two-dimensional human figures, but not for letters, have been found for athletes used to experience overhead positions. Also, they reported advantages of rotational athletes for mentally rotating the human figures in back-view only, not for front-view, stimuli. Based on embodiment theories, it was hypothesized that human stimuli in back-view might evoke a perspective transformation strategy, preferred by rotational experts. To probe this hypothesis, three-dimensional stimuli of human figures have been tested on gym-wheel experts and athletes with no specific rotational experiences. **Methods:** We compared gym-wheel experts' ( $n = 22$ ) and other athletes' ( $n = 17$ ) performance in mental rotation of 3D human figures holding a ball in his hand. The gym-wheel experts had at least eight years of experience in their sport. Each participant solved a chronometric mental rotation task with 208 human stimuli either rotated in one spatial dimension only or in two dimensions simultaneously. Participants had to decide as quickly as possible whether the presented figure holds the ball in his left or right hand. **Results:** A repeated-measures ANOVA of response times showed a main effect of angle disparity,  $F(15,555) = 79.83, p < .001, \eta^2 = .68$ . The interaction between angle disparity and group was not significant,  $F(15,555) = 1.63, p = .19, \eta^2 = .04$ . An analysis according to Stegmann et al. (2011) also showed no significant interaction,  $F(3,111) = 124.26, p = .23, \eta^2 = .04$ . **Discussion:** The findings by Stegmann et al. (2011) could not be replicated, challenging robust embodiment effects in motor experts. Also, the nature of the task (laterality decision of a ball instead of an arm solely) or the use of 3D figures, leading to higher response times at any axis, are factors that could have influenced participants' strategy. Further studies will address these issues.

### **Eight weeks of assisted cycling therapy (act) improves upper extremity motor function in Down syndrome**

Holzappel, Simon D.; Ringenbach, Shannon D.R.; Mulvey, Genna M.; Cook, Megan R.; Ganger, Rachel O.; Sandoval-Menendez, Amber M.; Arizona State University

We have previously reported beneficial effects of acute (i.e., single session) assisted cycling therapy (ACT) on manual dexterity in adolescents with Down syndrome (DS). In the present study, we report the chronic effects of 8 weeks of ACT, Voluntary Cycling (VC), and No Cycling (NC), on the same measure in adolescents with DS. Participants were randomly allocated to one of the three groups. Those in the ACT and VC groups completed 30-min sessions three times per week on a stationary bicycle. During ACT, the mechanical motor of the bicycle augmented the cadence to a rate that was at least 35% faster than the voluntary cadence. During VC, the participants pedaled at a self-selected rate. Unimanual dexterity scores as measured with the Purdue Pegboard test improved significantly more for the ACT and VC groups compared to the NC group. The ACT and VC groups did not differ. The ACT and VC groups also showed greater (non-significant) improvements in bimanual dexterity than the NC group. ACT lead to greater improvements than VC and NC in the assembly sub-test, which is a task that requires more advanced temporal and spatial precision between the hands. The difference of ACT to VC and NC approached conventional levels of significance ( $p \sim 0.11$ ). We combined the unimanual, bimanual, and assembly scores into a composite manual dexterity score. The ACT intervention lead to significant improvements ( $p = 0.03$ , Cohen's  $d = 0.31$ ) in overall manual dexterity compared to NC ( $d = -0.21$ ) while the improvements following VC failed to reach significance ( $p = 0.10$ ,  $d = 0.26$ ). These results are consistent with research in Parkinson's patients and our previous acute study with adolescents with Down syndrome. The present results support the efficacy and external validity of the salutary effects of ACT on global motor function and neural plasticity in the frontal motor cortex as this area of the brain is active during the Purdue Pegboard test and physical activity. This research has important implications for persons with movement deficits that affect activities of daily living.

### **Different damping responses explain different vertical endpoint errors between visual conditions**

Hondzinski, Jan M., Wings, Sara A., French, Allyson E., Soebbing, Chelsea M.; Louisiana State University

Performing goal-directed movements in the dark introduces specific challenges to people that do not exist in illuminated environments. A systematic offset appears in darkness, where upright subjects frequently point below endpoints of performances in normal room lighting. We showed previously that pointing lower in darkness along the earth-fixed vertical was not dependent on the pull of gravity and that biased endpoints resulted from shorter movement excursions. We explored whether different damping factors would explain the differences between visual conditions. Ten subjects produced straight arm pointing movements to REAL and remembered target location located at different levels in normal room lighting (LIGHT) or complete darkness (DARK) either standing UPRIGHT or INVERTED upside down. The dominant arm began extended DOWN by the hip or flexed UP by the ear. After viewing targets in remembered trials, they were blocked before pointing. Elevation angle during movement for each trial was modeled using a second-order linear system. We identified the time delay which minimized differences between the actual and modeled data and quantified the behavior as under-damped, critically damped or over-damped with a damping INDEX  $< 1$ , INDEX = 1, or INDEX  $> 1$ , respectively. ANOVA tests revealed an effect of visual condition on endpoint errors and INDEX ( $p < .05$ ). In the DARK, subjects undershot endpoints in the LIGHT ( $-1.7 \text{ deg} < -2 \text{ deg}$ ). A greater INDEX existed in DARK compared to the LIGHT ( $.96 > .83$ ) so that like REAL trials (INDEX = .82), subjects' movements in the LIGHT were best described as under-damped, while movements in the DARK were best described as critically damped. Significant negative correlations between errors and INDEX ( $r < -.76$ ) revealed good associations between the two. The data support other research and indicate average limb movements with visual feedback can be modeled by an under-damped response. The novel outcomes of the present study reveal that average limb movements without visual feedback can best be modeled by a critically damped response. *Helen "Bessie" Pliner Endowed Professorship*

### **Haptic information is more reliable than visual information in learning a novel pattern of bimanual coordination**

Huang, Shaochen, University of Wyoming; Zhang, Jiancheng, Ren, Jie, Shanghai University of Sport; Bingham, Geoffrey, Indiana University ; Zhu, Qin, University of Wyoming

Visual and haptic information are both useful for learning a novel pattern of bimanual coordination (Wilson et al., 2003, 2010). Previously, Mirich et al. (2014) reported that through prolonged training, youngsters relied more on the visual information to learn the bimanual coordination pattern so that the learned coordination could not be reproduced without the presence of visual information. In the current study, we included the older adults who trained with or without visual information, attempting to examine whether aging affects the utilization of visual and haptic information for learning the bimanual coordination pattern. Twenty participants in their 50s were recruited. They were tested for the ability to perform three bimanual coordination patterns:  $0^\circ$ ,  $180^\circ$ , and  $90^\circ$ , before and after the prolonged training sessions on  $90^\circ$ . During training, half of participants were provided with visual information to learn  $90^\circ$ , and the other half with haptic information to learn  $90^\circ$ . During testing, all participants were tested on  $90^\circ$  in both visual and haptic conditions. Data were combined with previous study on youngsters, and the percentage of time on task (PTT) was used for analysis. The results replicated the previous finding showing that performing  $90^\circ$  was significantly harder than  $0^\circ$  and  $180^\circ$ ,  $F(3,108) = 355.19$ ,  $p < 0.001$ , and training with visual or haptic information about  $90^\circ$  was both effective to improve  $90^\circ$  performance,  $F(1,36) = 51.76$ ,  $p < 0.001$ ;  $F(1,36) = 26.67$ ,  $p < 0.001$ . However, visual training only yielded the improved performance in the visual testing condition, while haptic training yielded the improved performance in both haptic and visual testing conditions,  $F(1,36) = 6.11$ ,  $p < 0.05$ . This occurred for both age groups. Hence, we conclude that aging does not affect the utilization of information for learning the bimanual coordination pattern, but haptic information seems to be more reliable than visual information for learning.

### Through the eyes of the elite-level athlete: Visual search of world-class tennis players when anticipating returning 100-mph plus serves

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Considerable research has well documented that successful performance in interceptive tasks (such as return of serve in tennis) is based on the performers' capability to capture appropriate anticipatory information prior to the flight path of the approaching object. Furthermore, research has indicated that much of visual information is available during the ritual, preparatory, and execution phases of the task. Athletes of higher skill tend to fixate on different locations in the playing environment prior to initiation of a skill than their lesser skilled counterparts. However, less research has examined the visual search strategies of the elite players in tennis and no research has been conducted on elite wheelchair tennis players. The purpose of this study was to examine visual selective attention strategies of elite (world-ranked) tennis players (able-bodied [AB] participants) and of elite (world-ranked) wheelchair (WC) tennis players. Sixty-three ranked tennis players participated in this study: 32 WC tennis players ranked between 1 and 82 on the International Tennis Federation tour and 31 athletes ranked between 44–440 on the Association for Tennis Professionals tour. Participants watched videos of a professional tennis player (able-bodied professional for the AB participants and a WC professional for the WC participants) serving and imagined competing in a match against the player as eye movements were recorded. Visual fixations on target locations, quiet eye duration, fixation duration were the dependent measures. Overall results demonstrated differences in target locations and quiet eye duration ( $p < 0.01$ ) between expert type (able-bodied elite tennis player vs. wheelchair elite tennis players) as well as gender differences for these dependent measures ( $p < 0.05$ ). Unique results were found in the fixation locations during the ritual phase and visual search behavior after the ball had been contacted, during the finishing phase. The results are discussed in light of visual motor control, perceptual-cognitive literature, and expertise.

### Role of the supplementary motor area in rapid adjustment of brief interceptive action using predicted information

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Successful interception (e.g., hitting balls) often includes predictive movement onset to circumvent severe time constraints and rapidly adjusting these movements against a continually changing environment. The internal feedback (IF) loop implies that rapid adjustment is accomplished by using not subsequently available visual information about circumstances but a priori predicted information about our movements in our brains. Ikudome et al. (2013) confirmed the IF loop by examining the role of the supplementary motor area (SMA), which generates the predicted information about movements before their onset in rapid adjustment. However, the contribution of the SMA to the IF loop, especially its involvement in adjustment of interception per se after movement onset, is unclear, since Ikudome et al. examined only the effect of transcranial magnetic stimulation (TMS) over the SMA before movement onset. Therefore, the present study further clarified the contribution of the SMA to the IF loop by examining the effect of TMS over the SMA after movement onset. Six participants had to intercept a moving target with as little temporal error as possible. A screen in front of them showed correct target velocity (i.e., certain condition) or incorrect target velocity (i.e., uncertain condition) before each trial. TMS was administered over the SMA and over the M1 as a control site. Delivery timing (–100 ms, 0 ms, and +100 ms relative to movement onset) was based on individual response times during a practice session held before the experimental session. Temporal error was significantly greater in the uncertain than certain condition,  $t(5) = 2.02$ ,  $p < .05$ , showing that participants needed to adjust their predictive movements after movement onset in this condition. However, temporal error in this condition was not further increased by TMS after movement onset. This shows that the contribution of the SMA is only the generation of the predicted information used in rapid adjustment. These results further clarify the neurological basis of the IF loop for interceptive action.

### Do participants use mental rotation when comparing two models from different viewing angles?

Ishikura, Tadao; Doshisha University

This study examined the role of viewing angle in determining whether two posed figures are the same or different, in terms of event-related potentials (ERPs) and cognitive load measured via response times. Fourteen healthy male university students (mean age = 22.4,  $SD = 1.4$ ) participated. They were asked to judge whether two posed figures were the same person or not. The difference in angular rotation between the two figures was 0°, 60°, 120°, or 180°. Angular differences of 0° received the fastest responses. The Pz scalp site had a larger amplitude from 250 ms to 500 ms from stimulus onset than from 500 ms to 600 ms, but there was no effect of viewing angle. Similarly, nor was viewing angle distinguished in pre-response ERP components. These results indicate that since there was no rotation-related negativity in the ERP data, individuals might judge whether two simultaneously presented figures are the same or different without mentally rotating the figures.

**Embodied mental rotation: A special link between egocentric transformation and the bodily self**

Kaltner, Sandra; Jansen, Petra; University of Regensburg

This experiment investigated the influence of motor expertise on object-based versus egocentric transformations in a mental rotation (MR) task using images of either the own or another person's body as stimulus material. In MR which is a specific visuo-spatial ability there are two different classes of MR strategies: Whereas in object-based transformations the observer's position remains fixed and participants are asked to mentally rotate the object in relation to the surrounding environment, in egocentric transformation tasks participants are asked to mentally change their own perspective which is a simulative process recruiting representations of our own body (Zacks, Mires, Tversky, & Hazeltine, 2002). According to the embodied cognition viewpoint, we hypothesized motor-experts to outperform non-motor experts specifically in the egocentric condition because of higher kinesthetic representation and motor simulations compared to object-based ones. In line with this, we expected that images of the own body are solved faster than another person's body stimuli. Results showed a benefit of motor experts compared to non-motor experts, especially in egocentric transformations,  $F(1,79) = 8.45, p = <.001, \eta^2 = .09$ . Regarding the factor "stimulus material," there was an advantage of representations of another person's body, but only for the object-based rotations,  $F(1,79) = 15.50, p = <.001, \eta^2 = .16$ . Since motor experts did not show any specific expertise in rotational movements, we concluded that using human bodies as stimulus material elicits embodied spatial transformations, which facilitates performance exclusively for egocentric transformations. Regarding stimulus material, the other-advantage ascribed to increased self-awareness-consciousness distracting attention-demanding resources, disappeared in the egocentric condition. This result may be due to the stronger link between the bodily self and motor representations compared to that emerging in object-based transformations.

**"Matched" or "mismatched" learning in pairs: Evaluation of dyad practice in a multi-skill context**

Karlinsky, April D.; Dhillon, Jaspreet; Hodges, Nicola J.; University of British Columbia

Practicing a novel motor skill in alternation with a partner can benefit learning compared to practicing alone. It is unclear if the benefits of turn-taking practice extend to multi-skill learning, where partners can practice the same or different skills to one another on consecutive turns. In this study, participants practiced 2 golf-putting skills either in alternating pairs or alone. To date we have tested 2 pair groups ( $n = 7$  pairs/gp) and a non-turn-taking group that only practices, while a partner observes ( $n = 2$ ). In the turn-taking pairs, partners either practiced the same skill (Match group) or a different skill (Mismatch group) to their partner on consecutive trials (i.e., different putters). Although contextual interference would be higher for the Mismatch group, presumably aiding retention, the Match group should benefit from observational practice of the to-be-enacted skill before each trial. All participants practiced in a relatively blocked schedule (6 trials/putter) across 2 days ( $t = 36$  putts each day) either alone (with a passive observer) or turn taking (observing and physically practicing). Individual retention testing was completed at the start of Day 2 ( $t = 12$  trials, no feedback) and 1 week later. Statistical analysis of the pair groups showed that both groups improved across practice days. Although the pair groups were not statistically different in delayed retention, there was a trend ( $p = .11$ ) for the Match group to be more accurate. We need to test more participants to make conclusions about the effectiveness of dyad practice as compared to practice alone. However, it appears that any benefits associated with this type of dyad practice for learning multi-skills seem to be more associated with observational practice, rather than enhanced interference.

**Multifrequency bimanual force production: 1:2 versus 2:1**

Kennedy, Deanna M.; Rhee, Joohyun; Shea, Charles H.; Texas A&amp;M University

Results from a recent experiment (Kennedy et al., 2015) indicated consistent distortion of the left limb forces that could be attributable to the production of right limb forces during a multifrequency bimanual task. However, distortions in the forces produced by the right limb that could be attributable to the generation of force in the left limb were not observed. Although asymmetric crosstalk has been implicated as a source for the observed distortions, it is also possible the distortions are due to the limb assigned the faster rhythm. Therefore, the present experiment was designed to determine if the influence of force produced by one limb on the contralateral limb could be a result of the faster frequency or a bias associated with limb dominance. Participants ( $N = 10$ ) were required to rhythmically coordinate a pattern of isometric forces with the left and right limbs in a 1:1, 1:2, and 2:1 pattern. The 1:2 task required the right limb to perform the faster rhythm while the 2:1 task required the left limb to perform the faster rhythm. The 1:1 task was used as a control. Lissajous displays were provided to guide performance. If the limb assigned the faster rhythm was responsible for the distortions in the contralateral limb, it was hypothesized that distortions would only be observed in the force trace of the limb producing the slower pattern of force whereas if asymmetric neural crosstalk was responsible for the distortions, it was hypothesized that in right-limb dominant participants the right limb would influence the left limb, regardless of limb assignment. Replicating the results of the previous experiment, distortions in the left limb were observed in the 1:2 task that could be attributed to the production of force by the right limb. However, identifiable distortions were observed in the force produced by both the left and right limb in the 2:1 coordination task. Observed distortions in the left limb, when assigned the faster rhythm indicated that the source of interference is not strictly due to limb assignment and is consistent with neural crosstalk.

### The influence of integrated feedback information on bimanual force control in older adults

Kennedy, Deanna M.; Shea, Charles H.; Texas A&M University

An experiment was designed to determine the extent to which older adults are capable of using integrated feedback information to coordinate bimanual force patterns and to determine if older adults exhibit increased interference between the limbs as compared to young adults. Consistent with the notion of neural crosstalk, it was hypothesized that older adults would exhibit greater interference between the limbs than young adults due to age-associated degeneration of the corpus callosum. Eight young (21.9 years) and 8 older (72.3 years) adults were required to rhythmically produce a pattern of isometric forces on a left side force transducer with the left arm that was coordinated with the pattern of isometric forces produced on a right sided force transducer with the right arm. Lissajous displays were provided with a goal template and a cursor indicating the forces produced with both limbs. The cursor moved from left to right as force was produced with the right arm and from bottom to top as force was produced by the right arm. The template illustrated the specific pattern of force requirements needed to produce the goal coordination pattern (1:1, 1:2). Participants performed 13 practice trials and 1 test trial per task. Each trial was 30 s. The results indicated very effective temporal performance and accurate force performance of the bimanual coordination patterns for both young and older adults with older adults performing the tasks as effectively as young adults. The results also indicated consistent and identifiable distortions in the left limb force and force velocity traces for both young and older adults in the 1:2 coordination task, but not the 1:1 task. For both groups, the interference observed during the 1:2 coordination task occurred when the right limb was initiating and releasing force. However, the force produced by older adults was significantly less harmonic than young adults indicating that older adults made more adjustments and/or hesitations than young adults. *NASPSA*

### Examining the role of consolidation for new motor learning following random and blocked practice

Kim, Taewon; Wright, David L.; Texas A&M University

Recent work examined the impact of prior random (RP) or blocked practice (BP) on acquisition of a novel motor task. A broader range of benefits were evident for retention of the motor sequences practiced during BP and RP and for new learning when the time between the BP and RP and practice with the novel task increased from 2 min to 24 hr. Providing a longer time window afforded learners the opportunity to consolidate the knowledge from BP and RP. Interestingly, the benefits from consolidation after RP, beyond BP, were limited to a faster rate of acquisition of a new task. It is possible that the limited benefit of consolidation in the case of RP may have been a function of how this practice format was constructed in these studies. In both RP and BP, three unique serial reaction time tasks (SRTT) were practiced. However, a trial with any SRTT involved the repeated production of a 7-element sequence for 30 s with 30 s of rest. Thus, while a trial was defined as 30 s executing one sequence, any one sequence was produced 12–15 times during this interval. Thus, while RP rotated motor sequences across trials, the learner experienced a form of BP even in this practice format. In the present study the task used was a discrete sequence production task (DSPT) (Abrahamse et al., 2013) which allowed presentation of the to-be-learned motor tasks to be presented in a “true” random format. The issue of interest was whether a broader range of benefits for future learning following consolidation would now emerge after RP compared to BP. Thus, subjects practiced three 7-element DSPTs in either a blocked or random format. Accuracy and speed were calculated for each trial. Either immediately or 24 hr after BP or RP was completed, training commenced with a novel DSPT. Retention of all DSPTs was assessed 24 hr later. RP resulted in superior retention of all tasks. Consolidation, from the 24-hr rather than 2-min interval, aided new learning. RP displayed a larger range of benefits for future learning via consolidation.

### The effect of attentional focus in balancing tasks: A meta-analysis

Kim, Taewon, Texas A&M University; Jimenez, Judith, University of Costa Rica

Evidence exists showing directing a learner’s attention away from their movement outcome (external focus) enhances motor skill learning, compared to when a learner’s attention is directed to the control of the movement (internal focus). An advantage to external focus has been revealed for a variety of motor tasks, such as balancing, throwing, and golf putting. The purpose of the present work is to present a meta-analysis to quantify the effect of attentional focus during the balancing task in motor learning. A literature search was conducted based on electronic databases in Web of Science, PubMed, and Google Scholar to identify studies through December 2014. Thirteen studies met the inclusion criteria, which were (1) an external and internal focus group, and balance as a dependent variable, (2) to report statistical data to calculate the ES (means and standard deviation, or  $F$  value). ES was calculated for the within-phase comparison. When the mean and standard deviation was reported, ES was calculated as  $ES = (MEF - MIF) / SD$  pooled, whereas when the  $F$  value (with 1  $df$ ) was reported, ES was calculated as  $ES = [2 \times (\sqrt{F})] / \sqrt{\text{error } df}$ . All individual ES were corrected for positive bias and overall ES was calculated following Thomas & French (1986). This analysis indicated that external rather than internal focus results in superior (a) acquisition of the balance test ( $ES = 0.42$ ,  $n = 10$ ;  $CI: 0.15-0.691$ ) and (b) greater retention ( $ES = 0.57$ ,  $n = 21$ ;  $CI: 0.37-0.78$ ). These data suggest that directly focus of learner’s attention to their movement allow learners to more beneficial in balance learning than a focus of learner’s attention their own body movement.

**Asymmetrical balance control during a simple kicking movement**

King, Adam, Gatteys, Trudi, Truman State University; Wang, Zheng, University of Texas Southwestern Medical Center

Interlimb performance asymmetry has been extensively examined in upper-limb motor tasks with much less known in regards to lower limb asymmetry. In some upper limb task individuals show a preferential use of a dominant limb; however, the demands of most lower limb movements require the coordination between both limbs resulting in different functions (stabilizing and mobilizing) between right and left legs. This study investigated the potential asymmetrical control of the lower limbs during a novel kicking tasks. In addition to kicking accuracy, the mobilizing (i.e., kicking limb) and stabilizing (i.e., balancing limb) components of the kicking movement were assessed to determine whether the right and left limbs differentially organized the movement. Subjects started and finished in an upright posture position with the right and left feet placed on adjacent force plates. Kicking movements were performed to three target directions ( $\pm 30^\circ$  and  $0^\circ$ ) with an emphasis on accuracy. Analysis of the movement was partitioned into preparatory, kicking, and return phases. Ground reaction forces and kinematic trajectories of key landmarks (i.e., hip, knee, and ankle) were analyzed in each phase. Subjects did not differ in kicking accuracy between the limbs and target direction. There were no statistical differences between the limbs in terms of transition impulse during the preparatory phase and both limbs showed similar duration during the kicking phase. However, during the preparatory phase the duration of body weight transfer and the anticipatory postural adjustment duration was significantly lower during right foot kicking compared to left kicking. The findings support the notion that asymmetrical control of the lower limb is dependent on the component (stabilizing and mobilizing) of the kicking movement. The findings underscore the notion that footedness needs to be addressed relative to the function of the limb when the motor task requires coordination between both limbs.

**Collective variable of a postural control system in a dynamic balance task**

Ko, Jihyun, Montana State University; Newell, Karl M., University of Georgia

The study was designed to examine whether the coordination between center of pressure (COP) and center of mass (COM) could be a candidate collective variable that captures the organization of the whole body postural system consisting of multiple body segments. In particular, we investigated the phase transition of the COP-COM coordination based on a moving support surface paradigm. 10 young healthy adults maintained postural balance standing on a moving platform that was sinusoidally translated in the anterior-posterior direction. The platform frequency was continuously increased and then decreased within the range from 0 to 3.0 Hz over a trial. A 3D motion analysis system recorded 4 angular joint motions (ankle, knee, hip, and neck) and allowed to estimate COM as well. Kinetic data measured by a force platform that was mounted on the moving platform derived COP. The COP-COM coordination showed a sudden qualitative transition at a certain frequency with between/within subject variability, in that it changed from in-phase to anti-phase and from anti-phase to in-phase in the frequency increasing and decreasing conditions, respectively. There were higher variability at the transition region and hysteresis depending on the direction of frequency change. In contrast, the coordination between ankle and hip consistently showed the transition, across participants, at 0.3 Hz where it was different from that the COP-COM transition occurred, and the variability was even higher after the transition. The findings provide information that continuously scaled frequency of the moving platform induced a non-equilibrium phase transition of the COP-COM coordination with critical fluctuations and hysteresis. Therefore, in conclusion, it is suggested that the COP-COM coordination can be considered as a collective variable of the whole body postural control system acting on a redundant postural task.

**Perception-action in children diagnosed with autism spectrum disorder**

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Autism spectrum disorder (ASD) is characterized by underdeveloped social and communication skills and often is related to difficulties in performing coordinated motor actions. Children diagnosed with ASD are reported as having difficulties in performing ballistic tasks that require a complex interaction between perception and action. It is unknown whether these deficiencies originate from difficulties in perceiving the characteristics of a stimulus (e.g., velocity, trajectory), difficulties in performing the actions to match these characteristics (e.g., action planning and execution), or a combination of both. The purpose of this study was to systematically examine these questions. Participants ( $N = 24$  males, 12 with ASD and 12 age-matched controls) were between the ages of 8 and 16. Participants performed a series of three tasks (both with upper and lower limb) with varying degrees of perceptual and motor demands: 1) a simple reaction time task (sRT), an anticipatory reaction time task with 2) an increased perceptual component (pRT), and 3) with an increased action component (aRT). The results suggest that there are no differences in sRT performance between children with ASD and their age- and gender-matched typically developing controls. Furthermore, the same pattern of results was observed when perceptual demands of the task were increased (pRT). In contrast, when motor demands were increased (aRT) but perceptual demands were kept constant, children with ASD showed a decrease in movement consistency and an increase in timing error. Altogether, these results seem to indicate that male children with ASD have no difficulties in detecting characteristics of ballistic stimuli or accurately planning and executing simple motor actions to match these stimuli. However, when planning and executing of more complex actions is required, their performance decreases considerably. Further research will be aimed at identifying whether decreases in performances are due to poor action planning, or difficulties in executing a planned movement.

### Assessing bimanual coordination with the microsoft kinect

Liddy, Joshua J.; Haddad, Jeffrey M.; Huber, Jessica E.; Claxton, Laura J.; Rietdyk, Shirley; Zelaznik, Howard; Purdue University

Marker-based systems are the gold standard for capturing 3D human kinematics. However, recent advances in gaming peripherals have provided low cost, portable alternatives to these expensive systems. Studies have shown that gaming devices such as the Microsoft Kinect adequately capture basic posture and gait measures (e.g., Clark et al., 2012). However, it is unknown whether these devices possess the resolution to capture spatiotemporal patterns of coordination, which often include measures of position and velocity. Therefore, the purpose of this project was to determine the ability of the Kinect to examine human bimanual coordination. We specifically examine bimanual coordination because it is a well-studied paradigm that has provided fundamental insights into human movement. Twenty-five college-aged adults performed sagittal plane wrist movements while seated. Subjects performed in- and anti-phase patterns at movement cycle times ranging from 1 s to 300 ms in decrements of 100 ms. Five trials of each pattern were presented in random order. Vicon and Kinect systems measured the 3D kinematics. Measures of continuous relative phase (CRP) and CRP variability (CRPSD) were calculated using methods outlined in Hamill et al. (2000). A mixed-model, repeated measure ANOVA was performed with frequency and pattern nested within device. Kinect CRP measures were higher for in-phase ( $p < .0001$ ) and lower for anti-phase ( $p < .0001$ ) while CRPSD was higher for both patterns ( $p < .0001$ ) compared to the Vicon. Additionally, the Kinect was unable to capture changes to CRPSD as movement speed increased. Intraclass correlations found excellent and moderate agreement for CRP (0.97) and CRPSD (0.68) respectively. The Kinect was able to distinguish differences between movement patterns and pattern variability. However, the Kinect is not able to capture subtle increases in CRPSD that occur as frequency is scaled. The Kinect appears well suited to capture global patterns of coordination, but not the small-scale fluctuations that are typically inherent in most dynamical systems assessments. *Microsoft Research Grant*

### Dual task interference during walking: The effects of texting on situational awareness and gait stability

Lim, Jongil; Amado, Avelino; Sheehan, Leo; Van Emmerik, Richard E.A.; University of Massachusetts at Amherst

Dual-task interference caused by mobile phone use while walking increases safety risks by increasing attentional and cognitive demands. Situational awareness, important for control of walking and safety, has been examined previously but measured only by the awareness of visually noteworthy objects in the environment (Hyman et al., 2010), the number of times the person looked up from the phone (Plummer et al., 2014), and unsafe behavior when mobile phone users cross the street (Stavrinou et al., 2011). This study systematically investigated the effects of texting on situational awareness to different environments and its consequent impact on walking dynamics. Twenty healthy volunteers walked on a treadmill while texting and attending to visual tasks simultaneously. Gait parameters and situational awareness were examined under single (walk or visual task only), dual-task (walk & text), and dual-task with visual task (walk, text, & visual task) conditions. The size of the visual field, display duration of the visual cue, and visual acuity demand (color or Landolt C optotype orientation change) were varied across the visual task conditions. More than half of the visual cues provided during walking and texting were not perceived (52.3%) as compared to visual task only condition. A greater loss of information in the upper left visual field indicated that not all parts of the visual field are affected equally while walking and texting. More visual cues were detected in color change task than the optotype task (23.3%), which signifies visual acuity dependent information loss. While gait parameters were not different among visual task conditions, greater lateral deviation was observed in walk and text condition compared to walk only condition, showing the dual-task effects of texting on walking dynamics. Overall, the results provide further evidence of dual-task effects of texting on situational awareness as well as walking dynamics. The study further highlights the specificity of loss of situational awareness associated with the nature of attentional resources.

### Effects of load configuration on movement coordination and visual information pick-up in expert marksmanship performance

Lim, Jongil; Busa, Michael A.; Amado, Avelino; Luis, Rosado D.; Darnell, Simon; Ducharme, Scott W.; Palmer, Christopher J.; Van Emmerik, Richard E.A.; University of Massachusetts

The pickup of task-relevant visual information from the environment is critical for accurately controlling goal-directed visuomotor tasks. Altering coordinative dynamics in response to equipment loads are necessary to facilitate the establishment of postures that allow for the maintenance of precision marksmanship. While the intrinsic coordinative dynamics of landing under load (i.e., a postural stabilization task) and its effect on dynamic visual acuity have been examined previously (Palmer et al., 2012, 2014), it is not clear how adaptations in these coordinative dynamics relate to the identification of visual information in the environment. The purpose of this investigation was to examine the effects of load magnitude and distribution on: 1) the ability to identify visual information, and 2) the segmental coordination patterns that facilitate this goal-directed movement. Twelve expert marksmen with military experience stepped off a platform onto force plates and were instructed to shoot at left and right targets as accurately and fast as possible, with the initial target direction indicated by a visual cue displayed on a centrally located monitor. For the current analysis, task performance was quantified by the time to discriminate (TtD) the direction of the visual cue. Coordination analysis (vector coding) between the head and trunk segments were examined from landing to target discrimination. The head gaze point, a vector from the helmet onto the target plane, was analyzed to quantify orienting (towards) and non-orienting (away from the visual cue) movement patterns. TtD was significantly longer in heavy load condition. Greater head leading and in-phase coordination patterns were observed for the lighter loads, while significantly more time was spent in a trunk-leading coordinative pattern in heavy loads. These results indicate that load affects the time to discriminate relevant visual information in the environment, resulting from different coordinative patterns between trunk and head that affect the timing of the head gaze point onto the visual target.



**The effects of high-low self-controlled feedback on motor learning and error detection capability**

Lin, Chinger; Lee, Shu-Hua; National Taichung University of Education

The present study was to examine the motor learning and error detection capability for later childhood could be enhanced by self-controlled feedback of predetermined high frequencies. Thirty-six participants ( $M_{age} = 10.2 \pm 0.3$  years) were randomly assigned to one of the three groups: (1) high frequencies self-controlled feedback group, (2) high frequencies yoked group, (3) low frequencies self-controlled feedback group. The task required participants to toss sandbags while blind-folded with the non-dominant arm. The process consisted of homogeneousness test, 60 trials in acquisition, questionnaire, 10 min immediate retention test and error estimation, and 24 hr delayed retention test and error estimation consisted of 10 trials each. Dependent variables were the accuracy scores of tossing sandbags and error estimation scores. The tossing accuracy scores of acquisition phase were analyzed in 3 (groups)  $\times$  6 (blocks) mixed-design two-way ANOVA with repeated measures on the blocks. The tossing accuracy scores and error estimation scores on immediate and delay retention tests were analyzed in 3 (groups)  $\times$  2 (tests) mixed-design two-way ANOVA with repeated measures on the tests. Results: (1) High frequencies self-controlled feedback group was not better than high frequencies yoked group on motor performance. High frequencies self-controlled feedback group was better than low frequencies self-controlled feedback group on the initial phase of acquisition of motor performance. (2) High frequencies self-controlled feedback group was not better than high frequencies yoked group and low frequencies self-controlled feedback group on motor learning and the error detection capability.

**Clustering fast aiming task data: The effect of movement distance on movement time variability**

Lin, Tzu-Hsiang, Liu, Yeou-Teh, National Taiwan Normal University

Fitts's law describes the robust linear relation between movement time and Fitts's index of difficulty (ID). However, many researches showed that the linearity between the movement time and ID broke down under specific ID combinations. Movement time variability in fast aiming task is widely discussed and remains explained with little consensus. In this study, we proposed two novel methods of clustering data from the fast aiming task to show the high  $R^2$  value of the linear relation in Fitts's paradigm for each cluster. Data in one cluster with high  $R^2$  value shares the same task properties, i.e., target width, distance, or ID. Based on the task properties of different clusters we could investigate how task properties affect movement time. We used 9 target widths and 9 distances to compose 81 task combinations to form a wide range of IDs for data clustering. Mean movement times of 8 participants were used to run the clustering algorithm. The result showed that the movement distance is the dominant factor of task properties for clustering movement time data. The  $R^2$  value of the linear relation between the movement time and ID for all 81 task combinations was .91. After clustering to three clusters,  $R^2$  increased to .96, .96, and .97 for each cluster. The increase of  $R^2$  indicates less movement time variability and shows the legitimacy in separating fast aiming movements by different distances. The results of the study provide support for the significant effect of movement distance on movement time while performing the fast aiming tasks.

**Examining the intrinsic dynamics: Influence of basketball expertise in learning novel throw task compare to roller ball task**

Liu, Yeou-Teh, Chuang, Kuo-Liang, National Taiwan Normal University; Newell, Karl M., University of Georgia

The individual differences of the motor ability are captured in the construct of the intrinsic dynamics of the performer based on the dynamical systems framework. Learners who have a prior experience of a similar task will perform the task better or learn the task faster. The purpose of the study was to explore the possible sources of individual difference in motor skill learning in order to better understand the learning process. Specifically, we hypothesized that the elite basketball players who had extensive throwing experience would learn a novel throw task better than those who had no related experience. In addition, for a motor task that does not share any similar movement organization of the basketball skills such as the roller ball task, the elite basketball players would not outperform the non-basketball players. Twenty-four adult volunteers participated in the study; 12 of them were elite basketball players and the other 12 had no training experience in any competitive sport. All participants practiced the novel throw task for 3 days, and the roller ball task for 5 days; 50 trials a day. In addition to the performance measure of each task, the angle-angle diagram and the relative phase of the novel throw task were examined for the development of the coordination patterns. The results showed that for the novel throw task the performance and the learning rate of the basketball players were higher than those of the non-players; the coordination analysis also showed a difference in changing patterns between groups. For the roller ball task, although there was no significant difference in task performance between the 2 groups, there were differences in the daily learning rates between the groups. In conclusion, when learning a new task, past experiences of movement activities of the learner influence the learning dynamics while the intrinsic dynamics of the learner affect the performance of the to-be-learned task. By analyzing the intra-individual data over the practice, it is possible to unravel the characteristics of the change processes of learning.

### Visual anticipation of throw direction in team-handball penalties: Skill differences in information pick-up strategies

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Skilled team-handball goalkeepers in contrast to novices seem to rely on multiple, globally distributed kinematic cues when anticipating a 7-m-penalty-taker's intention (Loffing & Hagemann, 2014). Evidence in favor of such skill-dependent information pick-up strategies in team-handball goalkeeping, however, is limited to the prediction of the type of throw (i.e., hard vs. soft shot). Here we examined whether skill differences in visual anticipation strategies occur also for the prediction of throw direction (i.e., left vs. right). In Exp. 1, 15 goalkeepers [GK] and 18 novices [NOV] anticipated the direction of 144 right-handed penalties occluded 40 ms before ball release. To estimate participants' information pick-up strategies, we spatially manipulated four regions of the throwers' body (head, ball+hand [BH], throwing arm + ball [TAB], upper body [UB]) such that these regions were removed or presented in isolation (Loffing & Hagemann, 2014). We also showed non-manipulated clips in a control condition. A 2 (skill)  $\times$  9 (display condition) mixed ANOVA on percentage of correct prediction revealed a significant interaction,  $F(8, 248) = 3.34$ ,  $p = .001$ ,  $\eta_p^2 = .10$ . The superiority of GK over NOV varied considerably across display conditions and GK performance was more affected by display conditions than NOV. Within-group pairwise comparisons between conditions indicated that accuracy in GK but not NOV gradually decreased/increased with more adjacent kinematic cues being removed/isolated (i.e., BH vs. TAB vs. UB; Cohen's  $d_z = 0.53$ – $0.97$ ). We partly replicated findings in Exp. 2 (5 display conditions: no manipulation and isolation of the above regions), where another 12 GK, 23 field-players and 23 NOV anticipated the direction of 160 right- and left-handed penalties. Information pick-up strategies tended to differ also between GK and field-players, but strategies did not vary by throwers' handedness. In sum, the skilled goalkeepers' global strategy appears independent of the perceptual task and may be a result of position-specific adaptation (cf. Williams et al., 2008).

### Under-powered and over-worked: Problems with data in motor learning studies

Lohse, Keith R.; Buchanan, Taylor L.; Miller, Matthew W.; Auburn University

Appropriate statistical analysis is essential for accurate and reliable research. Statistical practices have immediate impacts on the perceived results of a single study, but also remote effects on the dissemination of information among scientists (e.g., through withholding null results) and the cumulative nature of research (e.g., underpowered studies can be highly significant, but impossible to replicate). To accurately describe and quantify potential problems currently facing the field of motor learning, we systematically reviewed publications from 7 journals over the last 2 years to find experiments that tested the effects of different training conditions on delayed retention and transfer tests (i.e., "classic" motor learning paradigms). Eighteen studies were included in the review. Overall, these studies had small sample sizes ( $n/\text{group} = 12.00 \pm 11.2$ ), multiple dependent variables ( $2 \pm 2.39$ ), and a large number of statistical tests per dependent variable ( $49 \pm 39.94$ ; all values are median  $\pm$  SD). Looking at the learning effect specifically, that is, the effect of training conditions at the delayed test, the effect sizes were moderate ( $d = 0.59 \pm 0.54$ ) and statistical power was poor ( $1 - \beta = 0.48 \pm 0.27$ ). The distribution of effect sizes across studies was also consistent with publication bias (test of asymmetry,  $t(16) = 2.29$ ,  $p = 0.03$ ), suggesting studies reporting null results are not being published. Clearly, these meta-data suggest there are problems with the way we are conducting (or at least publishing) motor learning research. We provide several recommendations for how to address these issues: a priori power calculations, pre-specified analyses, data-sharing, and dissemination of null results. Furthermore, we hope these data will spark serious conversation and action from senior researchers in the field.

### Engaging environments enhance motor skill learning in a computer gaming task

Lohse, Keith, Auburn University; Boyd, Lara A., Hodges, Nicola J., University of British Columbia

There is a growing body of research on the potential for video game technology to enhance motor rehabilitation. One reason for excitement in this technology is the thought that individuals will be motivated to practice more if they are presented with more engaging environments (i.e., facilitating learning through increased practice). However, it is also possible that engaging environments directly affect the encoding of information during practice and ultimately affect retention. Thus, in the present study, we conducted a behavioral experiment to see if practicing a motor skill in an engaging computer game (the "Game" condition) would facilitate learning compared to a mechanically identical version of the same game with aesthetic features removed (the "Sterile" condition). In both conditions, the game required participants to "catch" objects that flew onto the screen as quickly as possible and then "throw" these objects at targets on the screen in order to score points. Based on an a priori power analysis, 40 novice participants were recruited through an online advertisement at the University of British Columbia (23F and 17M). Performance on all metrics was equivalent during acquisition, but on the delayed retention/transfer test (5–9 days later) participants who trained in the Game condition scored more points (418.24) than participants in the Sterile condition (388.43,  $p < 0.001$ ), caught a higher percentage of the flying objects (97.9 vs. 95.35%,  $p = 0.03$ ), hit a higher percentage of targets (93.69 vs. 90.25%,  $p = 0.05$ ), and showed faster total times per trial (3,039 vs. 3,343 s,  $p = 0.01$ ), but no difference in the time-to-catch (1,360 vs. 1,406 s,  $p = 0.34$ ). Exploratory analysis of survey data suggest that although groups did not differ with respect to intrinsic motivation, the Game group rated the training conditions as more engaging than the Sterile group. These data provide evidence that engaging environments convey an immediate benefit to learning, facilitating encoding for a fixed amount of practice.

### Gait variability and gaze fixation while synchronizing with an avatar exhibiting fractal patterns

Macpherson, Ryan P.; Rhea, Christopher K.; University of North Carolina at Greensboro

Previous work has demonstrated that entrainment to a visual stimulus can alter fractal patterns in gait, with a focus on the efficacy of discrete stimuli (flashing virtual footprints) versus continuous stimuli (walking avatar). Synchronizing to an avatar may negatively impact fractal gait patterns. A hypothesis is that extraneous information available from the avatar (movement of the head and trunk) may distract from the task of synchronizing to the avatar's heel-strike. This may inhibit entrainment and retention of new fractal patterns. This study examined the effect of gaze fixation location and subjects' fractal gait patterns while synchronizing to an avatar walking with a fractal stride time. Nine young healthy adults ( $21.0 \pm 1.9$  years) walked for three 10-min phases (pre-sync, sync, and post-sync) while their gait mechanics were recorded. Gaze location was also recorded during sync phase. The dependent variable for gait was stride time, which was analyzed for fractal patterns using detrended fluctuation analysis alpha (DFA- $\alpha$ ). For the gaze data, the area of interest (AOI) for each frame was calculated. The AOI was separated into percentage of time spent looking at the avatar's head, trunk, or legs. DFA- $\alpha$  significantly declined from the pre-sync phase ( $0.81 \pm 0.12$ ) to the sync phase ( $0.40 \pm 0.13$ ), but then returned to the pre-sync levels in the post-sync phase ( $0.77 \pm 0.15$ ) ( $F(2,16) = 21.8, p < .001$ ). Analysis of eye tracking data showed subjects attenuating significantly more time to the avatar's legs during the sync phase ( $84.6 \pm 27.6\%$ ) relative to the trunk ( $11.0 \pm 18.4\%$ ) or legs ( $4.4 \pm 9.5\%$ ) ( $F(2,24) = 45.1, p < .001$ ). These data show that subjects were attending to the avatar's legs during the sync task, which does not support the hypothesis that the avatar's head and trunk motion are distracting. Thus, the weakened fractal gait patterns for the subjects were likely due to the constraining nature of attempting to constantly entrain to the avatar's gait, whereas discrete visual information allows for self-organization when synchronizing to a heel-strike stimulus.

### Acute aerobic exercise effects on motor learning and neuroplasticity

Mang, Cameron S.; Snow, Nicholas J.; Campbell, Kristin L.; Boyd, Lara A.; University of British Columbia

Background: Recently, we found that a single bout of high-intensity cycling promoted sequence-specific implicit motor learning (*J Appl Physiol.* 2014;117:1325–1336.). This previous study used a continuous tracking task with a visuomotor adaptation. The exercise effects were specific to improvements in temporal error, suggesting a potential role of the cerebellum (*Neurorehabil Neural Repair.* 2004;18:134–144). Neuroplasticity was also facilitated by exercise, as evaluated via response to a paired associative stimulation (PAS) paradigm that involves cerebellar circuitry (1). This study was designed to determine whether these effects could be replicated using: 1) a serial tracking (ST) task with no visuomotor adaptation, and 2) a PAS paradigm that bypasses cerebellar circuitry. Methods: Sixteen young healthy participants completed the following sessions: (1) rest followed by practice of a ST task and a 24-hr retention test; and (2) cycling followed by ST task practice and a 24-hr retention test; (3) rest followed by PAS; (4) cycling followed by PAS. The ST task involved using a computer mouse to move a cursor to discrete targets with the non-dominant hand. The order of target movements included a repeated sequence, allowing for evaluation of implicit sequence-specific learning. Results: Initial analyses indicate no effect of exercise on learning of the ST task. Participants average movement time ( $p = 0.03$ ) and cumulative magnitude ( $p = 0.01$ ) improved from early practice to retention, with no differences between exercise and rest conditions. Analyses of PAS data are ongoing. Conclusion: The positive effects of a single bout of aerobic exercise on motor learning observed previously may be partly mediated by the cerebellum. PAS analyses will provide insight into whether the involvement of cerebellar circuitry is necessary for acute aerobic exercise to facilitate learning and plasticity. Our findings may have implications for understanding what types of motor learning and what brain regions are most positively affected by a single bout of aerobic exercise. *NSERC*

### Effects of feedback content on judgments of learning and actual motor learning

Meyer, Ben; Shippensburg University

A judgment of learning (JOL) refers to the ability to predict future performance in a previously practiced skill. In a recent study using a Koosh ball overhand throwing task, participants experienced false notions of learning based on transient performance information (Carter et al., 2014). These results held true even when participants were aware that their feedback reflected only their best or worst trials. The purpose of this project was to determine if the results obtained by Carter et al. could be replicated using a different throwing object (beanbag) and technique (underhand). Participants ( $N = 24$ ) threw beanbags at a target located on the floor at a distance of 6 m using a blindfolded, underhand, non-dominant hand technique. Visual feedback was given to participants after each 6-trial block regarding performance on either their best 3 trials (BF) or worst 3 trials (WF). Half of the participants were explicitly aware of their feedback content and the other half were unaware. After each 6-trial block (and before the learning tests) participants made JOLs. Retention tests (consisting of 12 no-feedback trials) were conducted 15 minutes and 48 hr after the practice blocks. A transfer test (throws from a 3-m distance) was also conducted 48 hr postpractice. Participants' throwing performance was significantly better in the transfer test than in the practice and retention tests ( $p < 0.05$ ). Differences were found between feedback groups; BF participants predicted greater learning after each practice block than WF participants ( $p < 0.05$ ). The participants showed little improvement in the practice blocks, in contrast to Carter et al. The results of this project are generally consistent with Carter et al.: performers made improper JOLs even when they were aware that their feedback revealed only their best or worst trials. These findings suggest that individuals are likely to make improper judgments about learning based on temporary performance data even when they have knowledge that their feedback merely represents their 3 best or worst trials in a block.

### **An effector-specific secondary motor task modulates action prediction after physical but not visual practice**

Mulligan, Desmond E., University of British Columbia; Lohse, Keith R., Auburn University; Hodges, Nicola J., University of British Columbia

In a series of studies we have been examining processes involved in action prediction and testing the role of the motor system (and experience) in action understanding. In the current study, we taught novices ( $N = 30$ ) to throw darts at 3 targets and tested their performance on a related prediction task (involving temporally occluded video clips), before and after practice. Importantly, the prediction task was performed while additionally performing a simple, secondary motor task with an effector that either would (right arm) or would not be (left arm) involved in the observed throwing action. A “motor” group physically trained to throw darts, a “perceptual”-training group learned to associate dart throw actions (occluded video clips) with landing outcomes and a final control group did not practice. While both trained groups improved their prediction accuracy significantly after training (motor,  $M$  post-pre = 25.81%,  $SD = 7.82$ ; perceptual, 12.59%,  $SD = 14.41$ ), only the motor group showed a significant decrease in prediction accuracy while performing the secondary motor task with their right hand post-practice, (motor,  $M$  control-right = 21.11%,  $SD = 10.04$ ; perceptual, 5.92%,  $SD = 7.45$ ). These results show evidence of motor simulation during action prediction, but only among observers with motor experience. This suggests there may be two distinct processes involved in action prediction—one visually guided, based on action recognition (used by the perceptual group) and one motor driven, based on simulation (used by the motor group). Because the interference effect was effector specific, these results also underscore the specificity of motor system involvement in action prediction. *Discovery grant to the last author from the Natural Sciences and Engineering Research Council of Canada (NSERC)*

### **Cognitive processes underlying anticipation in a context-oriented task**

Murphy, Colm P., Jackson, Robin C., Brunel University London; Roca, André, St Mary’s University; Williams, A. Mark, Brunel University London

While the way in which expert performers extract and process kinematic cues from an opponent’s postural orientation is well documented, we investigate the cognitive processes involved in anticipation based on contextual information alone (i.e., in the absence of kinematic cues). Long-term working memory theory (Ericsson and Kintsch, 1995) states that through extended experience and practice, high-skilled performers can encode and retrieve information from a knowledge representation stored in long-term memory. Research suggests that superior anticipation performance can be partially attributed to this ability to rapidly encode and retrieve domain-specific representations (e.g., Roca et al., 2011). High- ( $n = 10$ ) and low-skilled ( $n = 10$ ) tennis players watched animated footage of rallies from matches occluded at the opponent’s racket-ball contact and anticipated ball bounce location (depth and direction). Animated footage, which was generated using player movement and ball trajectory data, omitted player kinematics so that only contextual information was available. Retrospective verbal reports were collected and coded using Ericsson and Simon’s (1993) protocol analysis technique. High-skilled participants’ response accuracy scores (depth and direction combined) were significantly higher ( $p < .05$ ) than less-skilled participants ( $M = 71.5\%$ ,  $SD = 10.6\%$  vs.  $M = 50\%$ ,  $SD = 12.5\%$ ). Both groups performed significantly better than chance ( $p < .05$ ), indicating the importance of contextual information when making such judgements. In support of Ericsson and Kintsch’s (1995) long-term working memory theory, high-skilled participants made more evaluation and prediction statements than less-skilled participants. Moreover, these high-skilled athletes’ verbal reports were more detailed. These findings suggest that high-skilled performers employ more complex domain-specific memory representations than less-skilled performers when anticipating in the absence of kinematic cues. Results have implications for the testing and training of anticipation in sport and other temporally constrained domains. *Self-funded*

### **Additional illusory kinesthetic sensation reduces anticipation accuracy in skilled basketball players**

Nakamoto, Hiroki; Ikudome, Sachi; Unenaka, Satoshi; Funo, Taishi; Mori, Shiro; National Institute of Fitness & Sports in Kanoya

Expert athletes can rapidly and accurately anticipate future events by extracting anticipatory body kinematic cues inherent in opponents’ actions. In addition, recent studies have shown that experts may rely preferentially on sensorimotor resonance mechanisms (i.e., motor resonance), which simulate the other’s action in their own motor system. However, little is known about what types of information are simulated to anticipate an opponent’s action. Accordingly, the present study investigated the hypothesis that skilled players simulate others’ kinesthetic information to anticipate future outcomes during observation of others’ actions. Seven skilled and seven novice right-handed male basketball players anticipated the outcomes of basketball free throws based on another player’s free throw (ball flight information was occluded in movies) under the following conditions: simple observation of free throw actions (control), and additional vibration-induced illusory kinesthetic sensations of right wrist (right wrist vibration) or left wrist movement (left wrist vibration) during action observation. Anticipation accuracy (i.e., number of correct responses) was determined for each condition. Moreover, illusory volar-flexion angle was compared between the right and left hand. Anticipation accuracy in skilled players was significantly higher than was that in novice players in the control and left wrist vibration conditions, but significant differences were not observed in the right wrist vibration condition. The illusory volar-flexion angle in the right hand was significantly more augmented than was that in the left hand during action observation in skilled players. These results indicate that skilled basketball players are accustomed to the kinesthetic information for anticipation of shot outcomes. Thus, skilled players may automatically simulate kinesthetic information inherent in others’ actions.

**Gender differences in competition: A non-linear examination of performance and learning**

Olsen, Cameron S.; Ferguson, Natalie L.; Studenka, Breanna E.; Dorsch, Travis E.; Gordin, Richard D.; Utah State University

Examination of behaviors evolution over time, rather than at one specific point in time, can lend insight into the underlying state of the system (e.g., a more regular heartbeat is seen in those with heart pathology and greater regularity of force tracking is seen in those with Parkinson's (Ofori et al., 2010; Pincus & Goldberger, 1994). It is possible that variability of a continuously controlled aspect of performance might decrease in a competitive situation. The implications of changes in motor variability during performance are not yet well understood. Research has shown differences in the attitudes and expectations held by males and females in competitive situations (Croxtton, 1987; Van Loo, 2013). Specifically, male subjects exhibit more competitive attributes (i.e. ego orientation) in sport settings than females. Despite these findings, performance is often similar across genders (Croxtton, 1987). In light of these findings, we conducted a study to better understand how competition against same- and different-sex competitors affects the non-linear variability of motor control for an isometric force tracking task. On three separate days, participants completed 25 trials of practice, 21 trials of competition, and 5 trials to measure retention. The irregularity of motor behavior (ApEn) significantly increased for both female and male subjects when the competitor was of opposite gender. In addition, ApEn significantly increased on Day 3 over Day 1 for all pairings except when a female subject was paired with male competitor. Overall, performance also increased (lower RMSE) for all pairings, but less for females paired with males. Because increased ApEn is typically viewed as indicating more adaptive and automatic behavior, these findings could indicate that females who compete against males do not learn as much as individuals in other pairings. Future studies will need to delineate whether an increase in regularity of performance directly represents a psychological variable such as performance anxiety or learned helplessness.

**Positive perceptions of performance can hinder learning in a dynamic balance task**

Ong, Nicole T., University of British Columbia; Lohse, Keith R., Auburn University; Hodges, Nicola J., University of British Columbia

Subjective perceptions of success during practice have been shown to impact motor learning and memory consolidation processes, independent of objective performance during practice. In the current study, we tested whether feedback about performance, that was either strict (difficult task goal) or lax (easy task goal) with respect to time-on-target in a balance task, would replicate these effects. We also compared two further groups who either started off with strict feedback (difficult goal) and progressed to lax feedback, or had the reverse, to determine whether perceptions of improvement matter for motor memory consolidation, more than perceptions of success (as the Easy-Difficult goal group should show average accuracy across trials, yet not improve across practice). Participants practiced balancing on an unstable platform and percentage time-on-target (TOT) feedback, indicating the proportion of time a horizontal position was maintained within the various goal criteria, was presented after each 60-s trial. Importantly, during practice, the actual error of the groups was not different, but all groups improved across trials. With respect to feedback, the Difficult-Easy group started off with low perceived accuracy, but received feedback suggesting a significant improvement in TOT with practice (trial 1 = 6.78%; trial 12 = 63.2%), whereas the Easy-Difficult groups' feedback suggested a decrease in TOT across trials (trial 1 = 32.8%; trial 12 = 12.7%). Contrary to our predictions, the feedback did not impact learning in a way consistent with a motivational explanation. In retention testing and under secondary task conditions, all groups showed similar retention performance, except for the Difficult-Easy group who was the least accurate (with respect to TOT). These results serve to caution against the blanket use of "positive" feedback as a tool to aid learning. A potentially negative effect of perceived success is that less effort needs to be invested in practice, degrading retention.

**Attentional focus cues effect on object control skill performance in elementary children**

Palmer, Kara K., University of Michigan; Irwin, Jacqueline M., Dennis, Abigail, Auburn University; Porter, Jared M., Southern Illinois University; Robinson, Leah E., University of Michigan

**Background.** Attentional cues are well studied in adults but little is known regarding their effects in children. The purpose of this study was to determine the effect of a neutral, internal, or external attentional focus cue on children's object control skill performance. **Methods.** A total of 44 children ( $M_{age} = 7.7$  years, 20 boys and 24 girls) served as participants. Using a within-participant design, all participants completed the neutral condition during week 1; during the following weeks, participants completed the remaining conditions in a counterbalanced order. The object control subscale of the Test of Gross Motor Development-2nd Edition (TGMD-2; Ulrich, 2000) was used to assess motor performance. To ensure consistency across conditions, skill demonstrations and attentional focus cues were recorded and administered using an electronic tablet. The motor skill demonstrations remained identical across conditions, but the accompanying verbal instruction differed to encompass the prescribed attentional focus cue. The neutral cue had no specified focus, whereas the internal cue focused on movement production and the external cue focused on movement outcome. Children's motor performance was recorded and later coded by a single researcher blinded to the condition assignments. A repeated-measures ANOVA was used to determine if children's motor scores changed among the three conditions. **Results.** Findings demonstrate that children's performance did differ among conditions ( $F(2,43) = 3.5, p < .05$ ). Post hoc analysis revealed that children scored significantly higher in the external cue condition compared to the neutral cue condition (difference = 1.98,  $p < .05$ ). No other significant differences were present. **Conclusion.** These findings partially align with the literature and support that attentional focus cues have a positive effect on motor performance. Specifically, the children perform better when given external focus cues compared to neutral focus cues.

### Passing accuracy during a peripheral response and recognition task

Panchuk, Derek; Maloney, Michael; Australian Institute of Sport

The role of peripheral vision is widely acknowledged in team sport and is, anecdotally, valued by coaches as an indicator of how well athletes perceive their surroundings. Given the apparent importance of peripheral vision, there is little research examining the role it plays in supporting sporting performance. Previous research has focused on basic visual function and has shown little difference in the size of peripheral field between athletes and non-athletes. While sport-specific research suggests that both peripheral and central vision are used to support performance. In this study we used a novel approach to examine how quickly athletes were able to respond to teammates that appear in their periphery. Twenty-five ( $n = 25$ ) elite Australian Rules football players completed two tasks requiring them to handpass to a video image of a player running in their peripheral field of view. In the response task (RESP), they were asked to pass the ball to the player as quickly and as accurately as possible, while in the recognition task (REC) they were asked to only pass to players wearing a dark colored uniform. We compared the angle between the participant and the player on the video image when the handpass was executed (smaller angle = quicker peripheral response) and the accuracy of the pass (absolute error (AE), constant error (CE), and score; 0–3). Results showed that players executed the handpass earlier ( $p < .001$ ) in RESP (15.1 deg) compared to REC (26.8 deg). There were no differences in AE, however, CE was lower ( $p = .015$ ) in RESP (–.03 m) compared to REC (–.19 m). Players also scored higher ( $p < .001$ ) in RESP (1.36) compared to REC (0.55) and were only successful in recognizing the appropriate target 69% of the time. Given that peripheral vision is specialized for detecting movement and has a limited capacity for detecting features, it is not surprising that performance decreased on the recognition task. This task may be a useful tool for delineating the contribution of peripheral vision to sporting performance and discriminating performer expertise.

### Intended phase transitions using Lissajous feedback

Panzer, Stefan, Saarland University; Kennedy, Deanna, Shea, Charles H., Texas A&M University

Previous theoretical and empirical work indicates that intentional changes in a bimanual coordination pattern result in a loss of stability and that the time required to intentionally switch from one bimanual coordination pattern to another depends on the stability of the bimanual coordination patterns (Scholz & Kelso, 1990). Thus, transition from inphase to antiphase has been shown to be slower than switching from antiphase to inphase. The present experiment retests this notion under conditions in which online Lissajous feedback is provided. The experimental design required participants to switch from one goal phase offset to another and then back within a trial. Switching to and from inphase ( $0^\circ$ ) and antiphase ( $180^\circ$ ) were tested in Experiment 1, and to and from  $90^\circ$  and  $270^\circ$  relative phase was tested in Experiment 2. Transition times were estimated from the kinematic data. The results indicated that participants could switch relatively rapidly with little disruption in the harmonicity of the movement time series. Indeed, the switching times were quite similar across conditions and experiments. These results will be discussed in terms of the reduction in the attentional and perceptual constraints resulting from the use of Lissajous feedback.

### Are eye movements necessary to learn a visuomotor task?

Panzer, Stefan, Massing, Matthias, Saarland University; Blandin, Yannick, University of Poitiers

Two experiments were conducted to determine the influence of eye-movements on learning a visuomotor task. The task was to reproduce a 1300-ms spatial-temporal pattern of elbow flexions and extensions. In Experiment 1, the display of the projected spatial temporal pattern was 12 cm in the vertical and 8 cm in the horizontal line. In this display, eye movements were not required because central vision captures all information on the display. In Experiment 2, the display was magnified to 24 cm in the vertical and 16 cm in horizontal line, and eye movements were required to capture all information to perform the task. In both experiments, participants were randomly assigned to one of two practice conditions: a group that was permitted to use eye movements (FREE) and another group that was instructed to fixate a marker during acquisition (FIX) to minimize eye movements. All participants had to perform 100 trials during acquisition. Eye movements were recorded by an eye-tracking system. After a rest interval of 24 hr, the participants in both experiments returned for a retention test. The results of Experiment 1 indicated that participants in each practice condition increased their performance during acquisition. No differences between the FIX and the FREE conditions were detected in the acquisition and in the retention test. The results of Experiment 2 indicated that participants in each condition increased their performance during acquisition, and participants in the FREE condition outperformed those at the FIX condition during acquisition and retention. The findings of the two experiments demonstrated that a visuomotor task can be learned without eye movement, but permitting to use eye movements facilitates the response production when the display was enhanced and the spatial relation of the spatial-temporal pattern was increased.

**Does ischemia influence effector transfer?**

Panzer, Stefan, Leinen, Peter, Saarland University; Shea, Charles H., Texas A&amp;M University

Hikosaka et al. (1999) proposed that sequence learning involves both a fast developing, effector independent component represented in visual-spatial coordinates (e.g., spatial locations of end effectors and/or sequential target positions), and a slower developing, effector dependent motor component that is represented in motor coordinates (e.g., activation patterns of the agonist/antagonist muscles and/or the sequence of joint angles). Ischemia produced by limb compression is often used to investigate human sensory-motor mechanisms especially the activation pattern of the agonist/antagonist muscles. The primary prediction of the present experiment was that effector transfer would be degraded under ischemia conditions when the same motor coordinates are reinstated on the transfer test. Dominant right-handed participants were instructed to reproduce a 1300-ms spatial temporal pattern of elbow flexions and extensions. The vision of the moving limbs was covered. After an acquisition phase, participants were administered a retention and two effector transfer tests. The mirror effector transfer test, where the motor coordinates were reinstated, required the same pattern of muscle activation and limb joint angles as required during acquisition. The non-mirror transfer test, where the visual-spatial coordinates were reinstated, required movements to same visual-spatial locations experienced during acquisition. Both transfer tests were performed under an ischemia and no-ischemia condition. The results indicated that regardless of whether participants performed the effector transfer task under an ischemia or no-ischemia condition, performance on the mirror effector transfer test was superior to performance on the non-mirror effector transfer test. These results are consistent with the notion that movement codes based in motor coordinates were primarily responsible for sequence production. Thus, ischemia did not interfere with the use of codes based on motor coordinates for sequence production.

**Part-whole practice of continuous multifrequency bimanual movements**

Panzer, Stefan, Döhring, Falko, Saarland University; Shea, Charles H., Texas A&amp;M University

The design of the practice schedule seems to be generally important to learning, but especially when the task requires the simultaneous movement of both hands where the requirement for one hand is temporally and spatially different from that of the other hand. Recent research using aiming movements has demonstrated that practice should start with the hand that must perform the more difficult movement (Sherwood, 1994). The present experiment was conducted to determine the effects of part-whole practice schedules on acquiring a continuous multifrequency (2:1) bimanual coordination pattern. To better observe the impact of the practice schedule on the acquisition of the continuous bimanual task, online Lissajous feedback was provided to the participants to reduce attentional, perceptual and other cognitive constraints. Lissajous display with cursor indicating the position of the limbs and a template illustrating the desired movement pattern were provided to the participants. Right-handed participants were instructed to perform a 2:1 polyrhythm by performing flexion-extension wrist movements over 30-s trials. In this task, the right wrist had to move twice as fast as the left wrist. Participants were randomly assigned to one of two experimental conditions: in one condition participants practiced the right wrist movement first, and then with the left wrist, and finally both together (more difficult task). The other started with the left wrist and switch to the right limb. To perform the Lissajous template under the unimanual part practice schedule the cursor position of the unpracticed limb was generated by the computer at a frequency of 1 Hz. Under the test condition in which both hands must perform together, the data indicated no performance differences between the two groups. Thus, the results from aiming bimanual aiming tasks (start with the more difficult task) do not generalize to continuous bimanual movements. It appears that the practice schedule for part practice of bimanual movements is related to task characteristics (movements/continuous movements).

**Split attention degrades performance of complex bimanual patterns, such as producing a 1:1 90° relative phase or producing a 1:2 temporal pattern**

Park, Inchon; Buchanan, John J.; Texas A&amp;M University

Recent research has shown that split attention degrades performance of complex bimanual patterns, e.g., producing a 1:1 90° relative phase or producing a 1:2 temporal pattern. This experiment examined the impact of split attention on observational learning of a 90° bimanual pattern. The impact of split attention was assessed with a visual perceptual test and a motor test of the target pattern of 90°. The visual test required identifying the 90° pattern and the motor test required producing the 90° pattern without feedback. Attention was manipulated during observational training by using a live discovery model and a computer-generated animation to train three observer groups: 1) a multi-attention group that watched the live model and training animation simultaneously (model-animation); 2) a single-attention group that watched a live model (model-only); and 3) a single-attention group that watched only the animation (animation-only). Each observer in groups 1 and 2 were yoked to a unique model. The observers had two viewing days with 30 trials of viewing per day. The primary prediction was that the single-attention observer groups would show a greater benefit for physical performance and visual discrimination of the 90° relative phase pattern compared to the multi-attention resource observer group. All three observer groups were characterized by significant improvement in both the visual perception test and motor production test. Overall, the model-animation group was characterized by better motor performance than the animation-only group, with similar performance compared to the model-only group. This shows that perception and production processes may not be affected by split attention within an observational learning context. Instead, the current training procedure may have provided a means for the model-animation group to compare a model's error to an expert's performance (the animation). Research has recently demonstrated that expert performance when accompanied or combined with a beginner's performance is beneficial for observational learning of motor skills.

### Biological predispositions alter affectively modulated motor action in the absence of distance regulation

Park, Kyoungshin; Lee, Hyekeun; Fawver, Bradley; Hass, Chris J.; Janelle, Christopher M.; University of Florida

Biological predisposition perspectives posit that individuals possess an inherent, behavioral bias to elude harm. As such, motor responses to threatening stimuli are executed more quickly compared to responses executed in pleasant affective contexts. In contrast, distance regulation perspectives propose that the impact of emotion on movement speed is determined by perceptual regulation of physical distance to affective stimuli. We sought to test the central tenets of the biological predisposition hypothesis by determining whether initiation of a stationary cycle ergometer task would be altered under various discrete affective states, as manipulated through emotional images presented on a screen in front of participants. Importantly, the stationary nature of the ergometer task resulted in no change in the distance to the emotional stimuli, thereby allowing a clear test of biological predisposition postulates. Participants ( $N = 22$ ) executed cycle pedaling trials in response to the random presentation of attack, contamination, erotic, happy faces, sad faces, and neutral images. Motor response time, pedal initiation time, and instantaneous velocity and acceleration of pedaling were calculated. Findings indicate that average and maximum instantaneous pedaling velocity was significantly greater when viewing attack images than sad faces ( $ps < .05$ ), and maximum acceleration of pedaling was significantly greater for attack images compared to contamination and sad faces (both  $ps < .05$ ). The magnitude of differences between emotional categories was smaller than hypothesized, but overall, motor execution responses to threat were expedited compared to other affective stimuli. Findings suggest that biological predispositions to avoid threat are manifest in speeded whole body movement that are executed in the absence of real or perceived changes to physical distance.

### The effect of physical and mental practice on clinical skill learning

Perreault, Melanie E.; Brown, Chris; Doan, Rob; Dolbow, David; University of Southern Mississippi

Previous research has shown that a combination of physical and mental practice can be as effective as physical practice alone when learning sport-related motor skills (Feltz, Landers, & Becker, 1988); however, it is unclear whether this effect can be replicated for learning clinical skills in athletic training (AT) and kinesiotherapy (KT). Since AT and KT curriculum requirements leave little time to physically practice skills in the classroom, it is important to determine the most effective and practical form(s) of practice for students to use in and outside of class. Thus, the purpose of this study was to determine the effect of physical and mental practice on undergraduate AT and KT students learning three clinical skills: manual muscle tests of the (1) middle trapezius, (2) supraspinatus, and (3) middle deltoid. AT ( $n = 16$ ) and KT ( $n = 19$ ) undergraduate students 19–23 years old ( $M = 20$ ,  $SD = 1$ ) with no prior manual muscle testing experience were randomly assigned to one of three conditions: (1) physical practice, (2) mental practice, and (3) combined (physical and mental). Testing was conducted over three days consisting of two practice sessions and a retention test. Following initial instruction, participants either physically or mentally practiced each test three times during both practice sessions. The physical practice group physically performed each test on a model while participants in the mental practice group visualized performing each test on a model. Participants in the combined group performed physical practice during the first practice session and mental practice during the second practice session. All participants returned approximately 48 hr later to physically perform each test on a model. Performance of each test was evaluated via checklist by two qualified healthcare practitioners. An ANOVA revealed no significant differences between groups in retention ( $p > .05$ ). The findings suggest that mental practice may be a viable option for AT and KT students learning clinical skills when physical practice is not available in or outside of the classroom.

### Cognitive tasks of increasing load improve stability in challenging postural tasks

Polskaia, Nadia; Richer, Natalie; Thibault, Jeremie; Labelle, Isabelle; Lajoie, Yves; University of Ottawa

Empirical evidence, although conflicting, has found postural control to be susceptible to cognitive manipulations. However, it is unclear to what extent factors such as task and postural complexity modify the interaction between posture and cognition. The aim of the present experiment was to examine the impact of cognitive tasks of varying load and modality on postural stances with differing bases of support. Ten participants ( $M = 20.7 \pm 1.95$  years) stood as still as possible on a force platform while performing 12 conditions involving combinations of three postural stances (feet together [FT], feet apart [FA] and single leg [SL]) and two cognitive tasks of varying demand, each presented in two modalities (auditory and visual). The easy cognitive task (ECT) involved silently counting the number of times a single digit was presented in a sequence of 30 3-digit numbers. The difficult cognitive task (DCT) involved silently counting the number of times two separate digits were presented in a sequence of 30 3-digit numbers. An interaction effect was found between postural stance and cognition for sway area ( $p < 0.001$ ) and ML variability ( $p < 0.01$ ). Increase in cognitive load reduced sway area for FT and SL ( $ps < 0.01$ ), while no effect was found for FA ( $p > 0.05$ ). Increase in cognitive load reduced ML variability in SL only ( $p < 0.001$ ). Visual cognitive tasks were more effective in reducing area and AP variability than the auditory cognitive tasks ( $ps < 0.05$ ). The current set of results suggests that cognitive tasks can effectively withdraw attention from monitoring one's balance and in turn, facilitate stability. Additionally, the effectiveness of a cognitive task may in part be determined by its modality as well as the difficulty of the postural task.



**Improving hand dexterity in stroke by breaking maladaptive finger coordination patterns**

Ranganathan, Rajiv; Michigan State University

One of the most common impairments after stroke is the loss of hand function, which is often characterized by the presence of a single dominant finger coordination pattern and the inability produce other coordination patterns. We therefore examined whether we could use a novel virtual task to get participants to break these dominant coordination pattern. 8 chronic stroke survivors (mean 7 years post-stroke) wore a Cyberglove on their affected hand which measured the joint angles of the metacarpophalangeal joints. We then mapped these joint angles on to the position of a computer cursor. The goal of the participants was to learn to produce finger movements so that they could move the cursor on the screen back and forth between two horizontal targets. Initially we started with a mapping that allowed participants to use their existing dominant coordination pattern to do the task. Gradually, this mapping was changed so that the dominant coordination pattern was now part of the null space—that is, participants could no longer achieve the task without finding a new coordination pattern. We then repeated this over 5 sessions to examine if this practice could facilitate the learning of new coordination patterns and whether it would translate to improved hand function. Results showed that the ability to perform this task was closely related to their functional scores (as measured by the Jebsen test of hand function). Furthermore, we found that stroke participants learned to perform new coordination patterns, as measured by the shift in the first and second principal components. Moreover, we also found modest functional benefits after the 5 sessions of practice, suggesting that the training generalized outside of the practice environment. These results show that this training protocol can be used as a paradigm to improve hand dexterity by breaking these dominant coordination patterns and encouraging the practice of novel finger coordination patterns. *NIH R03 HD069806*

**Gunslinger effect and Müller-Lyer illusion: The role of target context during intended and reacted goal-directed aims**

Roberts, James W.; Lyons, Jim L.; Garcia, Daniel; Burgess, Raquel; Elliott, Digby; McMaster University

Free, internally driven movements are executed slower than stimulus-driven movements. Such movements may involve greater use of sensory feedback to terminate the limb at the target location, and thus, may be influenced by target context. Participants freely executed discrete goal-directed aims with the caveat that following a stimulus-response cue they would immediately respond. The stimuli were a human confederate or computer-generated cue. The potential targets were a series of Müller-Lyer configurations: tails-in, control (X), tails-out. There was a significant stimulus by trial category interaction for the time to peak velocity with faster movements during reaction compared to initiation trials following the human stimulus, but a reverse effect for the computer stimulus. A similar trend was exhibited for the time to peak acceleration and overall movement time. For the amplitude to kinematic landmarks, there was a significant trial category by landmark interaction indicating longer amplitudes at peak deceleration for reaction trials. Moreover, there was a significant effect of target at movement end as the tails-in aims resulted in shorter amplitudes than control and tails-out aims. Although the findings from the computer stimuli are at odds, the human stimuli appear to be consistent with previous studies. This difference may be due to the nature of the stimulus-response task as the human stimuli featured movements that were coincident with the movement of the reacting participant. These findings are consistent with a direct linkage between perceived and executed actions. Finally, the perceived target amplitudes appear to impact both initiated and reacted responses equally, although these target effects are manifested toward the end of the movement. *Natural Sciences and Engineering Research Council*

**Sport-specific perceptual-skill acquisition can be enhanced by degrading peripheral visual information**

Ryu, Donghyun, University of Hong Kong; Mann, David L., VU Amsterdam; Abernethy, Bruce, University of Queensland; Poolton, Jamie M., Leeds Beckett University

Skilled athletes have an advantage for decision making that holds irrespective of whether they use central or peripheral vision. For lesser-skilled athletes though, peripheral visual information may distract attention away from the critical information needed to support perceptual performance (Ryu et al., 2014). To test this we examined whether the rate of perceptual-skill acquisition could be enhanced by the selective impairment of information in the peripheral visual field. Recreational basketball players performed perceptual training over 3 days while viewing with either (1) full (unrestricted) vision, (2) a moving window (clear central and blurred peripheral vision), or (3) a moving mask (blurred central and clear peripheral vision). The window and mask moved commensurate with changes in the direction of gaze. Participants watched video clips of basketball play and at the conclusion of each clip made a decision about which teammate the player in possession of the ball should pass to. Tests of decision-making skill (unique to those used during training) were conducted in a pretest, posttest, and 2-week retention test. Results showed that the accuracy of decision making was greater in the posttest than in the pretest for all three training groups. Remarkably though, training with blurred peripheral vision resulted in an improvement from post to retention test that was not apparent for the other groups. The type of training had no measurable impact on the visual search strategies of the participants and so the training improvements appear to be grounded in changes in attentional control. The findings show that learning with impaired peripheral vision offers a promising form of training to align attentional focus with central vision to improve perceptual performance. Ryu, D., Abernethy, B., Mann, D.L., & Poolton, J.M. (2014). The contributions of central and peripheral vision to expertise in basketball: how blur helps to provide a clearer picture. *Journal of Experimental Psychology: Human Perception and Performance*, Advance online publication.

**Does performing an imagined Fitts's law task share similar characteristics to actually performing the task?**

Salsabili, Hoda; Haddad, Jeffrey M.; Pajouhi, Zoha; Cai, Fuwen; Ryu, Joong Hyun; Liddy, Joshua J.; Zelaznik, Howard N.; Purdue University

Imagined movements are purported to simulate many characteristics as real actions (Decety, 1996). Interestingly Fitts's law is obeyed when participants make movement time (T) judgments while imagining a Fitts task (Wong et al. 2013). However, judgments of T are more similar to real movements if participants have experience performing the task (Chandrasekharan et al., 2012). These results suggest that when making judgments about, people may estimate time rather than "mentally" perform the task. In this study, we compared time estimations and center of pressure (CoP) movements in participants who imagined performing a standing Fitts task with and without Fitts experience to participants who estimated time. Three groups of 11 college-aged participants performed a standing Fitts task at three indices of difficulty (IDs: 3.32, 4.90, 5.32). Twenty-five discrete movements were performed at each ID. Group 1 imagined performing the task without experience. Group 2 performed the Fitts task and then imagined performing the same task. Only MT data from the imagined movements were analyzed. Estimations of T were made by having participants move their finger at an interval they believed matched the time to complete the task. Group 3 estimated time between metronome beeps without receiving any Fitts instructions. The metronome matched the T of participants from Group 2. CoP velocity before and during the movement were used to assess postural adjustments. MT was longer ( $p < .05$ ) in Group 3 compared to Groups 1 and 2. There were no differences in CoP velocity between any of the three groups. However, as expected, CoP was higher in Group 2 when they actually performed the movement compared to the other groups when they imagined performing the movement. Although MT data suggests that imagining performing a movement shares similar characteristics to performing the movement, the postural responses differ. Thus, the intricacies that exist between the coordination of posture and manual tasks when performing real movements are not present when imagining the same task. *Purdue University*

**Implicit versus explicit self-defense instruction on self-efficacy, affect, and subjective well-being**

Sanders, Margaret Perry; Murray, Nicholas; Dlugonski, Deirdre; Raedeke, Tom; East Carolina University

Rising public health concerns are violence and violent crimes. To counter violence, some form of self-defense training is often sought out. Research on self-defense shows such training has a positive impact on a person's self-efficacy and affect. Besides enhancing self-efficacy, the instructional environment of a self-defense training program is important. Two types of motor learning beneficial to learning new motor skills is implicit and explicit learning. Implicit learning occurs without conscious awareness not easily verbalized whereas explicit learning involves verbal instruction and rules. The present study evaluated the effects of an implicit versus explicit 6-week self-defense training program on self-efficacy, affect, and subjective well-being. Thirty older adults (28 women, 2 men), randomly assigned to an implicit or explicit group, participated in a 6-week self-defense program. Participants completed a Self-Defense Self-Efficacy scale, the PANAS-X, and a Personal Well-Being Index-Adult and Subjective Vitality scale. A motor skills test was used to measure acquisition and retention. A 2 (group)  $\times$  2 (time) repeated measure of ANOVA was used to analyze each variable with follow-up post hoc test. Similar to past research, participation in a self-defense program was also resulted in increases in self-efficacy, positive affect, and subjective well-being. In addition, an implicit self-defense training program resulted in greater skill acquisition versus an explicit program. The study's findings also filled a void within research regarding the impact implicit/explicit learning has on self-defense, subjective well-being, and older adults. The study is unique in that few studies have evaluated the impact of self-defense classes in an older population. As the US population grows older, it will be imperative for research to identify the ongoing benefits of self-defense training with countering issues of violence.

**The influence of an anterior load on attention demand and obstacle clearance before, during, and after an obstacle crossing**

Saunders, Deanna; Richer, Natalie; Jehu, Deb; Paquet, Nicole; Lajoie, Yves; University of Ottawa

Carrying an anterior load while navigating an obstacle has been shown to increase attention demand, and this is thought to occur due to the added load as well as the occlusion of immediate anterior vision brought on by the load. Vision is an important factor when navigating an obstacle to aid in preventing any missteps while clearing the obstacle. The objective of this study was to determine whether or not an anterior load, the occlusion of anterior vision, or both increase attention demand when navigating over an obstacle. This study also set out to determine if obstacle clearance height is affected by the occlusion of anterior vision, the anterior load, or both. Sixteen young adults (average age 22 years) performed an obstacle clearance task consisting of three conditions; carrying no load, a clear 5-kg load and an opaque 5-kg load while performing a simple reaction time task. There were 96 trials performed: 9 control and 29 for each of the three conditions. Reaction time at five different locations along the walkway was examined (two steps before, one step before, lead limb crossing obstacle, one step after, and trailing limb crossing obstacle), as well as obstacle clearance height for both the leading and trailing limbs. Results displayed no significant difference ( $p = 0.6653$ ), across the three conditions for reaction time. There was, however, a significant difference showing that reaction times at the three locations before the crossing and at the crossing were greater than the two at the end of the crossing ( $p = 0.0005$ ). It appears as though there is planning occurring just before performing the obstacle crossing. A significant difference was found for obstacle clearance height for the opaque condition compared to the no load condition ( $p = 0.00126$ ). These results suggest that when performing an obstacle-crossing task, while carrying an anterior load the clearance will be increased to avoid contact with the obstacle but does not serve any detrimental effects on attention demand.

**Motor output variability (Schmidt et al., 1979) revisited**

Shea, Charles H.; Kennedy, Deanna M.; Wang, Chaoyi; Texas A&M University

Three experiments were designed to replicate and extend earlier motor output variability experiments by Schmidt et al. (1979). This highly cited paper (ISI: 891 citations) has played a prominent role in enhancing our understanding of the role motor output variability plays in the production of movement. The present experiments tested participants in an attempt to replicate the work of Schmidt et al. using the dominant-right limb to determine the force-force variability relationship (Exp. 1), the movement velocity-We relationship (Exp. 2) and then tested (Exp. 3) the same participants on reciprocal Fitts task with ID = 1.5, 3.0, 4.5, and 6.0. We also tested the participants in each experiment using their non-dominant left limb. Note that the same participants were tested in all three experiments. Our objective was to determine if individual differences in force and impulse variability would be predictive of Fitts task performance and to determine the differences, if any, in motor output variability of the non-dominant left limb compared to the dominant right limb. The data failed to determine differences in the force-force variability relationship between the left and right limb but did detect limb differences in the movement velocity-We relationship. The results are discussed in terms of the relationships between kinematic characteristics of the participants' performances in Exp. 1 and 2 and their performance on the Fitts task.

**Effect of fatigue on motor learning and proprioceptive accuracy in upper extremity**

Siekirk, Nicholas J.; Lai, Qin; Wayne State University

Internal representation of body in space is characterized by visual, vestibular, musculotendinous, articular, and cutaneous sensorial information. Previous research has shown that both localized and generalized voluntary exercise of the lower extremities, lumbar spine, and neck has been shown to be sufficient in disturbing musculoskeletal efficiency in maintaining posture. Therefore, the purpose of this study was to investigate the effect of fatigue on an upper extremity proprioceptive accuracy in motor learning. Right-handed participants (age = 19–30,  $n = 14$ ) were randomly and equally assigned to either fatigued or non-fatigued protocols. Fatigued protocol consisted of elbow flexion of ~85% 1 rep max; prior to each practice block to volitional exhaustion during acquisition. Participants placed the left forearm on kinesthesiometer and moved a handle to 3 locations (30, 50, and 70 degrees) while blindfolded. Acquisition phase consisted of 5 blocks (B1–B5) each with 12 trials. After 48 hr, participants performed 1 block retention test (RT) followed by 1 block transfer test (TT) with dominant arm. 100% verbal feedback was provided during acquisition phase but no feedback on RT and TT. ANOVA with repeated measures on acquisition block demonstrated both groups improved accuracy of angular movements as a result of practice,  $F(4,48) = 10.34, p < .01$ . The main effect of group was detected for acquisition,  $F(1,12) = 5.69, p < .05$ , where fatigue condition ( $M = 7.225$ ) produced more error than non-fatigue ( $M = 5.927$ ). A separated ANOVA on retention and transfer showed that fatigue group ( $M = 9.69$ ) increased total movement error,  $F(1,12) = 5.27 (p < .05)$ , compared to non-fatigue ( $M = 6.83$ ). No significance was observed between RT and TT in either group. Fatigue impeded proprioceptive accuracy. The findings indicated that local muscle fatigue affected not only acquisition but also retention and transfer of this upper extremity angular motion task. Bilateral transfer was observed in upper extremity proprioceptive task, independent of fatigue protocol. *Thomas C. Rumble Fellowship*

**The effects of age on timing of gross and fine motor movements**

Skabelund, Zach T.; Cummins, Daisha L.; Alphonsa, Sushma; Studenka, Breanna E.; Utah State University; Myers, Kodey; Utah State University

Timing may not be controlled the same for all tasks. For discrete tasks, like finger tapping, timing uses an internal clock. For smoother tasks, like circle drawing, no clock is used. It is believed that timing emerges from the control of another aspect of the movement itself (such as velocity). In certain cases, one type of timing may be impaired, while another remains fully functional. For instance, those with cerebellar lesions are impaired in tapping but not circle drawing (Spencer et al., 2003). Research has not yet examined how the timing of gross repetitive movements (such as walking and cycling) compares to timing of fine repetitive movements (such as tapping and circle drawing). To test the timing behavior in gross movement, we looked at the relationship between timing of fine motor movements (tapping and circle drawing) and gross motor movements (walking and cycling). Participants completed 10 trials of five tasks, cycling, walking, tapping with the right finger, tapping alternating right and left fingers, and circle drawing with the right hand. Each trial consisted of 10 metronome tones of synchronization and another 20 s of continuation. The metronome sounded every 600 ms. There was no correlation in the coefficient of variation of timing intervals between gross and fine smooth tasks (circle drawing and cycling). There were likewise no correlations between walking and tapping. Tapping with the right hand correlated with the time series of alternating right-left tapping, and surprisingly, tapping correlated with circle drawing for the older and younger group. The coefficient of variation of timing intervals revealed that, as an individual ages, both tapping and walking (movements believed to be controlled with an internal clock) become more variable, similar to the impairment seen with cerebellar lesion (Spencer et al., 2003), whereas timing without a clock (seen for more smoothly produced tasks) may be preserved.

### **Auditory spatial localization and the cost of corrective limb modifications**

Skultety, Jessica K., McMaster University; Roberts, James J., Liverpool John Moores University; Burkitt, James J., McMaster University; Hansen, Steven, Nipissing University; Lyons, James L., McMaster University

It has been shown that aiming movements are performed in a manner that optimizes energy expenditure and movement time. This leads to undershoot biases towards targets that are exaggerated in the vertical plane, presumably because movement reversals against gravity make target overshoots more costly for both energy and movement time (Lyons et al., 2006). It has also been shown that the frequency (i.e., pitch) of an auditory stimulus biases the perceived location of a target in space such that lower tonal frequencies tend to draw responses downwards and leftwards, and higher tones draw responses upwards and rightwards (e.g., Sonnada et al., 2009). As Hansen et al. (2013) demonstrated, this spatial association of tones has a greater effect in the vertical dimension. Thus, this study aims to explore the mediating effects of auditory cues when paired with aiming movements executed in the horizontal and vertical planes. It is hypothesized that the energy minimization undershoot biases associated with up/down aiming movements will be further biased by the pitch of an auditory stimulus. Specifically, higher and lower frequency tones (1250 Hz, 250 Hz) when paired with aiming movements toward upward and downward targets respectively, should minimize undershoot biases. Participants performed aiming movements to one of two vertically aligned targets spanning 20 cm from a centralized home position. A visual stimulus (color change of target) or one of two endogenously presented auditory stimuli (i.e., through headphones) signaled movement onset. Expected results confirming a reaction time advantage to an auditory cue were observed. Surprisingly, however, results suggest that while typical undershoot biases were evident in upward aiming movements, these effects were only minimally influenced by both congruent (high frequency) and incongruent (low frequency) auditory cues. These results will be further discussed in the context of the spatial characteristics of pitch.

### **Team-based learning outcomes: Developing a survey instrument to evaluate student learning**

Smiley-Oyen, Ann L.; Orgler, Lisa; Artz, Georgeann; Lamm, Monica; Dorneich, Michael; Bender, Holly; Bickelhaupt, Sara; Gahn, Sandra; Dorius, Cassandra; Jacobs, Keri; Iowa State University

**Introduction.** The specific aim was to develop a high-quality researched-based survey instrument to quantitatively measure less tangible student learning gains acquired in team-based learning (TBL) instructional settings. These learning domains included growth in areas of motivation for lifelong learning and pre-class preparedness, critical thinking and problem-solving ability, and professional and workplace preparation. **Methods.** Our three overarching constructs within the TBL framework were 1) attitudes and beliefs about learning; 2) motivation to learn; and 3) professional development. The survey of 44 questions was created and administered in-class to 25 motor control and learning undergraduate students. Based on those results, the same survey was administered online to a larger sample during consecutive semesters ( $n = 379$ ), and included students across disciplines. The survey required approximately 15 min to complete. Professors encouraged students to complete the survey, and many provided extra credit if completed. **Results.** Preliminary analyses of the pilot study suggested favorable to strong reliability for all three constructs, with Cronbach alphas ( $\alpha$ ) ranging from 0.67 to 0.90. Results from the larger sample demonstrated that the measures were significantly robust assessments of the three key concepts across samples ( $\alpha = 0.84-0.90$ ), and these measures fit the data exceptionally well ( $r^2 = .99$ ). **Discussion.** Traditionally, letter grades and numeric grade point averages are the hallmarks of students' ability to learn, but they do not capture all of the important learning outcomes. To fully understand the value of TBL as an effective pedagogy, it is important to measure student skill development, such as including ways to improve critical thinking skills. We conclude that this survey provides instructors with a valid and reliable method to make evidence-based decisions regarding TBL course improvement and provides a means to assess learning outcomes not otherwise evident on a student's grade report. *Miller Faculty Fellowship Award*

### **Transfer of learning between unimanual and bimanual rhythmic movement coordination is a function of the task dynamic (information and stability)**

Snapp-Childs, Winona, Indiana University; Wilson, Andrew D., Leeds Beckett University; Bingham, Geoffrey P., Indiana University

**Introduction:** Under certain conditions, learning transfers from trained to untrained versions of a task. However, it remains unclear what those certain conditions are and thus when learning should transfer. We examined this issue using coordinated rhythmic movement as a model system. Previously, Bingham (Bingham, 2001, 2004a, 2004b, and Snapp-Childs et al., 2011) created a coupled oscillator model of the underlying task dynamic which includes an account of the perceptual coupling between the limbs being coordinated. The model predicts (1) that learning a new coordinated rhythmic movement is primarily about learning to perceive and use the most stable information about the relative phase and (2) that stability in performance, both before and after learning, is also conditioned by coupling strength (lower for uni- than bi-directional coupling). So, with equal perceptual improvement, there should be equal transfer of learning between bimanual and unimanual coordination with performance evaluated relative to the strength of coupling. **Methods:** Two groups of seven individuals each were tested (1) in producing 90° relative phase unimanually (using a joystick to move a dot on a computer screen with respect to a computer controlled dot) and (2) bimanually (using two joysticks to move two dots on a computer screen with respect to one another) as well as (3) to discriminate 90° visually from other relative phases. Then, participants were trained to produce 90° either unimanually or bimanually and finally, tested for learning, transfer, and improvements in visual discrimination. **Results:** Both groups improved at the condition at which they were trained and in their ability to discriminate 90° visually and this learning transferred to the untrained condition. **Conclusions:** Transfer of learning is determined by the composition of the underlying task dynamic, and in the case of coordinated rhythmic movement this dynamic involves perceptual information and the acquisition of sensitivity to it.

**Effects of acute aerobic exercise on motor response inhibition: An ERP study using the stop-signal task**

Song, Tai-Fen, Chu, Chien-Heng, Yang, Kao-Teng, Chang, Yu-Kai; National Taiwan Sport University

The purpose of the current study was to examine the effects of a single bout of moderate-intensity exercise on aspects of motor response inhibition in young adults using both behavioral and electrophysiological approaches. Twenty-one right-handed college students (19–24 years old) were recruited. All participants were invited individually to the laboratory at about the same time of day, on three separate occasions that occurred at least 24 hr apart. During the first visit, participants were instructed to complete the demographic and health screening questionnaires, and were assessed for the peak of their cardiovascular fitness. During their second and third visits, participants were instructed to complete an exercise session and a control session, in a counterbalanced order. Immediately following the single bout of moderate-intensity exercise and a sedentary control session that involved reading, the P3 and N1 event-related potential (ERP) components were recorded while performing a stop-signal task. The results demonstrated that acute exercise induced a shorter stop signal response time (SSRT) as compared to the control session; nevertheless, the go response time (Go RT) remained unaffected. In examining the ERP data, acute exercise increased both P3 amplitude and P3 latency, but did not significantly influence the N1 component. These findings suggest that acute exercise possesses a selective and beneficial effect on cognitive functions, specifically affecting the motor response inhibition aspect of executive functions. Furthermore, acute exercise predominately impacts later stages of information processing during motor response inhibition, which may lead to an increase in attentional resource allocation and confer the ability to successfully withhold a response in order to achieve motor response inhibition.

**Gait variability in stroke survivors and healthy older adults**

Stout, Ruth D., University of North Carolina at Greensboro; Lewek, Michael D., University of North Carolina in Chapel Hill; Ross, Scott E., Rhea, Christopher K.; University of North Carolina at Greensboro

Neuromotor control is more variable after a stroke, partially accounting for an increased fall-rate in stroke survivors (73%) relative to healthy older adults (30%). The majority of stroke survivor gait research has focused on short duration trials, providing limited information about how neuromotor control evolves over an extended period of time. Longer trials allow for additional information, as metrics computed from detrended fluctuation analysis (DFA) and sample entropy (SampEn) can reflect the functional capacity of the neuromotor system. This study examined gait variability metrics in 20 healthy older adults ( $63.4 \pm 8.9$  years) and 7 non-cerebellar/non-brain stem stroke survivors ( $57.6 \pm 7.7$  years). The participants were all community dwelling and able to walk without an assistive device. Gait mechanics were recorded for 10 min while walking at a self-selected speed on a treadmill with a safety harness. The dependent variables (DVs) were step length, step width, step time, and stride time for both the affected and unaffected sides. The metrics of mean, standard deviation (*SD*), coefficient of variation (CoV), DFA, and SampEn were calculated for each DV. The mean, *SD*, and CoV were significantly different between groups (all  $p < .02$ ) for nearly all DVs (percent differences were  $39.3 \pm 30.4\%$  for mean,  $56.7 \pm 33.3\%$  for *SD*, and  $71.3 \pm 7.3\%$  for CoV when averaged across DVs). Only *SD* of step width was not different between groups ( $p = .80$ ). DFA- $\alpha$  and SampEn for all DVs were not different between groups (all  $p > .05$ ), with the exception of DFA- $\alpha$  of step length being lower for the stroke survivors ( $0.48 \pm 0.11$ ) compared to the healthy older adults ( $0.63 \pm 0.10$ ) ( $p = .002$ ). These data suggest that summary metrics (mean, *SD*, and CoV) may be the strongest indicators of gait dysfunction after a stroke. The stroke survivors had clear qualitative differences in their gait mechanics that led to functional limitations during walking. However, DFA and SampEn of step length, step width, step time, and stride time mostly failed to pick up these functional limitations.

**Neural activation during real-time stuttering, synchronization timing, and sequential timing tasks**

Studenka, Breanna E., Gillam, Ronald B.; Utah State University

Although research attempting to document general motor timing impairment in stutterers is equivocal, individuals who stutter do exhibit slower response initiation times than control subjects and have difficulty organizing and/or initiating new response sequences. While individuals who stutter do not seem to have impairment performing non-complex (isochronous) rhythmic tasks, they may have trouble detecting and/or responding to unpredictable changes in timing (e.g., phase shift perturbations). Furthermore, timing in stutterers is typically examined in a laboratory environment, far removed from situations where stuttering actually occurs. Indeed, for some stutterers, stuttering behavior occurs most often in stressful situations, such as when having to make a phone call. In light of this, in two different sessions, one involving actual phone calls, we examined the behavioral responses of 4 stutterers and 4 control subjects, to perturbations during synchronization tapping. Additionally, neural activation using near infrared spectroscopy (NIRS) was recorded during actual stuttering and following timing perturbations. In a follow up study, we also examined sequential tapping and circle drawing performance along with corresponding brain activation. Stutterers exhibited slight overcorrection response to tapping perturbations. Furthermore, we document greater coefficient of variation during sequential tapping in stutterers versus non-stutterers with no difference in variance of circle drawing intervals. General findings from neural imaging show greater activation in the pre-frontal cortex following a disfluency for stutterers. In addition, stutterers exhibited lesser cortical activation overall during circle drawing and tapping. Our findings support the idea of a general motor timing impairment in stutterers, specifically related to sequential timing and possibly tied to less cortical activation during timing and speech compared to rest.

### **Use of three-dimensional motion analysis to investigate motor learning from action observation training with immediate physical practice in chronic stroke**

Sugg, Kita, Dempsey, Alasdair, Muller, Sean, Murdoch University; Winstein, Carolee, University of Southern California

The mirror neuron system provides a biological link between action observation and actual performance of the same action. Previously we demonstrated the additive value of action observation plus physical practice for improving upper extremity movements in those with chronic stroke (Sugg et al., in press). Using a within-subject design 14 chronic stroke survivors demonstrated greater changes in clinical assessment scores during the action observation plus physical practice phase. Although clinical scores improved we know little about how actual motor performance changed. The purpose of this sub-study is to understand whether these clinical score changes represented restitution or substitution of motor control. Three-dimensional motion of the trunk and upper extremity was collected using 12 Qualisys cameras (Oqus 3+) and compiled in Qualisys Track Manager during reaching movements from four subjects who participated in the parent study. Three-dimensional motion was recorded at three sessions (baseline, post control phase and post action observation phase). At each session, kinematic data were collected from the affected and unaffected upper extremity during performance of five trials reaching towards targets of 50, 75, and 100% of seated arm distance. Visual 3D was used to calculate elbow angle during each reaching movement. Trunk data was assessed visually from sagittal plane video footage. Consistent with the clinical scores and in the 100% arm distance condition, there were significant improvements that were greater after the action observation phase compared to the control phase. Significant increases were seen in magnitude of elbow extension from collected kinematic data, along with a reduction in forward trunk flexion as observed from video footage. These preliminary results suggest the improvements from action observation were due to restitution of the normal arm/trunk coordination during reaching and not due to substitution of an abnormal coordination pattern. *Partially funded by the McCusker Charitable Foundation.*

### **Effect of dual task on choice reaction step initiation**

Sun, Ruopeng; Hartley, Caleb S.; Shea, John B.; Indiana University–Bloomington

The purpose of this study is to compare the effect of dual tasking (DT) on response preparation and response execution during choice reaction step initiation (CRST). Ten college students were recruited to participate in this study. Subjects were required to perform a rapid voluntary step with either the left or right leg after hearing an auditory tone (250 / 500 Hz) while standing on a force platform under single and dual task conditions. In the DT condition, subjects performed a finger tapping task in a prescribed pattern with the right index finger on a hand-held numeric keypad. The center of pressure (COP) was analyzed to determine the types of anticipatory postural adjustment (APA) prior to a step. The APA phase and stepping phase timing were calculated based on the COP trajectory. The dual task performance was evaluated by comparing the speed of button pressing before and during stepping, as well as the performance during static standing. Our results showed that APA error rate increased by 33% in the DT condition, while the finger tapping speed dropped 15% during the step execution phase. Furthermore, the reaction time (RT), APA phase, and stepping phase timing in the DT condition were significantly slower than in the single task (ST) condition. These results support findings of previous studies on performance decline of motor and cognitive tasks under DT conditions.

### **Increased corticospinal excitability and muscular activity in a lower limb reaction task under psychological pressure**

Tanaka, Yoshifumi, Shimo, Tatsunori, University of Fukui

There has been a recent increase in studies aimed at clarifying neurophysiological functioning related to motor performance under psychological pressure. The purpose of the present study was to investigate the effects of psychological pressure on cortical and spinal motor neuron excitability, lower limb muscular activity, and reaction times during a task involving dominant leg movement. Ten healthy participants performed a Go-NoGo task by raising their heel of the dominant foot from a foot switch. After 20 practice trials, participants performed 20 non-pressure and 20 pressure trials in a counterbalanced order. Stress responses were successfully induced, as indexed by significant increases in state anxiety, mental effort, and heart rates under pressure. Significant increases in motor evoked potential (MEP) amplitude of the tibialis anterior muscle (TA) occurred under pressure. In terms of task-related EMG amplitude, the co-contraction rate between the soleus (SOL) and TA muscles significantly increased along with SOL EMG amplitude under pressure. Hoffmann reflexes and reaction times did not change under pressure. We conclude that corticospinal excitability under pressure is dependent upon cortical activity that is particularly localized at the primary motor area, and is independent from spinal reflex excitability. *Grant-in-Aid for Young Scientists (b) from Japan Society for the Promotion of Science (JSPS) KAKENHI (No. 25750290)*

**Motor skill proficiency and physical activity in pediatric carriers and non-carriers of the BDNF Val66Met polymorphism**

True, Larissa, SUNY Cortland; Pfeiffer, Karin A., Smith, Alan L., Kagerer, Florian, Gerlach, John, Branta, Crystal, Michigan State University

Little is known about genetic influences on motor skill proficiency (MSP). Evidence suggests the brain-derived neurotrophic factor (BDNF) val66met polymorphism is associated with delays in fine motor learning and thus parallels may be drawn to gross MSP and the polymorphism (McHughen et al., 2010). Physical activity (PA) is an important factor in the secretion of BDNF (Egan et al., 2003). The purpose of this study was to assess prediction of carrier status (carrier/non-carrier) by gross and fine MSP, PA, and sedentary time. Boys and girls ( $n = 105$ ) aged 9–10 years gave saliva samples that were genotyped. Gross MSP was assessed using locomotor, object control, and total skill scores from the TGMD-2 (Ulrich, 2000). Fine MSP was assessed using scores on the pegboard and star-copying tasks from the BOT-2 (Bruininks et al., 2005). Participants wore an ActiGraph GT3X accelerometer to assess PA and sedentary time. Complete data were obtained from 82.9% of children: 64% of participants were non-Met-carriers, 30% were Met-carriers, and 6% were Met-Met-carriers. Boys spent less of their time sedentary (57.4%) than girls (62.4%), and more of their time in moderate PA (5.1%) than girls (3.5%). Boys outperformed girls on the object control subtest ( $M = 39.2$  vs.  $32.1$ ;  $p < .05$ ) and locomotor subtest ( $M = 42.0$  vs.  $40.3$ ;  $p < .05$ ). Higher object control scores and male sex predicted more time spent in moderate-to-vigorous PA (MVPA),  $F(5,81) = 9.47$ ,  $p < .001$ ,  $r = .61$ ). An inverse association between object control scores and sedentary time was found,  $F(5,81) = 3.86$ ,  $p < .005$ ,  $r = .38$ . Discriminant function analysis showed 27% of the variation in carrier status to be predicted by sedentary time, MVPA, locomotor skills, and fine motor skills. Those who were more sedentary, spent less time in MVPA, and had poorer fine and gross MSP were more likely to be characterized as a carrier. Though speculative, results suggest that more time spent in MVPA and less time sedentary may override deficits associated with the polymorphism.

**Detecting single-target changes in multiple object tracking: The case of peripheral vision**

Vater, Christian, Kredel, Ralf, Hossner, Ernst-Joachim; University of Bern

In sports games, it is often necessary to perceive a large number of moving objects (e.g., the ball and players). In this context, the role of peripheral vision for processing motion information in the periphery is often discussed especially when motor responses are required. In an attempt to test the basal functionality of peripheral vision in those sports-games situations, a multiple object tracking (MOT) task that requires participants to track a certain number of targets amid distractors, was chosen. Participants' primary task was to recall four targets (out of 10 rectangular stimuli) after 6 s of quasi-random motion. As a second task, a button had to be pressed if a target change occurred (Exp 1: stop vs. form change to a diamond for 0.5 s; Exp 2: stop vs. slowdown for 0.5 s). While eccentricities of changes ( $5\text{--}10^\circ$  vs.  $15\text{--}20^\circ$ ) were manipulated, decision accuracy (recall and button press correct), motor response time as well as saccadic reaction time were calculated as dependent variables. Results show that participants indeed used peripheral vision to detect changes, because either no or very late saccades to the changed target were executed in correct trials. Moreover, a saccade was more often executed when eccentricities were small. Response accuracies were higher and response times were lower in the stop conditions of both experiments while larger eccentricities led to higher response times in all conditions. Summing up, it could be shown that monitoring targets and detecting changes can be processed by peripheral vision only and that a monitoring strategy on the basis of peripheral vision may be the optimal one as saccades may be afflicted with certain costs. Further research is planned to address the question whether this functionality is also evident in sports tasks.

**Promoting gross motor skill in toddlers: Active Beginnings, a randomized controlled trial**

Veldman, Sanne; Okely, Tony; Jones, Rachel; University of Wollongong

Gross motor skills are the building blocks for physical activity and are associated with a range of positive health outcomes. To date, no known interventions have been implemented in toddlers (<3 years). The aim of this study was to examine the feasibility, acceptability, and potential efficacy of a gross motor skill development program for children aged 2 years. An 8-week, parallel-group pilot randomized controlled trial was conducted in May and June 2014 involving four long day care centers in Wollongong, NSW, Australia. Centers were randomized to the intervention ( $n = 2$ ) or control group ( $n = 2$ ) following baseline assessments. The intervention comprised a gross motor skill development program, Active Beginnings, which was implemented for 10 min/day. The control group continued their normal daily routine. Gross motor skills were assessed using the TGMD-3 (jump and kick) and the Get Skilled Get Active (balance) pre- and postintervention in all centers. During the intervention, feasibility and acceptability data were collected via checklists completed by educators. Data were analyzed using ANCOVA with adjustments for baseline values. Sixty children were recruited and at follow-up, 95% were retained. Children had a participation rate of 76% and educators rated 98% of the experiences as appropriate, with respect to the duration of the lesson and equipment needed. Children in the intervention group showed significantly greater improvements in gross motor skills compared to the control group. The adjusted mean difference for the total score (all three skills combined) was 4.21 components ( $p < 0.0001$ , Cohen's  $d = 1.13$ ). This is the first known study evaluating the effect of a gross motor skill intervention in 2-year-olds. The study has promising results and was found to be feasible, acceptable and potential efficacious in improving gross motor skills. This study can be easily translated into practice in early childhood settings and shows that young children can be taught gross motor skills and can improve their skill level when intentional teaching occurs.

### **Cognitive representation of open and closed skills**

Vogel, Ludwig, Schack, Thomas; Bielefeld University

Depending on the environment, complex sport movement can be classified as open, closed, or mixed skills. In predictable environments (closed) performance can be planned in advance, whereas changing environments require more variable (open) skills. We investigated the cognitive representation in the context of closed and open skills, applying a psychometric measurement method. In a closed sport environment, we examined two specific techniques (i.e., golf putt and golf pitch) in an expert-novices paradigm. Results showed that experts' representations were functionally organized to the biomechanical demands of the task, whereas novices' cognitive representations were organized less functional. In a more open sport environment, we investigated the cognitive structure of the attack hit in volleyball dependent from the player's position. We found significant differences between the cognitive structures of the player-position. Quick-spiker and the ace-spiker showed task-specific characteristics of their representation structure that were adapted to the open environment. Taking the results into account, it is obvious that coaches and athletes often interact by drawing on different mental representations. To optimize the training process in open and closed environments we show on the basis of different examples how to use the athlete's representation structure of complex movements for a suitable feedback. *German Research Foundation Grant DFG EXC 277 "Cognitive Interaction Technology"*

### **Learner-adapted motor skill acquisition: The influence of practice schedule on individual practice phases and consolidation of motor skills**

Wadden, Katie; Hodges, Nicola; Boyd, Lara; University of British Columbia

The *challenge point framework* outlines the theoretical concept of optimal challenge point during motor learning, and the important consideration of task demands and individual skill level. To investigate task demands and individual skill level, in Experiment 1, we quantified performance during motor skill acquisition using an exponential curve fitting method. Participants practiced a novel motor task that involved explicit instructions to match symbols in a repeating pattern that constituted three distinct sequences of movements performed in a serial, repeating order across one day of practice. Based on fitting of an exponential function to individual practice performance curves, data points of significant change from the slope of the function were calculated, and used to divide practice into three phases, from the beginning to end. The ratio of trials in each phase of skill acquisition provides a measure of the task demands throughout practice. A significant relationship emerged between the proportion of trials in practice phases and retention performance. We discovered a relationship between slower skill acquisition and improved retention. In Experiment 2, we manipulated individual practice schedules with a learner-adapted algorithm based on Choi et al., 2009, that extracted practice metrics from the phases of skill acquisition from Experiment 1. This algorithm manipulates task demands on an individual skill level to alter contextual interference (CI) and in turn systematically control task difficulty. The highest difficulty (High) condition, and thus highest level of CI, resulted in superior retention performance. Based on these results, we conclude that although the theoretical premise of the challenge point framework is compelling, its practical implementation requires additional research and development.

### **Where bimanual coordination pattern interacts with element difficulty: Examining coupling stability and harmonic nature of bimanual sequences**

Wang, Chaoyi; Kennedy, Deanna M.; Shea, Charles H.; Texas A&M University

An experiment was designed to investigate the influence of movement difficulty on the control process and organization of bimanual (in-phase and anti-phase) sequential movements. Participants were asked to move as quickly and smoothly as possible from one illuminated target to the next. When they achieved the target location the illumination was turned off and the next target in the sequence was illuminated. Participants were randomly assigned to one of four groups based on the size of the targets and whether the bimanual task was in-phase or antiphase. The manipulation of target size resulted in index of difficulty levels of 3 and 5. Eight participants in each bimanual group (in-phase and anti-phase) practiced 2 sessions of 11 trials (60 s per trial). As expected, the results indicated that the higher difficulty condition (ID5) results in longer element durations than observed for the lower difficulty condition. Also as expected, the element duration for anti-phase group was longer than for in-phase group. However, an interaction between coordination pattern and element difficulty was found in segment harmonicity and relative angle variability. The segment harmonicity and relative angle variability were higher for the in-phase than anti-phase groups for the ID3 tasks, but no difference was found between the two coordination modes for the ID5 tasks. The results support our initial hypothesis that the difference in coupling stability and harmonic nature in bimanual sequences was mainly observed in lower ID task.



**Differences in mu rhythm between successful and unsuccessful golf putting performance in skilled golfers**

Wang, Kuo Pin; Chen, Tai Ting; Chang, Yi Ting; Cheng, Ming Yang; National Taiwan Normal University; Huang, Chung Ju, University of Taiwan; Hung, Tsung Min, National Taiwan Normal University

Mu rhythm is most pronounced at the sensorimotor area of the brain within the frequency band between 8 and 13 Hz. The decrease of mu rhythm has been related to better motor preparation. Although previous studies have demonstrated in experts a mu rhythm lower than that of novices in simple motor skills, whether a similar pattern of differences can be observed between good and poor performance in skilled motor performers remains to be investigated. Therefore, this study focused on sensorimotor mu rhythm differences between successful and unsuccessful golf putting performance in skilled golfers. Methods: Twenty-seven skilled golfers (mean handicap = -2.4,  $SD = \pm 3.3$ ) were recruited and all participants performed a total of 40 putts in 4 separate blocks at an artificial golf green while electroencephalography (EEG) was recorded. Results: A 2 (performance: successful performance, unsuccessful performance)  $\times$  2 (time: T2 = -2 s ~ -1 s, T1 = -1 s ~ 0 s)  $\times$  3 (electrode: C3, CZ, C4) ANOVA revealed a significant interaction effect between performance and time. Post hoc simple main effect analysis indicated that the mu power for successful golf putting at T2 was smaller than that of unsuccessful golf putting performances. Discussion: The finding of this study is consistent with previous studies that showed, prior to skill execution, a smaller mu power was related to better motor preparation and predictive of performance.

**The impact of observing flawed demonstrations on clinical technical skill learning**

Welsher, Arthur M., Vanderbeek, Laura, McMaster University; Rojas, David, University of Toronto; Khan, Zain, Kapralos, Bill, University of Ontario Institute of Technology; Grierson, Lawrence E.M., McMaster University

There is strong evidence that certain neurophysiological processes link action and observation as they relate to movement (Higuchi et al., 2012) which supports the idea that learning a skill is enhanced via skill observation (Hayes et al., 2010). Recent research on this phenomenon indicates that skill learning through observation is optimized when the observation includes a combination of expert and novice models (Rohbanford & Proteau, 2011). The purpose of this study is to explore the impact of video-based observational practice on the clinical learning of medical clerks throughout McMaster University's distributed medical education network. First-year medical students ( $N = 23$ ) performed a pretest of a simulated elliptical excision, a common surgical skill, after which they were randomly allocated to three experimental groups: a group that observed expert demonstrations of the skill ( $N = 8$ ), a group that observed novice demonstrations ( $N = 8$ ), and a group that observed a combination of expert and novice demonstrations ( $N = 8$ ). All participants observed a total of 8 group-specific videos over 15 days using an Internet-mediated learning environment, and rated each video using a modified version of a standardized and validated global rating scale and checklist (Alam et al., 2014). Immediately following and 1 month after the 15-day observational period, participants returned to the lab for posttest and retention tests respectively. Preliminary results suggest that all learners improved at the elliptical excision over the intervention period, and that the observation of performance errors contributed significantly to this learning. The results of this study will be discussed with respect to the type of errors that facilitate skill learning and the impact that this has for applications of simulation-based education in health professions training.

**Multi-muscle activation patterns for fine and gross pointing movements differ across visual conditions**

Winges, Sara A., Hondzinski, Jan M.; Louisiana State University

Reaching and pointing movements made in dark environments often results in a vertical undershooting of a remembered target location when compared to illuminated environments. This effect has been observed for arm as well as finger movements. The present study was designed to examine patterns of muscle activity generated during these movements. Since the lights were extinguished just prior to movement onset in darkness, the planned movement should be the same across visual conditions. We hypothesized that endpoint precision would be correlated with changes in the multi-muscle patterns during the deceleration phase of the movement. Young adults with no reported neurological impairments produced pointing movements to real targets and remembered target locations in complete darkness (dark) or normal room lighting (light) from standing and side lying body orientations. During the pointing movement, gaze was anchored on target or remembered target locations. Subject performed six pointing movements with their arm and finger to targets located in front of the subject's midline at shoulder, eye, and mid trunk levels in each visual condition for each body orientation. Movements of the shoulders, elbow, metacarpophalangeal joint of the second digit, and the fingertip of the dominant pointing limb were recorded. Surface electromyography from anterior and posterior deltoid, latissimus dorsi, biceps, triceps, first dorsal interosseus, a portion of the flexor digitorum and extensor digitorum was recorded. Multi-muscle activation patterns for several subjects reflected earlier onsets and steeper increases in the initial burst during the acceleration phase of agonist muscle(s) in the dark compared to light, while other subjects produced lower burst amplitudes in the agonist muscle(s) in the dark ( $p < .05$ ). There were no clear differences between visual conditions in the multi-muscle patterns during deceleration ( $p > .05$ ). The phenomenon of undershooting was best correlated with modifications to the initial bursts of agonist muscle activity to reduce movement amplitude.

### **Autonomy support, enhanced expectancy, and external focus: Additive effects for motor learning**

Wulf, Gabriele, University of Nevada, Las Vegas; Chiviawsky, Suzete, Cardozo, Priscila, Federal University of Pelotas; Palmer, Kimberly, University of Nevada, Las Vega

Three factors have been postulated to be essential for optimal motor skill learning (Wulf, 2014): Autonomy support (AS), enhanced expectancies (EE) for performance, and an external focus (EF) of attention. Supporting learners' need for autonomy by giving them choices has consistently been found to enhance motor learning. Also, providing learners with positive feedback, including favorable social-comparative feedback, facilitates learning. Finally, directing learners' attention to the intended movement effect, or inducing an external attentional focus, has beneficial effects on learning. In 3 recent studies (Pascua, Wulf, & Lewthwaite, 2014; Wulf, Chiviawsky, & Cardozo, 2014; Wulf, Chiviawsky, & Drews, 2015) combining 2 of the 3 variables (AS-EE, AS-EF, EE-EF) in factorial designs resulted in superior learning relative to the presence of only 1 variable or none. In the current study, we examined whether the combination of all 3 factors would be able to enhance learning even further compared with combinations of 2 factors. Thus, our design included 4 groups: AS-EE-EF, AS-EE, AS-EF, and EE-EF. Participants were asked to throw beach-tennis balls at a target. In the AS conditions, they were allowed to choose the ball color before each 5-trial block. In the EE conditions, they received (false) social-comparative feedback indicating better-than-average throwing accuracy after every 10 trials. In the EF conditions, participants were asked before each 10-trial block to focus on the target. No significant group differences emerged during the practice phase. However, on a retention test 1 day later, planned comparisons confirmed our hypothesis: The AS-EE-EF had the highest accuracy score (39.0) and outperformed all other groups [ $t(48) = 2.191, p < .05$ ], which showed similar performances (AS-EE: 29.9; AS-EF: 27.2; EE-EF: 30.3). Thus, the present findings provide evidence for a new theoretical approach (Wulf & Lewthwaite, 2015), according to which AS, EE, and EF are essential, and seemingly irreplaceable, components of practice for optimal motor learning.

### **Directing attention externally effects heart rate and muscular endurance**

Yamada, Masahiro, Brown, Blake, Porter, Jared; Southern Illinois University

The constrained action hypothesis proposes that an external focus of attention improves motor performance compared to an internal focus of attention as a result of changes in movement automaticity. Little research has examined how altering focus of attention impacts muscular endurance. Additionally, little is known about the relationship between the focus of attention effect and heart rate, especially while performing a fatiguing task. This is of particular importance considering there is a strong correlation between heart rate and skeletal muscle activity. The present study examined the influence of focus of attention on heart rate and muscular endurance. Using a within-participant design, participants ( $N = 48$ ) performed a fatiguing wall sit task. Volunteers' were assessed on the wall sit task in three counterbalanced conditions: External, internal, and control. We examined two variables. First, the average heart rate was assessed during the task. Secondly, the duration until muscular failure was recorded. Our hypothesis was that heart rate would be lower in the external condition compared to the internal and control conditions. In addition, we predicted that the time to muscular fatigue would be greater during the external condition compared to the internal and control conditions. Results indicated that the average heart rate of the external condition was significantly lower than the internal condition. However, the heart rates of the external and control conditions were not different. In regards to muscular fatigue, the time until failure was significantly greater when participants focused their attention externally compared to when they were in the internal or control condition. Also, participants had a higher time until failure when in the control condition compared to the internal condition. The results of this study indicate that directing attention externally rather than internally not only improves muscular fatigue but also results in a lower heart rate when performing a fatiguing task.

### **The motor learning effects of applying knowledge of results with increasing precision when practicing a novel throwing task**

Yamada, Masahiro, Straughter, Sharrell, Porter, Jared; Southern Illinois University

The frequency of providing knowledge of result (KR) has been well investigated, and we know that generally providing a reduced frequency of KR during acquisition typically results in greater motor learning compared to providing frequent KR during practice. However, the effect of the precision of KR has not been thoroughly examined. Knowing how the precision of KR impacts motor learning is important for both theoretical and practical reasons. The purpose of this study was to determine whether increasing the precision of augmented feedback affected motor learning. The primary hypothesis was that the group that received only directional feedback would perform with higher accuracy scores during the transfer and retention tests compared to participants that received both directional and magnitude of error feedback. Participants in the study ( $N = 36$ ) were randomly assigned to conditions and all participants performed a total of 50 practice trials. The task required participants to toss a hacky sack, blindfolded, with their dominant arm to a target that was placed on the ground at a distance of 3 m. Participants in the "KR" group received KR consisting of either "Hit" or "Miss", the "KR-precision 1" group received "Hit" or "Missed" as well as direction of error feedback, and the "KR-precision 2" group received "Hit" or "Missed" plus the direction and magnitude of error feedback. All participants returned after 24 hr and performed a 10-trial retention test and a 10-trial transfer test without KR. Retention test results revealed that the KR-precision 2 group was significantly more accurate on the retention test compared to the KR-precision 1 group. Transfer test results indicated there were no significant differences between any of the groups. This latter result suggests that the precision of the feedback provided during practice did not influence the participant's ability to adapt to different performance characteristics.

**On- and Off-Line Learning Improves Children's Motor Performance**

Yan, Jin H., Shenzhen University; Chan, John, Beijing Normal University

Night- or day-time sleep enhances motor skill acquisition. However, prominent issues remained about the circadian (time of day) and homeostatic (time since last sleep) effects on developmental motor learning. Therefore, we examined the effects of nap schedules and "nap-test-intervals" (NTIs) on the learning of finger tapping sequences on computer keyboards. Children aged 6-7, 8-9, and 10-11 years explicitly acquired the short and long tapping orders that share the same movement strings. Following a constant 8- or 10-hr postlearning period in one of the four NTIs (2, 4, 5, 7 hr), children in the morning napping, the afternoon napping, or the waking groups performed the original long sequence in retention test and the mirrored-order sequence in transfer test. Age and treatment differences in the movement time (MT) and sequence accuracy (SA) were compared during skill learning and in retrieval tests. Results suggest that practice or nap affects MT and SA in a greater extent for the younger learners than for the older learners. The circadian effects may not change nap-based skill learning. Importantly, the longer NTIs resulted in superior retention performance than the shorter ones, suggesting that children require a relatively longer post-nap period to form motor memory. Finally, nap-based motor learning was more marked in skill retention than in skill transfer. Developmental brain plasticity may play an important role in motor learning. The discussion centers on memory consolidation and its relevance for skill acquisition from early to late childhood.

**The effectiveness of different gaze locations on bunting skills for professional baseball players**

You, Tsung-Lung; Lin, Ju-Han; Lin, Yen-Nan; Lee, Cho-Kang; National Dong Hwa University

The purpose of this research is to examine the effectiveness of the visual gaze on bunting. The participants of the research are skilled ( $n = 35$ , age:  $16.5 \pm 1.5$ , experience:  $7 \pm 2$ ) first-division high school baseball league players in Taiwan. Participants were asked to wear fitted mobile eye trackers so that data on the location where their visual gaze focused on as they hit 10 bunts on the baseball field can be collected. The performance measurement area was set up between the mound and the home base. ANOVA and correlation analyses were used to examine the gaze location differences and the relationship between ball speed and performance scores. Overall, the findings showed different locations had significant effects on the participants' performance ( $F = 41.818, p < .000$ ). The post hoc comparisons on gaze locations showed that the pitchers' release points were the locations the experts most frequently focused on, followed by the anticipated trajectory of the ball, and then the ball. In any case, the visual gaze always focused around the ball before bunting. In performance scores, the negative relationship between the release point and the ball speed was significant ( $r = -.372, p < .05$ ). It showed that players did not need to know the styles of the pitches while bunting. Finally, the different scores ( $F = 1.079, p = .352$ ) and ball speed ( $F = 1.455, p = .180$ ) did not significantly affect the gaze locations. In conclusion, the bunting performance was not influenced by the different gaze locations, and the ball speed did not change the players' gaze location.

**The discrepancy of cognitive function between opened-skill and closed-skill athletes**

Yu, Chiachuan; Liu, Suyen; National Chung Cheng University, Taiwan

The methods of selecting athletes are important and varied, especially for opened-skill and closed-skill sport and athletes. One possible selecting method is looking at their cognitive function of psychological aspect. Purposes: 1) to examine the index of cognitive function on opened-skill and closed-skill sport athletes and 2) to find out the differences of cognitive function between these two types of athletes. Methods: 10 of each swimmers and taekwondo athletes were asked to perform a combined flanker and stop signal task for 960 trials, which included four conditions—congruent, incongruent, go, and stop signal tasks. Attention, inhibition ability, and reaction time were collected and compared. Results: First, attention and inhibition ability were not significantly different between swimmers and Taekwondo athletes. Second, Taekwondo athletes had better reaction time than swimmers. Third, there are positive correlation among accuracy, accuracy of congruent, reaction time of congruent, accuracy of incongruent, reaction time of incongruent, accuracy of stop signal, and reaction time stop signal.

**Rapid decay of fast visuomotor adaptation**

Zbib, Basel, Akhavan, Kiarash, Abu-Shaaban, Mohammad, Cressman, Erin; University of Ottawa

When subjects are presented with rotated visual feedback of their hand during goal-directed movements in a virtual-reality environment (i.e., subjects view a cursor representing their hand that is rotated  $30^\circ$  clockwise relative to their hand's actual position), they typically adapt their movements so that the cursor is brought to the target, thus reducing reach errors. Importantly, when subjects are then asked to reach in the absence of visual feedback, they continue to reach with adapted movements. These reaches are referred to as *reach after-effects*, and are considered evidence of motor adaptation. The current experiment investigated the time course of motor adaptation. Specifically, subjects trained to reach to a single visual target while seeing a cursor that was aligned with the actual position of their hand (50 trials: aligned reach training), or while seeing a cursor that was rotated  $30^\circ$  clockwise relative to their hand (150 trials: rotated reach training). Reach adaptation was assessed following the aligned reach training trials and at seven different times during the rotated reach training trials by having subjects reach to the target without visual feedback (i.e., reach after-effect task). Moreover, at every time point, subjects' reach adaptation was assessed immediately after the reach training trials, and following a 5-min delay, in which subjects sat passively or completed a passive arm movement task. As expected, results revealed an increase in both the immediate and delayed reach after-effects over training trials. However, results showed that the delayed reach after-effects had a significantly smaller initial rate of change and final magnitude as compared to the reach after-effects immediately following training, regardless of if the subjects' hands were passively moved or not during the delay interval. This rapid decay in reach adaptation after just 5 min suggests two separate adaptive mechanisms: a faster process that weakly retains information, and a slower process that strongly retains information (Smith, Ghazizadeh, & Shadmehr, 2006).

### Does a chronic physical activity intervention benefit timing in young children with ADHD?

Zelaznik, Howard N., Purdue University; Smith, Alan L., Michigan State University; Hoza, Betsy, University of Vermont; Delli Paoli, Anthony G., Michigan State University; Dorsch, Travis E., Utah State University; Schmidt, Andrew, University of Vermont

Children with attention-deficit/hyperactivity disorder (ADHD) exhibit greater risk for motor skill deficits than their typically developing (TD) peers (Nigg, 2006). In recent work with 7- to 12-year-olds using a continuation timing task, children with ADHD when compared to TD children showed an overall timing deficit; children with ADHD were more variable in timing, had substantially fewer trials exhibiting lag one covariance, and did not use solely an open-loop timing strategy (Zelaznik et al., 2012). In the present work, we aimed to (1) assess the replicability of these findings with younger children and (2) determine if a chronic physical activity (PA) intervention would reduce the expected timing deficit in children with clinically substantial ADHD symptoms. Young children ( $n = 102$  ADHD-risk,  $n = 82$  TD; ages 4–8 years) performed a repetitive index finger tapping task. They entrained to a metronome beating at 2 Hz (500-ms interval) for 15 beats and then attempted to maintain temporal accuracy and precision when the metronome disengaged for an additional 36 finger taps. Each child completed 15 trials of this task prior to and following a 12-week before-school intervention that involved random assignment to a program involving 31 min of daily moderate-to-vigorous PA or a structured classroom (sedentary) program of equal length. We analyzed the entire set of tapping trials and the best eight (based upon the coefficient of variation in the interval time series). At pre- and postprogram, children with ADHD-risk exhibited a larger coefficient of variation in timing than TD children. There was no difference in the number of trials that obeyed the assumptions of the classic Wing and Kristofferson (1973) timing model, and no difference for the best eight trials. There was no evidence of pre- to postprogram change in timing precision. We conclude that some ADHD-related motor timing deficit is evident in early childhood, at ages that often precede typical formal diagnosis of ADHD, and that this level of deficit persists and is not reduced by a chronic PA intervention. *Supported by R01MH082893 (Hoza/Green) from the National Institute of Mental Health*

### Generality and specificity in individual differences in Fitts's law

Zelaznik, Howard N., Beckman, Laura; Purdue University

Two experiments are reported that allowed us to examine the relationship between individual differences in Fitts's law performance. Twenty-three subjects (Exp 1) and 47 subjects (Exp 2) performed five trials in a continuous repetitive Fitts's law task. Distance varied from 3.125 cm to 25.000 cm and target width varied from 0.25 cm to 1.00 cm. ID values ranged from 4.64 to 7.64 bits (Exp 1) or from 2.64 to 7.64 bits (Exp. 2). The major dependent variable was the index of performance, IP, defined as the obtained index of difficulty divided by the average movement time. First, across the two experiments, we observed reliable individual differences for the IP. The lowest reliability value was .88 (Exp. 1). Second, all pairwise correlations for IP across any two Fitts-task conditions were statistically significant. Third, in order to examine whether there was any specificity in the pattern of individual difference correlations, we discovered that the value of the correlation was correlated negatively ( $-0.60$ ) with the magnitude of the ID difference. In other words, the strength of the correlation was determined by the similarity of the ID values for the two tasks. We interpret this latter relation as being in support of the Meyer et al. (1988) optimized submovement model for Fitts's law.

### The influence of musical training on lifting bottles of unknown weights

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Music is a powerful medium that creates numerous connections within the sensory-motor areas of the human brain. Recent imaging studies (fMRI) have demonstrated this effect in both musicians and non-musicians, with both showing increased activation in sensory and pre-motor areas when listening to rehearsed pieces or familiar melodies (Baumann et al., 2007). Studies of reach-to-lift movement have shown that both object size and object weight affect movement kinematics (Eastough & Edwards, 2007), and objects of same weight but different sizes are lifted with different forces (Brenner & Smeets, 1996). The current study was aimed to explore how musical experience would help the lifter to use the auditory information about the object to improve the corresponding lifting performance. Ten participants with or without musical training (half in each) were recruited and tested by the Montreal Battery for Amusia (MBEA). Ten glasses bottles of two sizes were painted opaque and filled with different amounts of water to create eight weight variations. There were two pairs of bottles that were weighted the same in different sizes: one weighted low, and the other weighted high. Participants were asked to reach to lift those bottles three times using the non-dominant hand, with and without hearing the sound (counterbalanced in order) when the bottle was struck. The lifting performance was evaluated using the normalized jerk score (NJS). The results showed that the musicians had a significantly higher mean MBEA score ( $t = 4.38$ ,  $p < 0.01$ ), and a significantly lower mean NJS than the non-musicians,  $F(1,8) = 16.11$ ,  $p < 0.01$ , independent of object size, weight and the sound condition. However, when objects of the same weight were presented in different sizes, the lifting performance was significantly affected in the silent condition for the non-musicians,  $F(1,4) = 11.54$ ,  $p < 0.05$ . The hypothesis that musical training can help the lifter to use the auditory information about the to-be-lifted object to enhance the lifting performance is supported.

## Developmental Perspectives: Motor Control/Coordination/Rehabilitation\*

### Effects of a traditional cradling practice on infant motor development

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Previous experimental and cross-cultural work shows that childrearing practices influence infants' experience, which in turn, affect infants' motor development (Adolph, et al., 2010). For example, infants who receive vigorous exercise as part of daily caregiving routines achieve sitting and walking milestones at earlier ages than infants who do not (Hopkins & Westra, 1988). Reciprocally, childrearing practices that restrict movements delay the onset of motor milestones: Putting infants to sleep on their backs delays onset of crawling (Davis et al., 1998). Throughout Central Asia, caregivers swaddle and bind infants in a *gahvora* cradle, and infants sleep, eat, and are toileted in the cradle throughout the day so that arm and leg movements are constrained. However, effects of this widespread practice have not been studied. We observed 23 16- and 24-month-olds in Tajikistan, a country in Central Asia, whose caregivers used the *gahvora*. We used a time diary to estimate how many hours per day infants spent in the cradle. We determined infants' highest level of gross motor skill (sitting, crawling, cruising, walking) based on video recordings of their natural, spontaneous activity out of the *gahvora*, and we collected footfall measures of infant walking in the standard gait test. Preliminary work revealed a dose–response effect of cradle hours. Statistically controlling for infants' age, infants who spent less time in the *gahvora* demonstrated the highest level of motor skill during natural activity,  $r(68) = -.40$ ,  $p < .05$ . Relative to Western norms, Tajik infants were delayed by weeks to months. In the standard gait test, infants with fewer cradle hours displayed faster walking,  $r(19) = .69$ ,  $p < .05$ ; longer step length,  $r(19) = -.72$ ,  $p < .05$ ; and fewer steps per minute,  $r(19) = .43$ ,  $p < .05$ . Work indicates that restricted movement due to cradling delays motor development, and infants who spent most of the day in the *gahvora* were severely delayed. Future work should assess Tajik infants who have never been cradled rather than relying on comparisons to Western norms.

### Proprioception: Its development, its trainability, and its effect on motor control in neurological disease. Is proprioception a critical factor for obstacle avoidance behaviors in Parkinson's disease?

Almeida, Quincy J.; Wilfrid Laurier University

Mobility deficits in Parkinson's disease have a tremendous impact on independence in Parkinson's disease (PD). Interestingly, patients with PD experience greater gait deficits when required to adapt to changes in their environmental surroundings, especially when obstacles in the environment can lead to potential trips, falls or cause injury. Understanding the underlying mechanisms of gait impairment can be critical to our understanding of the pathogenesis of many basal ganglia disorders, as well as the development of novel treatment strategies in PD. Given that sensory and perceptual systems are required to accurately detect and make judgments about obstacles that we interact with, as well as our ability to assess the progression of successful (or unsuccessful) planned movements relative to obstacles or threats in our environment, it is important to consider the role that proprioceptive deficits may play in PD during movement. This presentation will provide evidence that proprioception may be a core factor contributing to gait impairments when negotiating narrow and crowded spaces, as well as a critical factor explaining trips and fall when stepping over obstacles. A number of experiments attempting to isolate the role of proprioception during gait in typical PD will be presented. Further, the potential for proprioception to contribute to severe gait deficits will also be evaluated. Whereas freezing of gait (FOG) is one of the most debilitating symptoms associated with PD, there is considerable debate about the underlying mechanisms of FOG. In some cases, FOG is improved by enriching the visual environment with step cues, yet in other circumstances the richness of the visual (and sensory) environment can be the very trigger of FOG (e.g., narrow doorways, cluttered spaces, visual or auditory dual tasks). Thus, how vision may be compensating for proprioceptive deficits will also be discussed. Finally, the potential for translating our understanding of proprioceptive deficits into therapeutic interventions for PD will be discussed.

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\*The abstracts are alphabetically arranged by the first author's surname within each of the three sections—Motor Learning and Control, Developmental Perspectives: Motor Control/Coordination/Rehabilitation, and Sport and Exercise Psychology. A *funding source*, if provided, is given in italics at the end of an abstract.

### Children's structure of gait variability is altered while wearing athletic footwear compared to barefoot

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There is an optimal level of variability present in most biological phenomena, including human movement. Deviations from this optimal level of movement are commonly associated with movement problems such as falls in older individuals and developmental delays in children. Walking barefoot, the most natural state of walking, could be assumed to hold an optimal state of variability. This study investigated the structure of variability in children while walking on a treadmill with and without footwear. Children with the average age of 7.5 years old participated in a single data collection session. Reflective markers were placed at specific anatomical locations of each participant's lower limb and trunk. Participants were acclimated to the treadmill while a self-selected comfortable walking speed was determined. Three-dimensional kinematics were acquired for one 3-min trial per condition at 60 Hz using motion capture software. The conditions included the participants walking on the treadmill wearing running footwear and while barefoot. Joint flexion/extension angles for ankle, knee, hip, and trunk were calculated relative to the laboratory coordinate system. The stride-to-stride variability of the angle time-series were calculated for each condition. Structure of gait variability was measured using the largest Lyapunov exponent (LyE). Compared to the barefoot condition, ankle, knee, hip, and trunk angle LyE values were decreased while wearing footwear. The decreased LyE while wearing footwear indicates a decreased attractor divergence compared to walking barefoot. This means that wearing footwear leads to a more regular gait pattern. What is unknown is how this decrease in gait variability while wearing shoes is related with healthy development. Additionally in children of this age, it is possible that the decrease is caused by familiarity with walking in footwear. Further research should be conducted to investigate whether gait variability is different in these two conditions prior to familiarity with walking in shoes and if not, when the difference develops.

### Evidence of object prioritization in infancy

Arnold, Amanda J.; Collignon, Alex; Gaona, Priscilla; Sheets, Rhiannon; Smith, Stephanie; Claxton, Laura J.; Purdue University

Older adults in natural settings and young adults in experimental settings surprisingly maintain hold of non-stabilizing objects (such as a cup of coffee) during a loss of stability. This is potentially counterproductive since the hands are not free to aid in balance recovery (Robinovitch et al., 2013; Bateni et al., 2004). It therefore appears that in certain situations, holding an object is prioritized over maintaining stability (Bateni et al., 2004). It is unknown if this phenomenon is present in infancy or emerges later in adulthood as people gain experience holding potentially fragile or valuable objects (e.g., no one wants to drop a cell phone or child). Therefore, we investigated whether infants also maintain hold of non-stabilizing objects when experiencing a naturally occurring loss of balance. 16 infants (9 girls;  $M_{\text{age}} = 11$  months / 3 weeks; range = 9/2 to 13/2) participated in the study. Infants could stand independently, but were not yet independently walking. Infants stood while holding an easily graspable toy and while not holding a toy. Coders recorded how each trial ended (step, fall, kneel, squat, or parent repositioned infant). A fall was defined as a loss of balance in either a forward or backward direction before the infant was caught by the parent or experimenter. When a toy-hold trial ended in a fall, the coder recorded whether or not the infant maintained hold of or dropped the toy. Out of the 88 toy-hold trials, falls occurred on 40 trials. When a trial ended in a fall, infants continued to hold the toy on 87.5% of the trials (significantly different from chance,  $z = 3.35$ ,  $p < 0.001$ ) and dropped the toy on only 12.5% of the trials. These results indicate that similar to adults, infants maintain hold of non-stabilizing objects during a loss of stability. Thus, this behavior is present early in the life span and does not simply emerge through experience.

### The impact of holding a toy on arm guard positions in newly standing infants

Arnold, Amanda; Collignon, Alex; Gaona, Priscilla; Sheets, Rhiannon; Smith, Stephanie; Claxton, Laura J.; Purdue University

Holding a toy leads to fewer falls in newly walking infants (Karasik et al., 2012). Similarly, in newly standing infants, holding a toy results in longer standing times and less postural sway (Claxton et al., 2013). This apparent increase in standing and walking stability may emerge because infants adopt a different arm guard position while holding onto a toy or may emerge because infants actively stabilize their body so they can more effectively focus on and interact with the toy (Claxton et al., 2013). In the case of walking, Mangalindan et al. (2014) found that newly walking infants adopted a higher arm guard position when walking with a toy. It is unknown if changes in arm guard position are also present when standing with a toy. Thus, this study investigated changes in arm guard position when infants are standing and holding versus not holding a toy. Sixteen infants (9 girls;  $M_{\text{age}} = 11$  months / 3 weeks; range = 9/2 to 13/2) participated. Infants could stand independently, but were not independent walkers. Infants stood independently while holding an easily graspable toy (T) and not holding a toy (NT). Infants' arm guard positions were coded as high (HG), middle (MG), or low guard (LG). Because LG was used infrequently (T = 0, NT = 2), this arm position was not included in the following analysis. There was no significant difference between the number of trials that infants used HG (T = 30; NT = 29) or MG (T = 44; NT = 28) for either condition;  $\chi^2(1) = 1.39$ ,  $p = 0.24$ . Therefore, unlike newly walking infants, newly standing infants did not adopt a higher arm position when holding a toy. In fact, there were no differences between the frequency of high and middle arm positions, regardless of whether the infant was holding a toy. These results support the explanation that infants might be engaging in concurrent task demands, and be increasing stability to better focus on the toy in their hand (Claxton et al., 2013). However, given differing demands underlying static and dynamic balance control, further research is needed to investigate the effects of holding an object.

### Postural sway of sitting infants on solid and foam surfaces while engaged in concurrent tasks

Arnold, Amanda J.; Harris, Rachel C.; Liddy, Josh J.; Claxton, Laura J.; Purdue University

Independently sitting infants alter sway based on concurrent task demands. Infants reduce sway to better interact with a toy held in their hand (Claxton et al., 2014), and to better focus on a small image viewed on a monitor (Claxton et al., 2013). Because these tasks likely have different attentional demands, the current study investigated whether holding a toy or looking at a toy would result in a greater reduction of sway in an easy postural task (sitting on a solid surface) and a difficult postural task (sitting on a foam surface). Eight independently sitting infants ( $M_{\text{age}} = 7$  months; 21 days; range = 6; 21–8; 4; 6 boys) participated. While sitting on each surface, the experimenter showed the infant a toy for 2–3 s and then gave it to them. Sway area (SA) and sway velocity (V) were calculated from the CoP data (120 Hz) and compared using repeated-measures ANOVAs. SA had main effects for surface and task. Infants had a moderately smaller SA when sitting on the solid surface ( $M = 859 \text{ mm}^2$ ,  $SD = 184$ ) versus the foam surface ( $M = 1443 \text{ mm}^2$ ,  $SD = 242$ );  $F(1,7) = 5.10$ ,  $p = 0.058$ . Infants had a smaller SA when looking at the toy ( $M = 727 \text{ mm}^2$ ,  $SD = 86$ ) versus holding the toy ( $M = 1574 \text{ mm}^2$ ,  $SD = 290$ );  $F(1,7) = 11.00$ ,  $p < 0.05$ . For V, there was a moderate interaction effect,  $F(1,7) = 5.19$ ,  $p = 0.057$ . For the solid surface, no difference existed in V when infants looked at ( $M = 93 \text{ mm/s}$ ,  $SD = 25$ ) or held the toy ( $M = 99 \text{ mm/s}$ ,  $SD = 25$ );  $t(7) = 0.62$ ,  $p = 0.56$  (paired-samples  $t$  test). However, for the foam surface, V was significantly faster when infants held ( $M = 144 \text{ mm/s}$ ,  $SD = 39$ ) versus looked at the toy ( $M = 104 \text{ mm/s}$ ,  $SD = 21$ );  $t(7) = 2.70$ ,  $p < 0.05$ . Overall, faster of concurrent task and difficulty of postural task both impacted postural sway. Looking at the toy held by the experimenter led to a greater reduction in sway. The more challenging postural task of sitting on foam led to a greater velocity of sway when holding the toy as compared to looking at the toy. Results from this study demonstrate that a concurrent task with solely visual demands leads to a greater reduction in sway, even when the postural demands of the task increase.

### A needs assessment of the fundamental motor skills of urban and rural children in Indonesia

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The World Health Organization's (WHO) "Global Recommendations on Physical Activity for Health" (WHO, 2011) identified the importance of preventing chronic disease through promoting physical activity at a population level, specifically in developing countries such as Indonesia. Indonesia has joined the ranks of the top-10 most obese countries in the world. As obesity rates in Indonesia have escalated, the little data that is available shows time spent in physical activity has been replaced by screen time, especially in urban areas (Collins, Pakiz, & Rock, 2008; Roemling & Qaim, 2012). Both the Indonesian government and the WHO have identified the importance of developing policies and strategies to promote physical activity and motor competence in Indonesian children (Goodway, Famelia, & Bakhtiar, 2014; Roemling & Qaim, 2012; WHO, 2012). Yet little to no data exists in Indonesia to guide such policies. Recognizing that fundamental motor skill (FMS) competence is an important predictor of physical activity, this study was a first step in guiding policy decisions. The purpose of the study was to examine the FMSs of Indonesian boys ( $n = 335$ ) and girls ( $n = 385$ ) from West Sumatera aged 6.08 to 10.92 years, along with potential gender differences. Furthermore, to investigate differences in FMS by geographic location (rural,  $n = 349$ ; and urban,  $n = 371$ ). All children were tested on TGMD-2 by trained evaluators. A 2 Gender (boys, girls)  $\times$  2 Geographic Location (rural, urban) MANOVA on object control (OC) and locomotor standard scores (SS) revealed significant main effects for Gender ( $F(2,715) = 16.43$ ,  $p < .001$ ;  $\eta^2 = .04$ ) and Geographic Location ( $F(2,715) = 3.74$ ,  $p < .05$ ;  $\eta^2 = .01$ ) with no significant interaction. Univariate tests for locomotor SS showed there was a significant main effect for Gender ( $p < .001$ ) and Geographic Location ( $p < .05$ ). For OC SS there was only a significant effect for Gender ( $p < .001$ ). In all cases, girls outperformed boys on FMS. These data will serve to inform policy development and professional practice in Indonesia.

### Explicit motivations modify occupational handling strategies and postures

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Handling is a functional skill that can be performed through alternative movement combinations depending on an individual's physical and cognitive states. State modifications may have opportunity to change behaviors, including potentially injurious occupational work practices. In this experiment, we studied the differences in handling and posture amongst individuals given various cognitive states, and eye tracking was used to confirm a relationship between visual attraction and ergonomic behaviors. Participants ( $N = 31$ ; 16F) were equipped with a pair of Mobile Eye – XG eye tracking glasses (ASL, Bedford, MA USA). Subjects stood in front of a horizontally positioned suitcase that was vertically adjusted to 53% of their height, and featured three handles: one at the front, and one on each lateral end. Participants were randomly presented with one of three scripts (positive, negative, neutral) which would hypothetically induce different suitcase handling behaviors. Participants' handling techniques and motivation factors (MF) were recorded alongside the eye tracking data. The motivation scale (–5 to +5) results indicated a high MF for the positive group (4.1) while negative and neutral groups had MFs of (–0.4) and (2.4) respectively. In terms of handling techniques, the positive group favored single hand handling (90% of trials) while the negative and the neutral groups preferred handling with two hands (73% and 63% of trials respectively). An attraction index (AI) that identifies the strength of eye fixations [ $\# \times$  duration (seconds)  $\times$  target proximity (pixels)] for each handle was developed. The front handle had the highest AI (4.0) for the positive group, whereas the left handle (1.9) and the right handle (1.4) had the highest AIs for negative and the neutral groups respectively. When carrying out an occupational task, the goal is to perform the task most efficiently, without compromising on the safety factor. Our results suggest that appropriate motivation conducive to a positive cognitive state may encourage safer ergonomics and decrease handling related injuries. *NSERC Discovery Grant*

### **Motor performance, socioeconomic status, body mass index, and gender in children: Comparative and Associative Study**

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Changes in motor performance over time are influenced by environmental and biological factors. The objectives of the study were as follows: To compare motor performance of boys and girls from different socioeconomic status and to verify the associations among motor performance, socioeconomic status, sex, and body mass index. Participants in the study were children from high ( $N = 45$ ) and low ( $N = 43$ ) socioeconomic status. Children from high socioeconomic status demonstrated higher motor performance; sex differences were not observed. Girls from low socioeconomic status demonstrated better object control performance compared to boys; similar performance was observed for locomotion. A linear regression analysis indicated that the model with socioeconomic status and body mass index was significant [ $F = r^2 = 0.607 (3.84) = 45.8, p < 0.001$ ]. Socioeconomic status was motor performance's strongest predictor (69.7%). Association studies are needed to better explain the motor performance in different contexts. *CAPES and CNPQ*

### **Proprioception: Its development, its trainability, and its effect on motor control in neurological disease—Contributions of proprioception and optic flow to gait toward a target in Parkinson's disease**

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More than a century ago, Parkinson's disease (PD) was considered to be exclusively a “motor output” disorder. However, sensory and perceptual deficits have recently been identified in PD and may have an important underlying contribution to movement disorders. Traditional views of basal ganglia involvement in movement functions have been well established, while non-motor functions (such as arousal and pain sensitivity) have only recently become recognized. Some of these non-motor functions are supported by anatomical evidence (e.g., sensory processing). Given that sensory and perceptual processes are needed to evaluate targets that we walk to within our everyday environments, it is important to consider how the basal ganglia may be involved in integrating information from each of the various sensory sources during movement, especially proprioception system. While walking to objects in our environment, proprioception (sensory feedback derived from the muscles of the limbs) confirms characteristics of each step as we progress toward the target. So, it is equally critical to understand how interactions between different sources of sensory-perceptual feedback contribute to gait. To enhance our understanding of sensory-perceptual functions of the basal ganglia that contribute to movement, this presentation will examine how optic flow and proprioception interact when people with PD walk towards a target. Studies that manipulate the role of proprioception during gait in typical PD will be presented. People with PD are more dependent than healthy people on optic flow information during gait, probably to compensate the proprioceptive deficits. Our recent study suggests that a dependence on full vision to compensate for proprioceptive deficits (i.e., proprioceptive deficits that cause greater error and effects on gait regardless of optic flow or no vision to guide movement). Thus, the potential for vision to be acting in compensation for proprioceptive deficits will be discussed. Finally, effects of PD medication on proprioception will be considered, especially during gait.

### **The effects of optic flow on tactilely facilitated neonatal stepping**

Barbu-Roth, Marianne, Paris Descartes University; Anderson, David I., San Francisco State University; Saulton, Aurélie, Huet, Viviane, Paris Descartes University

Early coupling of terrestrial optic flow and air-stepping has been shown in neonates well before upright postural control and steering of locomotion have been experienced. These results highlight that vision alone can trigger locomotor-like leg movements as early as birth. While the kinematic characteristics of newborn air-stepping and upright tactile-stepping are very similar, air-stepping lacks the tactile inputs present in over-ground stepping. The current study examined whether the quantity and quality of neonatal leg movements in upright tactile-stepping would increase with the addition of terrestrial optic flow. The stepping patterns of twenty-seven 3-day-old infants were video recorded as they were held upright and stationary with their feet contacting a silicone mattress. The infants were exposed to four different conditions. In the first, a white light was projected onto the mattress (White), while in the other 3 conditions a similar pattern of black dots moving at a velocity of 17 cm/s on a white background was projected onto the mattress with 0% coherence (Random) or 100% coherence toward the infant (Toward) or 100% coherence away of the infant (Away). Each condition was presented randomly and lasted 1 min. A significant effect of Condition for the number of steps,  $F(3, 78) = 5.6, p < 0.05$ , revealed that significantly more steps were taken in the Toward condition than in the other three conditions, which were not significantly different from each other. A significant effect of Condition for the duration of each step,  $F(3, 78) = 3.3, p < 0.05$ , revealed that the step durations in the Toward and Away conditions were significantly longer than in the Random condition. The enhancement of tactile-stepping when the optic flow simulated forward locomotion suggests that visuotactile coupling is present at birth. These results not only confirm that vision is important for stepping, but suggest that the availability of optic flow in the presence of a support surface may make the tactile information from the surface more usable.



**The T-SKIP package intervention: Coaching preschool teachers to promote motor competence**

Brian, Ali, Louisiana Tech University; Goodway, Jacqueline D., Sutherland, Sue, Logan, Jessica, Ohio State University

Many young children who are socio-economically disadvantaged demonstrate significant delays in their fundamental motor skills (FMS) including object control skills (OC). Early motor skill intervention to preschoolers delivered by motor development experts can remediate OC delays. Unfortunately, few early childhood centers employ motor development experts. Moreover, preschool teachers rarely receive motor development content through their pre-service teacher training programs. There is a gap in the literature as to the efficacy of preschool teachers to teach OC skills to preschoolers. The purpose of this study was to investigate the influence of a motor skill intervention (MSI) called T-SKIP (Teacher-led Successful Kinesthetic Instruction for Preschoolers) taught by preschool teachers on the OC skills of preschool children. Participants ( $N = 122$ ) consisted of a T-SKIP intervention group ( $n = 63$ ) and a Comparison group ( $n = 59$ ). The MSI group received two 30-min T-SKIP sessions per week for 8 weeks delivered by their preschool teacher. Before starting T-SKIP, teachers received a 6-hr initial professional development session and all intervention materials. T-SKIP teachers received continuous coaching/support during each session by a motor development expert. All students were evaluated on object control (OC) skill competence using the Test of Gross Motor Development-2 OC skill subscale prior to and following the intervention. There were no pretest between-group differences ( $p = .254$ ). A two-level hierarchical linear model with students nested within teachers significantly predicted posttest OC scores for the T-SKIP group ( $p < .001$ ) but not the Comparison group ( $p = .263$ ). Therefore, students in the T-SKIP group improved OC skills while Comparison students remained constant. The findings revealed that providing preschool teachers with continuous professional development with an evidenced-based curriculum such as T-SKIP may result with students developing OC skill competence and remediating existing delays.

**A lifespan view of coincident timing ability and tool use**

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Coincidence timing is defined as making a motor response at the same time that a moving object arrives at a designated intercept point. Little is known about using coincident timing via action representation abilities, especially via use of tools. To this end, a lifespan design with three age groups (children, young adults, and older adults) was used to examine spatial-temporal coincidence by intercepting moving targets with their arm and tools of 10, 20, 30, and 40 cm. The task required participants to use a keypad to stop a moving target that moved towards the body in three separate orientations (midline, right, left), progressively, under five conditions (arm and tools 10, 20, 30, and 40 cm). Three trials per condition were allowed. A 3 (Age)  $\times$  5 (Condition) mixed-model analysis was conducted on the difference between the actual (correct) distance and the "stopped" distance (as determined by the participants) in each direction and orientation. Age was significant in all orientations, with children overestimating the interception point more than both young and older adults, who did not differ from each other ( $ps < .05$ ). Condition was significant in the left and right orientations ( $ps < .05$ ), with post hoc results indicating that participants significantly overestimated their interception with the 40 cm tool in comparison to all other tool lengths and the arm. These findings suggest that representing the interception of objects with and without tools has a distinct developmental trend that may be associated with growth and the ability to create dynamic representations of spatial metrics for action plans. However, this ability does not seem to decline with age, as older adults are able to maintain a similar ability to young adults for planning and generating dynamic visuospatial representations of interception abilities. Taken together, these findings add to our understanding of critical periods for the ability of building, updating, and connecting spatial maps to motor skills.

**Postural control development through early adulthood**

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The ability to stay upright (i.e., postural control) develops and changes throughout the lifespan. Previous literature has shown that postural control typically does not stabilize until later in adolescence, or early adulthood. Recent research has used a nonlinear dynamics framework to identify developmental patterns in postural control that may not be observed when applying traditional "Gaussian" measures. The purpose of this study was to examine postural sway differences between children, adolescents, and adults using classical and nonlinear measures to identify development trajectories in postural control. Forty-eight females were recruited and divided into three age groups (21 elementary-aged girls [E;  $9.1 \pm 1.3$  years], 14 high school freshmen girls [F;  $15.4 \pm .4$  years], and 13 adult women [A;  $22.4 \pm 4.7$  years]). We examined four center of pressure (CoP) variables averaged over two 30-s trials while participants stood quietly on a force plate with eyes closed and feet together. Variables included path length (PL), mean CoP speed, standard deviation (SD) of CoP speed, and sample entropy (SampEn) of CoP speed. One-way ANOVAs were computed for each variable to determine group differences ( $\alpha = .05$ ). The E group had significantly higher values compared to the F and A groups in PL (E:  $41.6 \pm 8.1$  cm; F:  $28.6 \pm 5.2$  cm; A:  $25.5 \pm 5.1$  cm), mean CoP speed (E:  $1.38 \pm 0.27$  cm/s; F:  $0.95 \pm 0.18$  cm/s; A:  $0.85 \pm 0.17$  cm/s), and SD CoP speed (E:  $1.05 \pm 0.20$  cm/s; F:  $0.67 \pm 0.11$  cm/s; A:  $0.58 \pm 0.10$  cm/s) (all  $p < .001$ ). The F group had a significantly lower SampEn compared to the E and A groups (E:  $1.05 \pm 0.09$ ; F:  $0.92 \pm 0.09$ ; A:  $1.00 \pm 0.08$ ) ( $p < .001$ ). All of the classical measures tested in this study indicate that postural control stabilizes by the freshman year of high school. However, the SampEn data, highlighting a change in complexity in the CoP speed dynamics, signifies a potential reorganization of neuromotor control. This is likely due to maturation processes at this critical developmental time point.

### Use of mental imagery strategies to reduce fall risk in the elderly

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According to the Center for Disease Control and Prevention (2013), falls are one of the main causes of accidents and fatalities among the elderly and therefore, there is a pressing need to find a solution to this problem. The purpose of this study was to examine whether mental imagery training in reaching situations could help minimize or reduce falls among older adults. A total of 23 participants between 65 and 81 years old were recruited from a senior citizen community. Participants were divided into three different groups: Group 1 was the control group ( $n = 9$ ,  $M_{\text{age}} = 74.67$ ;  $SD = 6.44$ ) and the other two groups (intervention) were divided by age—Group 2, 65 to 73 years ( $n = 7$ ,  $M_{\text{age}} = 67.71$ ;  $SD = 2.06$ ) and Group 3, from 74 to 81 years ( $n = 7$ ,  $M_{\text{age}} = 76.00$ ;  $SD = 2.94$ ). Both intervention groups went through the same training protocol. All groups were pretested and posttested on reach estimation accuracy. Our hypothesis was that the mental training intervention would have a positive influence on reach estimation, thereby reducing fall risk. The main hypothesis was supported, showing that training did have a positive effect on reach estimation  $F(1,12) = 5.103$ ,  $p < .05$ . This study has potential for future research, and if training is found to be successful, fall incidences could be reduced in the elderly population by implementing this training in future rehabilitation programs and nursing homes.

### Does Nordic walking training improve gait performance and postural stability in older adults?

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**Aim:** The aim of the present study was to determine the impact of an 8-week Nordic walking (NW) program on older adult gait performance and postural stability. **Background:** Declines in gait speed, stride length, cadence, and postural stability are common effects of age and have been linked to increased fall risk and functional decline. Physical activity can slow or prevent such gait declines in older adults. In young adults, NW training has been shown to increase stride length and gait speed. However, few studies have examined its effect in older adults. As well, NW could improve postural stability, but no research has been done and remains to be assessed. **Methods:** Gait and postural stability in NW and normal walking were assessed and compared following an 8-week NW program ( $\times 2/\text{week}$ ) in 9 healthy older adults (age  $69 \pm 7.3$  years). Participants performed 6 walking trials: 3 with poles and 3 without. Gait and trunk ROM in all planes of motion were quantified using 6 inertial sensors (APDM) placed on the upper, lower limbs and torso. Gait and trunk measures were assessed using one-way repeated measures ANOVAs to compare NW to normal walking. **Results:** Participants showed increased stride length ( $p = 0.001$ ) and double support ( $p = 0.012$ ) when pole walking, but decreased gait speed ( $p < 0.001$ ) and cadence ( $p < 0.001$ ). No differences were found for all postural stability variables. **Conclusions:** Contrary to past literature in young adults, NW did not improve gait speed in older adults. However, older adults reported feeling more stable, which is in line with the increased double support phase and possibly allowed them to increase their stride length. This confidence when walking with poles might allow for an increase their cadence if asked to walk faster. This remains to be tested. Our pilot data did not show any differences in trunk ROM; however, this may change with testing of the other 6 participants. Otherwise, it may be explained by an insufficient intensity of the program to evoke change. Further, we expect to see an effect of the NW program on gait kinetics.

### Identifying profiles based on actual and perceived motor competence: Differences in physical activity, sports participation, and motivation towards physical education

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**Objectives:** Positive relations between motor competence (MC), physical activity (PA) and sports participation have been identified in previous studies by means of variable-centered analyses. To expand these findings, the present study used a person-centered approach aiming at a) investigating if different combinations of actual and perceived MC (AMC; PMC) exist, so that some students score high on the one and low on the other while others score high or low on both; and b) exploring how students with different types of MC-based profiles might differ in terms of PA, sports participation and quality of motivation for physical education (PE). **Methods:** 215 adolescents (66% boys; age =  $13.64 \pm 0.58$  years) completed validated questionnaires to assess PA and sports participation (FPAQ) and motivation for PE (BRPEQ). The CY-PSPP was used to measure adolescents' PMC. AMC was assessed with the KTK. Cluster analyses were used. **Results:** Next to two foreseeable groups (one group displaying high levels of AMC and PMC, and one group with low levels of both), two other, less evident, groups were identified: one with high levels of AMC but low levels of PMC and one with low AMC but high PMC. Analyses indicated that the group characterized by low AMC and low PMC displayed the least beneficial pattern of outcomes while students with low AMC but high PMC were significantly more physically active, more involved in community sports, and more autonomously motivated for PE. Those scoring solely high on AMC showed similar results as students with low AMC and high PMC but were less autonomously motivated. **Conclusion:** Although AMC and PMC are overall positively related, the current results show that, at the individual level they do not necessarily go hand in hand. Further research could aim at exploring characteristics of students with an unexpected profile, to come to a deeper understanding of why higher levels of PMC are associated with more beneficial outcomes among students with similar AMC-levels. It should also be studied why some students with high AMC perceive themselves as less competent.

**Pushing yourself, carrying others: Occupational affordances are dictated by co-worker capacity**

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Safe performance in many manual materials handling (MMH) tasks requires unspoken, immediate, and accurate perception of co-workers' physical capacities. Moreover, those perceptions often need to be amalgamated with our own affordances to plan and perform safe co-lifting. The current study is a pair of experiments that examine the effect of acute and chronic occupational stresses on perceptions of MMH affordance for self, for others, and for co-lifting. In the first experiment, 32 healthy young adults made a baseline affordance perception of safe vertical height in a simulated MMH task. Participants were then randomly assigned work-related physical or cognitive stress [5 min of 30 step-ups per minute with a 2.27-kg load in the hand(s) or 5 min of jigsaw puzzle assembling, respectively]. Following the stress episode, participants made a second affordance perception, and this pattern was repeated three times. A subset of participants ( $n = 16$ , 9 cognitive stress) also made affordance estimates for a co-worker who was not stressed. Results show that affordance self-perceptions were inflated by repeated bouts of occupational stress, but stayed consistent for co-workers. In the second experiment, 46 healthy young adults were presented a scenario where they would be co-lifting with a virtual co-worker. Information on the current musculoskeletal discomfort (MSD) of the virtual co-worker was provided, and participants were randomly assigned to "good" ( $n = 15$ , no reported MSDs), "fair" ( $n = 15$ , mild reported MSDs to some anatomical regions), "poor" ( $n = 16$ , moderate MSDs to most regions) co-workers. Participants had previously completed the same MSD instrument. Results showed that participants were more likely to pick a co-lifting load that matched their co-worker's MSD status than their own, particularly for poor musculoskeletal health levels. The results of both experiments suggest that we are sensitive to co-workers occupational affordances, and that social constructs may encourage us to prioritize others' affordances over our own. *NSERC Discovery Grant*

**Proprioception: Its development, its trainability, and its effect on motor control in neurological disease—Robot-aided visuomotor training improves proprioceptive and motor function in healthy adults**

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Current forms of robotic rehabilitation are almost always geared towards improving motor function. Yet, many neurological diseases such as Parkinson's disease are associated with proprioceptive impairment that negatively impacts motor recovery. It is unknown whether robot-aided sensory training geared to improve proprioceptive function will ultimately translate into improved motor function. To address this question, we administered a proprioceptive training protocol in healthy young adults ( $N = 11$ ) using a wrist robotic device coupled with a real-time virtual visual environment setup. Method: Training involved moving a virtual ball on a tilting surface to a target by making appropriate small-amplitude wrist flexion/extension movements. With increase in participant's proficiency, task difficulty was increased by adjusting virtual ball's responsiveness. Proprioceptive acuity and precision of goal-directed active wrist movement were both assessed without vision before and after training to evaluate sensory and motor function. For proprioceptive acuity, position sense discrimination thresholds were obtained using controlled passive robotic motion of the wrist. Movement error represented the difference between controlled passive motion to a 15° flexion target and a subsequent active movement to the same target. Results: All participants showed improvements in proprioceptive thresholds (mean: pre/post = 2.1° / 1.4°). Wrist movement precision improved in 9/11 participants while 2/11 showed a reduction in motor precision (mean: pre/post = 3.0° / 2.4°). Discussion: This study demonstrates: First, proprioceptive acuity improves after a brief proprioceptive training in young healthy adults. Second, although not trained, movement precision also improved in most participants (82%). Both results show that a) a short specialized training can enhance proprioceptive acuity and b) such training may transfer, that is, inducing changes in the precision of active movement. The results provide a basis to apply such training to neurological patients with known proprioceptive dysfunction.

**Assessing newborn crawling in response to terrestrial optic flow**

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We have recently reported a very precocious coupling between vision and crawling in humans, evidenced by 3-day-old newborns increasing their leg stepping when positioned in prone and exposed to terrestrial optic flows simulating their motion forward or backward. However, as relatively few full arm steps were observed in the aforementioned study it was difficult to know exactly what effect the optic flows had on arm movements. Here we investigated whether coding leg and arm movements more precisely based on the number of individual flexion and extension movements, rather than on the number of flexion-extension cycles, would yield additional insight into the coupling between vision and crawling. Twenty-six 3-day-old infants were video recorded in a prone position on a transparent water-mattress inclined 5 degrees downward, through which a black and white checkerboard pattern was projected. Three conditions were presented randomly for 1 min to each infant: (1) Static—the checkerboard was static and optic flows were only generated if the newborn moved on the mattress, (2) Toward—the checkerboard moved toward the infant simulating forward self-motion if the infant was not moving or a faster velocity of forward motion if the infant was already crawling, and (3) Away—the checkerboard moved away from the infant simulating backward propulsion if the infant was not moving or slower backward motion if the infant was already moving forward. A significant effect of Condition for the number of leg flexions and extensions,  $F(2, 50) = 3.2, p < .05$ , revealed that Toward and Away elicited significantly more leg movements than Static. Although no effect of Condition on arm movements was observed, more movements were made on the right side,  $F(1, 25) = 6.8, p < .05$ , and a significant interaction between movement type (flexion/extension) and Side,  $F(1, 25) = 5.1, p = .03$ , revealed no differences on the left side but more flexion than extension movements on the right side. The new method provides further insight into the character of newborn crawling.

### Effects of breathing patterns and the relationship between speed and accuracy

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Through acting time and position of a target marker, this study investigates how conscious breathing and vocalism influence speed and accuracy of sports performance. A total of thirteen participants used four conscious breathing or vocalism patterns and horizontally (parallel with the ground) moved a stylus from the right start position to the left goal marker. Goal marker positions (short/long) and sizes (large/middle large/middle small/small) changed some ratio patterns. Using Fitts's law, the target distance and size were calculated. Results indicated differences between various types of target markers. The usage of long distance patterns was more time consuming than that of short distance patterns. In comparison with same distance patterns, small size patterns were more time consuming. In addition, using vocalism patterns, such as increasing power, was the least time consuming than other breathing patterns. Therefore, it can be concluded that breathing and vocalism are effective for speed and accuracy, subliminally facilitating changes in speed.

### Effects of active video gaming on executive function in children with and without autism spectrum disorder

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With rates of autism spectrum disorder (ASD) on the rise, practitioners, teachers, and parents, teachers require innovative, cost-effective interventions to address issues associated with the disorder. One area of difference in ASD is executive function (EF). Could certain types of physical activity, which has been shown to improve executive function in typically developing children, lead to similar improvement in individuals with ASD? This study was designed to compare the acute effects of walking, active videogaming (AVG) and passive video gaming (PVG) on children with and without ASD. Method: A randomized repeated measures design was used. Six boys with ASD and 5 TD boys (ages 8–11 years), performed 20 min of one of the three activity conditions (active videogame, passive video game, walking) each day for 3 testing sessions. On a separate pretest session and after each condition participants took a modified Flanker test to examine inhibition component of executive function. We assessing response time (RT) and accuracy of response (A) and defined improvement as both a decrease in RT and an increase in A. Using a chi-square goodness-of-fit test, we found that both groups improved significantly ( $p = .018$ ) in only the AVG condition. Although preliminary, these results suggest that children with ASD may experience improved executive function after an acute bout of AVG play. Given behavioral characteristics associated with ASD, active video gaming may offer a novel way to promote both physical activity while improving executive function.

### Developmental trajectories in actual and perceived motor competence, physical activity, and health-related fitness as predictors of weight status

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This study evaluated a conceptual model (Stodden et al., 2008) that suggests a child's weight status will be synergistically influenced by motor competence (MC), physical activity (PA), health-related physical fitness (HRF), and perceived motor competence (PMC). The model also suggests the combined predictive utility of these factors will increase across childhood. We hypothesized that MC, PA, PMC, and HRF would more strongly predict healthy vs. unhealthy/obese weight status across early to middle to late childhood. Using a cross-sectional design, we tested 419 children ages 4–5 ( $n = 139$ , early), 7–8 ( $n = 133$ , middle), and 10–11 ( $n = 139$ , late) on 12 measures of MC (product and process), HRF (Fitnessgram), PA (accelerometry), and PMC, resulting in a total of 16 predictors. Unhealthy weight/obese status was designated as a BMI% > 85th%. Discriminant function analyses were conducted for each age group. For the 4- to 5-year-old group, none of the 16 predictors were able to significantly predict weight status, either collectively or individually. For the 7- to 8-year-old group, weight status was significantly predicted by six of the potential 16 predictors ( $\chi^2 = 13.854$ ,  $df = 6$ ,  $p = .031$ , correct classification = 83%). For the 10- to 11-year-old group, weight status was significantly predicted from a much larger subset of 13 of the 16 potential predictors ( $\chi^2 = 53.546$ ,  $df = 13$ ,  $p < .001$ , correct classification = 88%). Overall, the healthy weight group had better scores than the unhealthy weight group, supporting the conceptual model hypotheses. These findings provide empirical evidence for the notion of positive and negative developmental trajectories of these health-related factors, as the strength of associations among variables and their collective ability to predict weight status increased across early to middle to late childhood. *NIH R21 HD055621-01A1*

### Three-month-old infants do not show preference for social images

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The increasing occurrence of autism spectrum disorders (ASD) creates a crucial need for clinicians to identify ASD-related deficits as early as possible so that children can receive access to intervention services sooner. Currently, the typical age of diagnosis for ASD is around 3 years of age. However, signs of atypical behavior have been documented retrospectively by parents as occurring earlier than this 3-year mark. It has been suggested that gaze behavior could be a useful marker of developmental disruption in children with ASD. A very simple method, known as the *preference looking paradigm*, has been utilized successfully in toddlers as young as 14 months for the identification of ASD, but it has not been tested in infants. Therefore, the purpose of this study was to investigate gaze behavior in typically developing infants at 3 months of age before using this paradigm in infants at risk for ASD. Identifying early preferential looking differences in typically developing infants may allow for an increased understanding of the underlying visual processes, the development of an early detection paradigm for autism, and the advancement of foundational knowledge from which treatments for autism can be developed. Five typically developing infants were examined in this study at 3 months of age. Each infant was shown a preferential looking paradigm with dynamic social images presented on one side and dynamic geometric images on the other. Results showed that, of the five infants tested, none of them displayed a preference for either social images or geometric images. Each participant tended to focus on the center of the screen (between the two images). This is the first study to show that when 3-month-old infants are presented with dynamic social and geometric images, they do not show a preference. More data are needed to solidify this finding.

### The effects of a motor intervention on performance of the PDMS-2 for Hispanic low-SES pre-K children

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The National Institute of Early Education Research indicates that the number of children attending state-funded prekindergarten (pre-K) programs has dramatically increased in the last decade. The majority of children who attend state fund pre-K programs are from a low-socioeconomic status (SES). Furthermore, children in poverty often demonstrate significant delays in motor skill performance (Pope, Liu, & Getchell, 2011; Goodway, Crowe, & Ward, 2011). The purpose of this study was to examine the effects of an intervention on the gross and fine motor skill performance of Hispanic low-SES pre-K children. One hundred six pre-K children were randomly assigned to the experimental group ( $n = 53$ ) and the control group ( $n = 53$ ). They were assessed on their fine and gross motor skills using the Peabody Developmental Motor Scales-2 (PDMS-2) before and after the 15-week intervention. The children in the experimental group received 550 min of direct instruction to target gross and fine motor skills on stationary, locomotion, object manipulation, grasping, and visual-motor integration. The control group children received 550 min of activity-based lessons that were designed only to keep the children moving and active. A repeated-measures ANOVA was conducted on the PDMS-2 quotient scores to compare motor performance of children in the experimental and control groups. A significant group difference was found between the two groups. Follow-up ANOVAs revealed that children in the experimental group elicited significantly higher quotient scores than those of children in the control group across all gross tasks (i.e., stationary, locomotion, and object manipulation). No significant difference was found on fine motor skill performance between the two groups. These results suggested that Hispanic low-SES pre-K children benefited from a planned motor intervention program on their gross motor skills. The findings indicate that evidence-based programs may provide direction to teachers and educators and they are recommended to incorporate movement programs into the pre-K curriculum.

### Pathways to competence: Influencing the development of motor skills in preschool children

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Previous studies of mastery motivational climates (MMC) within physical education have shown that providing students opportunities to become self-directed leads to positive outcomes, including skill attainment and increased perceptions of ability. Nonetheless, none of these studies have examined children's participation within the actual interventions, and hence there has been no micro-analysis of the pathways children follow as they develop from novice learners to skill mastery. Using an ethnographic approach accompanied by significant visual imagery recall techniques (Pope, 2010), a cohort of children ( $N = 10$ ;  $M_{age} = 4.6$ ) were followed as they participated in a year-long (twice weekly for 45 min) MMC intervention. Data sources included the children's performance on the Test of Gross Motor Development-2 (Ulrich, 2000), interviews with the teacher, and analysis of photographic images of the children during play. The results showed that the children significantly improved both their locomotor ( $M = 34.6$  to  $85.10$ ,  $F[1,9] = 61.49$ ,  $p < .001$ ,  $\eta^2 = .872$ ) and object control skills ( $M = 8.5$  to  $72.8$ ,  $F[1,9] = 55.74$ ,  $p < .001$ ,  $\eta^2 = .861$ ). The interviews and photo analyses revealed that the children moved through 3 phases on their pathway to mastery. Within these phases, "state of being" nouns were created to describe the key characteristics of the children's progress. In phase 1, labeled "captivation" and "exploration," the teacher experienced challenges in developing the managerial system since children were on task approx. 50% of the time. In phase 2, "consolidation" and "cooperation," the teacher noted that the children had developed sufficient self-management skills and engaged more often in appropriate classroom tasks. In the phase 3, "erudition" and "collaboration," appropriate behavior occupied most of the class time. These descriptions suggest that early involvement in MMC is associated with behaviors that teachers find problematic, but as children become more acclimated with the intentions of autonomy support, they become more partners with teachers than adversaries.

### Physical activity from infancy through toddlerhood

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**Introduction:** During early infancy, level of physical activity (PA) is unstable, often fluctuating in intensity from one month to the next. PA levels are highly variable between infants as well, with some infants producing greater PA than others (Ulrich & Hauck, 2013). Given this variability, it is of value to investigate potential benefits of increased PA in early infancy. Still, little is known regarding the influence of PA in early infancy on health and developmental outcomes in childhood. The purpose of this study was to initially evaluate the relationship between level of PA in early infancy and PA in toddlerhood. **Method:** 27 infants participated longitudinally from 6 to 18 months of age. PA was assessed monthly using an accelerometer. Prior to independent walking, PA was measured via an Actical accelerometer on the right ankle. Data are summarized as raw counts per minute. Once walking, PA was measured via an Actigraph accelerometer on the waist and validated cut points were applied. Data are summarized as minutes per day of sedentary, light, and moderate-intensity PA. **Results:** PA level at 6 months of age is significantly correlated with PA level at 18 months of age. Infants generating greater counts per minute of activity at 6 months are significantly less sedentary at 18 months of age ( $r = -.539, p = 0.017$ ). **Conclusion:** Infants producing greater physical activity in early infancy spend less time in sedentary activity as toddlers. This finding is novel and a first to consider early motor behavior relevant to health behaviors occurring later in childhood. This knowledge should generate research exploring the manipulation of PA in infancy as well as the impact of infant PA on motor skill development and early onset of obesity.

### Proprioception: Its development, its trainability, and its effect on motor control in neurological disease—The development of proprioceptive acuity in children

Holst-Wolf, Jessica M.; Yeh, I-Ling; Konczak, Juergen; University of Minnesota

Previous attempts to map the time course of proprioceptive development during childhood either used difficult movement tasks, nominal measurement scales, or only examined small study samples. The aim of this study was to map the development of proprioception in a large population of healthy children using a single-joint movement and a continuous acuity measure. **Method:** Participants include 120 healthy children (5–14 y/o; M/F = 41/79) and a reference group of 20 healthy adults (19–25 y/o; M/F = 10/10). Limb position acuity was assessed using a bimanual manipulandum. The task involved horizontal rotation of both forearms. The participant's non-dominant forearm was passively moved to one of three target positions 40°, 60°, or 90° of elbow extension from a starting position of 30° of elbow extension. With the reference arm at the target position, participants actively matched the reference position with the dominant arm. Encoders in the manipulandum lever arms recorded the endpoint angular position of each arm for each trial. Targets were presented in pseudo-random order with five repetitions of each target position. For each trial, position error (PE) was defined as the difference between the angular positions of matching and reference arm. **Results:** 1) No consistent bias in PE was observed across age. Mean PE did not shift across age groups. 2) PE variability decreased with age. 3) PE increased with increasing target position consistently for all ages. **Discussion:** Proprioceptive development during childhood is characterized by an increase in precision, not an age-related change in bias. This bimanual acuity measurement method is fast, provides objective data and is easily performed even by kindergarten age children. The setup is mobile, enabling proprioceptive assessments in school settings. This normative dataset on proprioceptive forearm acuity provides the basis against which pediatric populations with proprioceptive deficits can be compared.

### Do self-conscious emotions mediate the relationship between anxiety and physical activity?

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Individuals with anxiety symptoms report lower levels of physical activity (PA) and more sedentary behaviors than non-anxious individuals. The mechanisms linking anxiety symptoms, PA and sedentary behavior are largely understudied. Self-conscious emotions (guilt and shame) are known correlates of sedentary behavior and PA, and have been theoretically linked to anxiety disorders. The purpose of this study was to test self-conscious emotions as mediators of the association between anxiety symptoms and activity behaviors. Three behaviors associated with physical activity were measured: sedentary time, sport participation, and moderate-to-vigorous physical activity (excluding sport). Self-reported symptoms of anxiety were collected at age 20 years whereas self-conscious emotion, sports participation, sedentary behavior, and activity levels were reported at age 24 years in 771 adults participating in the Nicotine Dependent in Teens study. Data were analyzed in multiple mediation models for each of the sport, PA, and sedentary behavior outcomes. Guilt and shame mediated the association between anxiety and weekly minutes of sport ( $B = -8.48, 95\% \text{ CI } [-13.23, -5.02]$ ), but not the relationship between anxiety and PA. In the sport model, guilt was associated with greater activity levels ( $B = 59.31 \text{ min}$ ) and shame was associated with lower activity levels ( $B = -90.82 \text{ min}$ ). Shame mediated the relationship between anxiety and weekly sedentary behavior ( $B = 0.51 \text{ hr}, 95\% \text{ CI } [0.04, 1.19]$ ). Given these findings, the guilt and shame felt by anxious individuals might prevent them from engaging in sport and increase their sedentary time. Given the strength of associations, shame is identified as a potential target for interventions aimed at improving sport participation and sedentary behavior in anxious individuals.

**Does motor skill performance relate to cardiovascular fitness in children?**

Irwin, Jacqueline M., Auburn University; Palmer, Kara K., Robinson, Leah E., University of Michigan

**Purpose:** To examine the relationship between motor skill performance and fitness in children. **Methods:** Forty-four 3rd-grade children (23 boys;  $M_{age} = 8.7 \pm 0.6$  years) served as participants. Motor skill performance was evaluated using the Test of Gross Motor Development–2nd Edition (TGMD-2; Ulrich, 2000) raw scores and cardiovascular fitness was assessed by averaging two trials of the Progressive Aerobic Cardiovascular Endurance Run (PACER; Meredith & Welk, 2007). Pearson correlations were used to examine the relationships between variables. **Results:** For the TGMD-2, boys scored  $33.3 \pm 5.3$  on the locomotor subscale,  $37.4 \pm 5.1$  on object control subscale and  $70.6 \pm 7.8$  for total TGMD-2 score. Girls scored  $34.0 \pm 4.1$  on the locomotor subscale,  $35.8 \pm 5.1$  on object control subscale and  $69.8 \pm 7.8$  for total TGMD-2. For the PACER, boys averaged  $24.9 \pm 15.2$  laps and girls averaged  $18.8 \pm 8.4$  laps. No statistically significant relationships were observed between motor skill performance and PACER scores for the overall group. Examination of the relationships by sex revealed no statistically significant relationships between PACER score nor any motor variable in boys. However, total motor skill performance was moderately associated with PACER scores ( $r = 0.46, p < 0.05$ ) in girls. When examining this relationship for the girls' motor subscale, locomotor skills were not associated with PACER scores but a strong relationship was present for object control skills ( $r = 0.51, p < 0.05$ ). **Conclusion:** These results support existing evidence that proficiency of object control skills in girls may be a critical link in understanding physical activity and physical fitness in girls.

**Movement skills and fitness as predictors of later physical activity**

Jaakkola, Timo T.; University of Jyväskylä

Transition from childhood to adolescence is a critical period when individuals adopt behaviors such as physical activity. It has been suggested that fundamental movement skills and physical fitness are antecedents for the later physical activity engagement. The purpose of this study was to investigate the role of fundamental movement skills and physical fitness collected at Grade 7 in predicting self-reported physical activity six years later. The participants of the study were 333 (200 girls, 133 boys;  $M_{age} = 12.41$ ) Finnish students. Adolescents' fundamental movement skills, physical fitness were collected at baseline measurement. Fundamental movement skills tests consisted flamingo standing test (balance skill), leaping test (locomotor skills), and figure-8 test (manipulative skills). Endurance running (aerobic fitness) and abdominal muscle endurance (muscular fitness) constituted the fitness tests. Self-reported energy expenditure (metabolic equivalents: total METs) and intensity of physical activity (light, moderate, vigorous) was collected 6 years later using the International Physical Activity Questionnaire. Previous levels of physical activity, sex, and body mass index were controlled in the analyses because there is evidence demonstrating that these variables have association with physical activity in adolescence. Results of this study showed that after controlling previous levels of physical activity, sex, and body mass index, fundamental movement skills predicted total METs as well as light, moderate, and vigorous physical activities. Additionally, results indicated that after controlling previous levels of physical activity, sex, and body mass index, physical fitness predicted METs, moderate, and vigorous physical activity levels. Regression analyses also indicated that fundamental movement skills and physical fitness predicted more intensive than light later physical activity. This study showed that fundamental movement skills and physical fitness are antecedents of later physical activity engagement.

**Effect of different positioning devices on leg movement quantity in infants**

Jiang, Crystal; Smith, Beth A.; University of Southern California

**Background.** This study explores infant leg and foot movements when infants are constrained in a car seat or Bumbo seat or encouraged to move in a jungle gym. We will determine if commonly used infant-positioning devices affect infant movement rates and whether any effects are more or less pronounced in infants at risk or with developmental delay. Our results will begin to inform parents and therapists about use of these devices in a therapeutic context. Here we describe preliminary findings on quantity of leg and foot movements in infants with typical development. **Methods.** We collected data from 10 infants with typical development between 2 and 6 months of age. Video data were recorded at 30 Hz for 4 min while infants were placed in the following randomized conditions: supine, in a standard car seat, in a Bumbo seat, in supine under a jungle gym. Trained behavior coders identified the start and stop time of leg or foot movements from frame-by-frame video analysis. We have analyzed data from three infants to date. Once all data are behavior coded, we will use a repeated-measures analysis of variance to test for a condition difference at  $\alpha = 0.05$ . **Results.** Preliminary analysis showed the average quantity of leg movements in 4 min was 265 in supine, 245 in a standard car seat, 164 under a jungle gym and 77 in a Bumbo seat. Average quantity of foot movements in 4 min was 84 in a Bumbo seat, 20 in a standard car seat, 7 in supine, and 2 under a jungle gym. **Conclusions.** Preliminary analysis supports that movement rates were affected by positioning devices. Specifically, no change in leg movements but more foot movements were observed when infants were constrained in a car seat, less leg but more foot movements were observed when infants were constrained in Bumbo seat, and less leg and foot movements were observed when infants were under a jungle gym. Anecdotally, infants shifted to more arm and less leg movement when under the jungle gym. Next steps are to analyze arm movements, statistically test our results, and assess infants at risk or with delay. *Grant from the USC Undergraduate Research Associates Program (PI: Smith) and K12-HD055929 (PI: Ottenbacher). Also funded by USC's Provost's Undergraduate Research Fellowship*

### Natural infant walking

Lee, Dokyeong; Hasan, Shohan; Adolph, Karen; New York University

**Introduction:** Traditionally, researchers have studied developmental changes in infant walking proficiency over a straight, uniform path. However, recent video analyses show that during natural locomotion, freely moving infants do not traipse back and forth in straight line. Instead, they walk curved omnidirectional paths; they frequently turn, start and stop, and fall (Adolph et al., 2012). Thus, our purpose was (1) to obtain footfall measures of walking proficiency during natural infant locomotion and (2) to compare infant walking in the traditional straight-path paradigm and during natural, spontaneous activity. **Methods:** We assessed infant walking proficiency based on standard footfall measures in two conditions: in the traditional straight-path paradigm and during 20 min of spontaneous natural activity in a lab playroom. Infants (13, 15, and 19 months of age) walked over a pressure-sensitive carpet that recorded timing and placement of their steps—step length, stride width, single support percentage, and double support percentage. **Results:** Preliminary video data replicated previous work: Natural infant walking looked very different from traditional straight path gait measures. Rather than producing straight continuous walking sequences, during spontaneous activity, infants walked in curved staccato paths, with bouts ranging from 2 to 10 steps in length. The gait carpet data provided novel insights: In natural walking bouts that contained more than four consecutive steps (thus allowing standard gait measures), infants displayed shorter step length, larger stride width, and shorter single support percentage than during the traditional straight-path test. Double support percentage, however, was similar across conditions. **Conclusions:** Findings indicated that walking proficiency based on traditional straight-path gait measures is inadequate for understanding the characteristics of natural walking. Quantifying walking proficiency in natural infant walking may provide an alternative perspective on developmental changes in walking proficiency.

### Effects of socioeconomic and overweight status on infants' motor milestones

Lee, Dokyeong; Majumder, Omran L.; Jimenez-Robbins, Carmen; Cole, Whitney; Hasan, Shohan; Messito, Mary Jo; New York University; Gross, Rachel, Albert Einstein College of Medicine; Mendelsohn, Alan Lewis; Adolph, Karen; New York University

The prevalence of overweight status in the U.S. is skyrocketing in young children. Moreover, low-socioeconomic status is associated with risk of being overweight. However, little is known about effects of overweight and socioeconomic status on motor development—onset ages for independent mobility. We observed 65 infants from middle-class White families and 44 infants from low-income Latino families at 10, 13, 15, and 19 months of age. Low-income infants were more at risk of being overweight ( $= 85$  weight-for-length %); 31% of the low-income group were overweight compared to 21% in the middle-class group. We determined infants' onset ages for belly crawling, hands-knees crawling, cruising, and walking from a structured interview, and assessed crawling/walking proficiency. Middle-class infants showed typical onset ages: on average, belly crawling at 6.6 months, hands-knees crawling at 8.2 months, cruising at 9.4 months, and walking at 12.2 months. In contrast, low-income infants achieved belly crawling and hands-knees crawling at approximately the same age (8.5 and 8.9 months, respectively) and showed delays in achieving each milestone compared with the middle-class group: cruising at 10.0 months and walking at 13.4 months. Moreover, overweight status in low-income infants was positively correlated with delays in onset ages of milestones. Overweight low-income infants began hands-knees crawling, cruising, and walking at least 2 months later compared to babies with low % ( $= 30\%$ ). The overweight effect did not exist in middle-class group for any motor milestone. Low-income infants showed less mature gait patterns. For walking, low-income infants showed shorter step length (25.57 vs. 29.67 cm,  $p = .04$ ), slower speed (86.48 vs. 113.70 cm/s,  $p = .02$ ), and tended to show wider step width (11.55 vs. 10.30 cm,  $p = .35$ ) and narrower dynamic base (129.04 vs. 140.53°,  $p = .15$ ). For crawling, low-income infants showed slower speed (47.11 vs. 64.90 cm/s,  $p = .01$ ) and cadence (2.42 vs. 2.88 steps/s,  $p = .03$ ). Results suggest that interactions between socioeconomic and overweight status may contribute to delays in independent mobility. *NICHD R37-HD03348 to Karen Adolph*

### Effects of early treadmill practice on behaviors and underlying mechanisms in babies born with myelomeningocele

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Therapists recognize the need for rigorous and earlier intervention for young infants with disabilities, but very few studies have tested the effects. Our purpose was to determine the effects of early and aggressive treadmill practice on the development neuromotor control (stepping and onset of motor milestones) and underlying mechanisms (bone mineral contents [BMC] and spinal-level reflex integrity) in infants with myelomeningocele (MMC) across the year. Ten infants with MMC received home-based, parent-administered treadmill stepping practice 5 days per week, 10 min per day starting at 1 month of age for 12 months. We measured treadmill steps (frequency, quality, muscle activations), motor milestones, BMC, and spinal-level reflexes. Outcomes were compared to data previously published for infants who did not receive practice. Practice enhanced step quality: interlimb coordination was more often alternating and foot contact with the treadmill was more likely with heel or flat part of foot. Practice enhanced onset of motor milestones (e.g., rolling, sitting, or walking): for example, infants with practice took the first independent steps at a mean age of 21 months old and it is 2.2 months faster than their peers without practice. The BMC of MMC infants with practice was only slightly lower than healthy infants across the first 18 months of life and higher than peers with MMC who did not receive practice. Practice improved the rate of bone mineralization in infants with MMC at all sites measured, but its effect was statistically pronounced in the lower body. Practice also improved the integrity of spinal reflexes. This pilot study demonstrates the feasibility of using home-based, early aggressive intervention for infants with MMC starting at 1 month after birth. Future studies should include larger samples and concurrent control group, assess does-response issues, and determine optimal timing and duration.



**Age differences in movement coordination when learning a novel virtual task**

Lee, Mei-Hua, Michigan State University; Farshchiansadegh, Ali, Northwestern University

Do motor learning strategies in children fundamentally differ from that in adults? In spite of its theoretical importance, addressing this question involves methodological challenges because in typical motor tasks, any differences in learning strategies between children and adults are often confounded by differences in task familiarity and changes in body scale. In order to minimize these confounds, we investigated how children and adults acquire a motor skill in a novel virtual task. Participants' upper body movements were measured using 4 inertial measurement units (IMU) and mapped to cursor position. The body space was an eight dimensional space (2 signals per IMU) and the control space was a two dimensional space. They learned to control a cursor on a computer screen in a center-out reaching task to peripheral targets. Principal component analysis (PCA) was used to perform the dimensionality reduction. In addition to being a novel task, this task could be body scaled, thereby ensuring that both children and adults could potentially perform the task using their existing movement abilities. Both children and adults practiced for a total of 160 trials reaching toward 4 targets. To examine the generalization, we also included three generalization tests during learning (pre-, during and postpractice), where participants reached toward 4 additional targets. Results show that children tended to have longer movement times (approx. 2x longer) compared to adults. This difference was due to the decreased ability in children to control the cursor and not simply due to slower movement speeds. In terms of strategies, we investigated how participants coordinated their body to accomplish the task. We found that compared to adults, children had much higher variance along the first principal component, indicating that they tend to use one strategy throughout practice. These results suggest that the lower task performance in children is associated with difficulty in distributing motor variability over multiple dimensions.

**Developmental changes in object-based and egocentric transformations**

Lehmann, Jennifer, Kaltner, Sandra, Jansen, Petra; University of Regensburg

While mental rotation is defined as the process of imagining how a two- or three-dimensional object would look if rotated away from its original upright position (Shepard & Metzler, 1971), one can distinguish between two different types of mental transformation strategies: object-based and egocentric (Zacks, Mires, Tversky, & Hazeltine, 2002). However, little is known about the difference between these two transformations with focus on developmental changes. Therefore, we compared 38 children (8–11 years), 38 adults (18–25 years) and 38 older adults (60–71 years) using two object-based conditions (letters, human figures) and one egocentric condition (human figures). Important results were that children and older adults showed slower overall reaction times compared to adults,  $F(2,109) = 112.65, p < .001, \eta^2 = .67$ . Regarding mental rotation speed, children and older adults rotated slower than adults,  $F(2,109) = 11.537, p < .001, \eta^2 = .175$ . With respect to both types of transformations, there is a difference between egocentric and object-based human figures in adults and older adults (adults:  $t(37) = -3.422, p = .002$ , older adults:  $t(36) = -3.339, p = .001$ ), but no such difference was found in children,  $t(36) = -1.737, p = .091$ . Surprisingly, the comparison of reaction times in object-based and egocentric transformations revealed that only in children was there a difference between the human figures in the object-based and egocentric condition,  $t(37) = -2.512, p = .016$ , which did not occur in adults and older adults (adults:  $t(37) = .967, p = .340$ , older adults:  $t(37) = -.038, p = .970$ ). Since mental changes in working memory are mediated by age differences in cognitive processing speed, cognitive speed is supposed to be the contributing factor for developmental changes. Regarding both types of transformations, an egocentric advantage over object-based rotations was only found in adults and older adults, which led us to tentatively propose that children show deficits in perspective taking compared to adults and older adults.

**Examining prefrontal cortex activity during a cognitive and motor task in boys with and without autism spectrum disorder**

Liang, Ling-Yin, University of Evansville; Golden, Daphne K., University of Scranton; Getchell, Nancy, University of Delaware

Autism spectrum disorder (ASD) is a common neurodevelopmental disorder characterized with deficits in social communication, repetitive behavioral patterns, and often, movement dysfunction. Researchers have linked some of these issues to executive function / atypical prefrontal cortex activity. In the current study, we use functional near-infrared spectroscopy (fNIRS) to examine hemodynamic response associated with neural activity in the prefrontal cortex in boys with and without ASD during a cognitive (Tower of Hanoi) and motor (tapping) task. Method: A total of 12 boys (7 ASD,  $11.9 \pm 3.2$  years old; 5 typically developed (TD),  $11.8 \pm 3.0$  years old) completed 3 min of baseline (resting with eyes open) followed by two randomly ordered conditions: 2 min of finger tapping (TAP) and 2 min of Tower of Hanoi (TOH). Performance on TOH was measured by number of moves to complete the puzzle and level of successful performance (3 or 4 discs). Cerebral hemodynamic flow was measured with the fNIRS device via a 16-channel sensor placed on the prefrontal cortex. Measures of change in concentration of oxygenation (?oxy-Hb), deoxygenation (?deoxy-Hb), and total hemoglobin (?total-Hb) were taken throughout each condition. Results: In the cognitive task, the ASD group finished the TOH using more moves than the TD group in both 3-disc (12.4 vs. 23 moves) and 4-disc (19 vs. 22.5 moves) conditions. The ASD group had a higher peak value in ?oxy-Hb in the TOH condition and a greater rate of change in ?deoxy-Hb from TAP to TOH condition than the TD group. No differences were found between groups in the tapping condition. The lower performance scores combined with different oxygenation measures suggests that the ASD group had difficulty organizing and planning during the TOH task. Further, the tapping task required little motor planning, given the oxygenation values and lack of differences between groups.

**Modulation of kinesthetic impairment in bimanual movements**

Lincoln, Faith; Kagerer, Florian; Ward, Jayne; Michigan State University

Previous research has shown that balance, and proprioception of the lower limbs are impaired in patients with multiple sclerosis (MS). The extent of kinesthetic impairment in the upper limb for this population is not well known. Therefore, this study aims to identify the impairment in the upper limb in MS patients with respect to kinesthesia, and determine if this performance can be modulated by simultaneous utilization of the contralateral limb. Patients with MS aged 32–61 with mild-to-moderate severity, and diagnosed within the last ten years, as well as age- and gender-matched healthy controls, performed center-out movements by controlling a cursor on a horizontally positioned computer screen with a joystick underneath ensuring that participants could not see their hand movements. All participants started by performing unimanual trials with each hand under conditions in which the movement path was visible on the screen (visible condition), or there was no visual feedback (kinesthetic condition). This was followed by a mixed bimanual condition where the kinesthetic hand performed simultaneously with the visible contralateral hand. Finally, they performed a simultaneous bimanual condition where movements of both hands were visible. Preliminary data show that kinesthetically guided movements of MS patients in both unimanual and bimanual conditions are slower, less linear, and less accurate when attempting to reach targets compared to the controls. At the same time, MS patients show improvement of endpoint error in the dominant limb, and movement linearity in either kinesthetically guided arm when utilizing bimanual coordination compared to unimanual movements. This might indicate that sensorimotor function in patients with multiple sclerosis could benefit from therapeutic interventions that use both limbs simultaneously.

**Motor assessment for children with autism spectrum disorder: A case study**

Liu, Ting, Texas State University; ElGarhy, Sayed, Fayoum University; Breslin, Casey M., Temple University

Without proper motor assessment, children with autism spectrum disorder may be placed in educational settings that are inappropriate for their motor abilities. However, the choice of which assessment to use is considered a challenge for many practitioners, especially with the number of instruments available. The purpose of this case study was to compare several widely used developmental instruments (BOT-2; MABC-2; PDMS-2; TGMD-2) that were designed for motor skill assessment. The participant was a 5-year-old boy with high functioning autism. He was assessed at a local elementary school gym for all four motor assessments. His gross motor performance was inconsistent between the PDMS-2 and the TGMD-2. In addition, he was classified as below average for MABC-2 balance tests but his balance performance was average for the BOT-2. For fine motor skills, he was average for the grasping and the visual-motor integration subtests in the PDMS-2. These scores were consistent with his BOT-2 fine motor performance (average). However, they were inconsistent with the manual dexterity in the MABC-2 (below average). Overall, he performed the best in PDMS-2 out of the four instruments. The possible explanation is that the PDMS-2 has a large number of similar tasks; the repeated items with varying levels of difficulty might have given him the chance to practice and perform better as the assessment progressed. Though he scored the highest in PDMS-2, this does not indicate the other three instruments were unsuitable for him. Each assessment has its advantages and limitations and can have different results due to the individual tested. Practitioners should take into consideration the purpose of their testing and each instrument's proper age range, type of motor skills, and functioning when they choose the motor assessment.

**Extended retention of gait patterns after training with a fractal visual stimulus**

LoJacono, Chanel T.; Frame, Logan J.; Rhea, Christopher K.; University of North Carolina at Greensboro

Fractal gait patterns are observed in healthy adults, but injury, aging, and pathology can degrade these patterns. A change in gait fractal patterns may reflect the reduced adaptive capacity of the neuromotor system, potentially increasing the risk of an injury. Previous work has used visual and auditory stimuli to develop new fractal gait patterns. However, it is unknown if the new gait pattern is retained after a period of rest. The purpose of this study was to determine if fractal gait patterns persisted after a 5-min period of rest following 10 min of training to walk with a new fractal gait pattern using a visual stimulus. The visual stimulus consisted of a left and right footprint flashing on a projection screen, which indicated the desired timing of heel-strike for each limb. The timing structure of each footprint was fractal, as quantified by detrended fluctuation analysis alpha (DFA- $\alpha$  of the stimulus was 0.98). Young healthy adults ( $n = 16$ ,  $24.4 \pm 3.5$  years) walked for 30 min on a treadmill, which was separated into three 10-min phases. No visual stimulus was presented in the first phase (baseline phase), which was immediately followed by the second phase that consisted of having the participants synchronize their gait cycle to the visual stimulus (sync phase). Next, the participants sat down for 5 min, after which they completed the third phase of walking without a stimulus (retention phase). DFA  $\alpha$  for stride time of the right limb during baseline phase was  $0.76 \pm 0.10$  and then significantly increased during the sync phase to  $0.84 \pm 0.06$  ( $p = 0.025$ ). The retention phase exhibited a DFA- $\alpha$  of  $0.80 \pm 0.08$ ; however, it was not significant from the baseline ( $p = 0.122$ ) or sync ( $p = 0.219$ ) phases. These results suggest there may be a dose–response effect, as the DFA values after training (retention phase) were not as high as observed during the training (sync phase), but also did not return to the lower baseline levels.

**Motor-cognitive skill intervention in a hospital environment: The impact on the development of infants with cystic fibrosis**

Mattiello, Gabriela M.P., HCPA Hospital of Clinics Porto Alegre; Panceri, Carolina, Pereira, Keila G., Valentini, Nadia C., Universidade Federal do Rio Grande do Sul

**Objective:** The aim of the study was to describe the impact of cognitive-motor intervention in motor and cognitive development of infants with cystic fibrosis. **Methods:** The intervention group (IG) consisted of 6 infants ( $M_{\text{age}} = 3$  months old;  $M_{\text{gestational age}} = 37$  weeks) diagnosed with cystic fibrosis and admitted to the pediatric unit of a university hospital. The data from two control groups (CG1 and CG2) were obtained from a database from the same university. The control groups were 12 typically developing infants matched for age, sex, and family income to the IG. The IG was assessed before and after intervention using the Alberta Infant Motor Scale (AIMS) and the Bayley Scales of Infant Development (BSID-III). The CG1 CG2 were assessed using AIMS. Results showed delayed motor development of IG at preintervention compared with the scores of healthy babies of the same age (CG1). Postintervention performances for the IG were similar to healthy infants of the same age (GC2). From pre- to postintervention, the IG showed significant positive changes in the AIMS total raw score ( $p = 0.026$ ) and the percentile ( $p = 0.043$ ). Positive changes were also observed for the BSID-III raw scores for gross motor development ( $p = 0.042$ ) and fine motor ( $p = 0.043$ ). Positive and moderate-to-strong correlations were observed between the percentiles of AIMS and BSID-III ( $r = 0.982$  and  $p = 0.000$ ), and between percentiles of BSID-III motor and cognitive scores ( $r = 0.365$  and  $p = 0.238$ ). The intervention positively affected the motor and cognitive development of infants with cystic fibrosis. *CAPEP and CNPQ*

**Visual flow stimulation improves perturbation response in experienced ice skaters**

Mercier, Brittany; de Bruin, N.; Steinke, C.; Brown, L.; Doan, J.; University of Lethbridge

Sports activities can be full of visual cues, including structured environments, moving targets, and rapid visual flow. These cues can facilitate motor performance amongst experienced athletes, and might be useful in training and therapeutic sessions. The objective of this study was to determine if ice skating visual flow influences postural muscle activity, and to determine how these influences differ between experienced and non-experienced skaters. Subjects consisted of 27 healthy individuals ( $21.9 \pm 10.1$  years, 13 males). Each subject completed 9 trials with an ice skating visual flow video, and 9 without, and presentation order was alternated between participants. Three random ordered repeats of three 60-s postural trial types [quiet standing, sway-referenced platform rotation, unexpected perturbation ( $-6.350$  cm, in  $0.318$  s after delay of  $10$  s)] were delivered in each visual condition (Equitest CRS, Neurocom, Clackamas, OR, USA). Surface electromyography (EMG) was taken bilaterally at peroneus longus, biceps femoris and erector spinae for 18 ( $21.3 \pm 2.7$  years, 8 males) of the participants. Subjects were divided into experienced and non-experienced skaters based on self-reported skating ability. During quiet standing and sway conditions visual stimulation increased CoP displacement and velocity for both groups. A significant improvement was found among the experienced group during the perturbation condition under visual stimulation. This effect was evidenced by increased mediolateral (M/L) stability, reduced M/L center of pressure range, and smaller M/L and anteroposterior maximum velocities. The EMG results for these same trials demonstrated a significant increase in magnitude of peroneal and biceps femoris activation. These results suggest that ice skating visual flow increases dynamic balance among experienced skaters. This is accomplished by increased activation of the biceps femoris and the ankle stabilizing peroneals, suggesting that a preparatory state may be primed by relevant the visual cueing. *Alberta Innovates-Health Solutions*

**Dose-response relationship: The effect of motor skill intervention duration and changes in motor skill competence**

Palmer, Kara K., University of Michigan; Dennis, Abigail, Auburn University; Robinson, Leah E., University of Michigan

**Background.** Literature supports the effectiveness of motor skill interventions on improving motor skill competence in young children (Robinson, 2011). However, the ideal intervention dose (i.e., number of minutes for motor instruction) has not clearly been established. The purpose of this study was to examine the effects of three different doses of a motor skill intervention on changes in motor skill competence scores in preschool aged children. **Methods.** A total of 115 children served as participants. Children were divided into one of four groups: control or no intervention ( $n = 45$ , 57% males,  $M_{\text{age}} = 4.8$  years) and three treatment groups: T1 with 660 intervention minutes ( $n = 25$ , 50% male,  $M_{\text{age}} = 4.8$  years); T2 with 720 intervention minutes ( $n = 18$ , 48% male,  $M_{\text{age}} = 4.7$  years); or T3 with 900 intervention minutes ( $n = 23$ , 52% male,  $M_{\text{age}} = 4.8$  years). Motor skill competence was assessed using the Test of Gross Motor Development–2nd edition (TGMD-2; Ulrich, 2000). All participants completed the TGMD-2 prior to (pretest) and following the intervention (posttest). A change score (i.e., subtracting posttest scores from pretest scores) was calculated for total TGMD-2 scores and each subscale; object control and locomotor. Multivariate analysis of variance was conducted to determine if changes in motor skills significantly differed among the four groups. **Results.** Findings demonstrate significant differences among the four groups for the total TGMD-2 score ( $F(3,111) = 19.0$ ;  $p < .001$ ), object control score ( $F(3,111) = 7.1$ ;  $p < .001$ ) and locomotor score ( $F(3,111) = 19.0$ ;  $p < .001$ ). Bonferroni post hoc analysis revealed that there were significant differences between the control group and each of the treatment groups but no significant differences were present among the treatment groups. **Conclusion.** This study concludes that 660 and 900 min of high-quality motor skill instruction results in similar improvements in young children motor skill competence.

### Motor ability and cognition in children: A systematic review and meta-analysis

Palmer, Kara, University of Michigan; Lohse, Keith R., Wilson, Alan E., Auburn University; Robinson, Leah E., University of Michigan

Background. Research supports a positive relationship between cognition and physical activity, but this relationship has not been established between cognition and movement or motor ability. The purpose of this meta-analysis was to examine the relationship between motor ability and cognition and to determine if this relationship differs between fine and gross measures of movement. Methods. Suitable research articles were identified through a systematic literature search, and a final sample of ten articles that met the inclusion criteria were used. All data were entered into Excel and reduced by hand. The final, reduced data was analyzed using the “metafor” package in R. Results show a positive relationship between cognition and overall motor performance ( $r = 0.19$ ;  $p < .01$ ) and both gross ( $r = 0.15$ ;  $p < .01$ ) and fine motor ( $r = .27$ ;  $p < .01$ ) ability. Each analyses displayed a significant amount of heterogeneity. A secondary analysis demonstrated a trend that fine motor performance is more related to cognition than gross motor performance, but this result was not statistically significant ( $r = 0.12$ ;  $p = 0.15$ ). Conclusion. Results support that motor ability and cognition are related, but the strength of this relationship likely depends on how these constructs are operationalized, the participant population, and the specific measurement of the motor abilities and tasks.

### Visual contribution to walking: How is it in children with a risk of motor coordination disorder?

Palomo, Miriam; Psotta, Rudolf; Abdollahipour, Reza; Agricola, Adrian; Valtr, Ludvik; Palacky University Olomouc

Research on fine motor skills have shown that children with developmental coordination disorder (DCD) rely more heavily on vision to perform movements skills than their typically developing (TD) peers. The purpose of the current study was to investigate the contribution of visual information during walking in TD children and children with risk of developmental coordination disorder (DCDR). Thirty-two children (21 boys and 11 girls,  $M_{age}$ : 8.9,  $SD$ : 0.9 years) were divided into two motor competence groups according to the total test score of the Movement Assessment Battery for Children–Second Version (MABC-2): sixteen TD and sixteen DCDR children. They were asked to walk along a 10-m walkway where the Optojump-Next instrument was placed. Participants walked in the same visual environment. They walked in self-selected speed under four visual conditions: full vision (FV), limited vision 100 ms (LM-100), limited vision 150 ms (LM-150), and non-vision (NV). For visual occlusion in LM-100 and LM-150, participants were equipped with Plato Goggles that shut for 100 and 150 ms, respectively, within each 2 s. An eye mask was used to cover the participant’s eyes in the NV condition. The results showed that TD children were significantly faster in speed and they walked with longer steps and strides than DCDR children regardless the vision condition. Furthermore, the speed of walking and the step and stride length decreased significantly as the occlusion time increased regardless the level of motor competence. Time variables including stance phase (s), single support (s), load response (s), and pre-swing (s) were significantly different between TD and DCDR children regardless the visual condition. In addition, only stance phase (s) and single support (s) were also significantly different between the various visual conditions regardless the motor competence group. The present study suggests that withdrawing and limiting the vision affect distance, speed, and time parameters of the gait cycle in DCDR more than TD children. *Supported by the European Structural Funds and state budget of the Czech Rep. [POSTUP II, No. CZ.1.07/2.3.00/30.0041]*

### Determination of biological, social and environmental risk factors for hospitalization for respiratory disease of infants

Panceri, Carolina, Pereira, Keila G., Valentini, Nadia C., Universidade Federal do Rio Grande do Sul

Objectives: To describe the biological and environmental characteristics of infants hospitalized for respiratory diseases and investigate associations between the recurrence of hospitalization and biological, socioeconomic and family environment. Methods: descriptive, cross-sectional and prospective study conducted in the pediatric unit of a public university hospital. Participated 39 infants (1 to 16 months old). Questionnaires were conducted with the infant’s parents for sample characterization. Family environment (Affordances in the Home Environment for Motor Development–Infant Scale; AHMED) and socioeconomic level (Brazilian Criteria for Economic Categorization) were also assessed. Results: The backward linear regression showed a significant association model ( $R^2 = 0.80$ ) between the recurrence of hospitalizations and the age of the child ( $\beta = 0.32$ ,  $p = 0.025$ ), maternal age ( $\beta = -0.57$ ,  $p = 0.0001$ ), maternal education ( $\beta = -0.32$ ,  $p = 0.011$ ), physical conditions of the residence ( $\beta = -0.47$ ,  $p = 0.004$ ), AHMED maternal practices ( $\beta = -0.34$ ,  $p = 0.023$  and  $\beta = -0.24$ ,  $p = 0.050$ ) and inside-the-house physical space ( $\beta = 0.413$ ,  $p = 0.004$ ). Conclusion: Environmental factors were more associated than biological factors with the number of admissions for respiratory diseases in infants in the present sample. The results reinforce the importance of actions taken to reduce environmental risks in order to diminish the recurrence of respiratory diseases in early childhood and provide interventions focused on the comprehensive health of the child. *CAPES and CNPQ*

### **Plantar pressure regularity is increased under the lateral forefoot in the elderly**

Pisciotta, Eric J., Yentes, Jennifer M.; University of Nebraska at Omaha

The primary goal of this research was to identify alterations in plantar pressure distributions due to aging. Specifically, to quantify the regularity of peak pressure patterns under distinct anatomical regions of the foot during consecutive stance cycles in order to determine if aging leads to alterations in the regularity of peak plantar pressures. By quantifying the regularity we can gain insights into the temporal structure of the preferred peak loading pattern during walking. It was hypothesized that elderly subjects would distribute loads to the lateral aspect of the foot, localizing towards weaker metatarsal structures and that elderly would display a greater regularity of peak pressures. Four healthy young ( $28.7 \pm 4.5$  years) and four healthy elderly ( $77.3 \pm 8.9$  years) subjects were recruited to participate in this study. A clinical foot evaluation was conducted in order to screen for foot deformities. Subjects were fitted to a control shoe with a pair of pressure insoles (PedarX, Novel Electronics) and asked to walk on a treadmill at their preferred speed for 10 min. Data was analyzed by dividing the insole pressures into seven anatomical regions (heel, medial mid-foot, lateral mid-foot, lateral metatarsal, first metatarsal, lateral toes, and the hallux). The peak pressure in each region for 300 consecutive steps was determined and sample entropy was utilized to quantify the regularity of peak pressures in each region for the right foot. An independent *t*-test was used to compare the regional sample entropy between age groups. The sample entropy of the right lesser toe region (digits 2–5) was significantly ( $p = 0.036$ ) reduced (more regular) in comparison to the healthy controls. Although not significant, there was a tendency for decreased peak pressure sample entropy (more regular) in other regions, such as the lateral metatarsal, in older adults. These preliminary results suggest repetitive loading of high pressures under the lateral forefoot in elderly. This may have further implications for elderly persons with foot pain, diabetic ulcers, or at risk for falls.

### **Balance strategies depend on age while establishing single leg stance**

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Multiple strategies of postural control to initiate and maintain single leg stance (SLS) have been identified as ankle, hip, and mixed strategy. This study aims to investigate the temporal dependency of leg joint kinematics and adopted balance strategies during the early phases of SLS. It is hypothesized that the older adults (OA) will continue to use a mixed strategy, involving ankle and hip joint while younger adults (YA) will adopt an ankle strategy right after SLS was established. Twenty-three subjects (YA:  $n = 15$ , age =  $22.5 \pm 3.4$ , weight =  $63.2 \pm 10.5$  kg, height =  $168.9 \pm 9.3$  cm, and OA:  $n = 8$ , age =  $67.6 \pm 4.1$ , weight =  $63.2 \pm 13.9$  kg, height =  $162.6 \pm 10.4$  cm) with no previous injuries or history of falls performed a forward step to establish SLS. A six-camera Vicon system measured kinematic data. Average joint angles and angular velocities for ankle, knee, and hip were calculated using Open Sim. The first 4 s of SLS were analyzed: S1, S2, S3, and S4. A generalized linear mixed model was used for statistical analysis. YA showed significant changes in joint angle and decrease in angular velocity in all joints between S1 and S2 ( $p < 0.05$ ) and then maintained joint angle and angular velocity in hip and ankle, only the knee joint showed an additional angle change between S2 and S3 ( $p < 0.05$ ). OA showed similar results for hip abduction and hip rotation; however, hip flexion and knee flexion angles continued to change in S3 and S4 ( $p < 0.05$ ). Ankle angle initially increased in OA in S2 ( $p < 0.01$ ) followed by a decrease between S3 and S4 ( $p < 0.05$ ). OA decreased their angular velocity later than YA, after S2 in the hip and ankle and after S3 in the knee ( $p < 0.05$ ). Age impacts the adoption of ankle and hip strategy over time while establishing SLS. YA show a mixed strategy in S1 and S2 and reach a stable position in S3 while OA continue to use a mixed strategy and do not reach a stable position within the first 4 s of SLS.

### **Effects of an adapted animal-assisted intervention on physical activity and quality of life for children with mobility disabilities**

Ross, Samantha M.; Tepfer, Amanda; Baltzer, Wendy; Udell, Monique; Ruaux, Craig; MacDonald, Megan; Oregon State University

Children with mobility disabilities report significantly lower levels of physical activity (PA) compared to peers without disabilities (Law et al., 2006). Traditional PA interventions have observed positive gains in motor ability and physical fitness but long-term adherence is poor (Damiano et al. 2009). Animal-assisted therapy (AAT) is an emerging alternative approach, with the presence of a service/therapy dog shown to increase PA levels, motor skills and self-reported quality of life (QoL; Winkle et al. 2012). However, the use of the family dog in an animal-assisted adapted PA intervention for children with mobility disabilities is unknown. Purpose: To examine the effects, in children with mobility disabilities, of an 8-week animal-assisted adapted PA program, using the family dog in relation to gross motor skills, PA and QoL. Methods: Children with mobility disabilities ( $n = 6$ ; 9–15 years) and their family dog were recruited for an 8-week animal-assisted adapted PA program. Locomotor and object control skills were examined using the Test of Gross Motor Development–2nd ed. (TGMD-2, Ulrich, 2000), an ActiGraph GTX3+ accelerometer was worn for 7 days to measure PA and the Cerebral Palsy QoL measure was completed by both the child participant and the parent/caregiver. All assessments were administered at baseline, postintervention and at a 12-week follow-up. Results: Change over time was examined at an individual and group level. Locomotor skills increased an average of 6 points, with no consistent change in object control scores. On average, light PA increased by 35 min and moderate-to-vigorous PA increased 45 min immediately postintervention. Marked declines in PA were observed at follow-up. Results from the QoL survey revealed both children and parents perceived positive benefits in participation, physical health, and social well-being domains. Individual changes will also be discussed. Conclusion: Inclusion of the family dog in an AAT has the potential to promote positive gains in motor skill, PA levels, and QoL.

**Gait adaptations at walk onset for infants wearing a flexible support garment**

Sansom, Jennifer K., Central Michigan University; Ulrich, Beverly D., University of Michigan

**Introduction:** An infant's first steps are a remarkable achievement and signify an important transition toward independence. However, for infants with neuromotor delay, walking may be inhibited or delayed due to instability. To facilitate leg/pelvic control and coordination, some clinicians use flexible external garments [e.g., Lycra garments (LG)] to augment treatment interventions. However, these assistive devices are largely untested in infants learning to walk. The purpose of this study was to determine the real-time gait adaptations made by infants who were typically developing while wearing a LG when first learning to walk. **Method:** We tested 9 infants at walk onset (i.e., 3–5 independent strides) in 4 conditions: 1) cruising in diaper only (C), 2) cruising in LG (C-LG), 3) independently walking in diaper (IW), and 4) independently walking in LG (IW-LG). We placed 22 retro-reflective markers on anatomical landmarks. **Results:** At walk onset, infants took a similar number of steps, spending comparable amounts of time in swing, stance, and double support across conditions despite a decrease in velocity when they walked independently (IW, IW-LG). When wearing the LG during independent walking (IW-LG), infants took shorter strides [ $F(3,32) = 5.06, p = .006$ ] that were less variable in length [ $F(3,32) = 2.80, p = .056$ ] and width [ $F(3,32) = 7.635, p = .001$ ]. **Discussion:** Our results show that newly walking infants who are TD show enhanced gait stability when wearing a LG during independent walking. Future research examining the underlying mechanisms and responses for these adaptations is needed and will help determine if these adaptations will be beneficial for infants with neuromotor delay. *U.S. Dept. Educ Office of Special Educ & Rehabilitative Svcs H424C010067 awarded to Dale Ulrich*

**Categorization in rock climbing**

Schack, Thomas, Bielefeld University

In indoor rock climbing, the perception of object properties and the adequate execution of grasping actions highly determine climbers' performance. In two consecutive experiments, effects of climbing expertise on the cognitive activation of grasping actions following the presentation of climbing holds was investigated. Experiment 1 evaluated the representation of climbing holds in the long-term memory of climbers and novices with the help of a psychometric measurement method. Within a hierarchical splitting procedure subjects had to decide about the similarity of required grasping postures. For the group of climbers, representation structures corresponded clearly to four grasp types. In the group of novices, representation structures differed more strongly than in climbers and did not correspond to grasp types, but rather to superficial stimulus features. To learn about categorical knowledge activation in Experiment 2, a priming paradigm was applied. Images of hands in grasping postures were presented as targets and images of congruent, neutral, or incongruent climbing holds were used as primes. Only in climbers, reaction times were shorter and error rates were smaller for the congruent condition than for the incongruent condition. The neutral condition resulted in an intermediate performance. The findings suggest that perception of climbing holds activates the commonly associated grasping postures in climbers but not in non-climbers. The findings of this study give evidence that the categorization of visually perceived objects is fundamentally influenced by the cognitive-motor potential for interaction, which depends on the observer's experience and expertise. Thus, motor expertise not only facilitates precise action perception, but also benefits the perception of action-relevant objects.

**End-state comfort across the lifespan: A cross-sectional investigation of how the mode of action execution influences motor planning in an overturned glass task**

Scharoun, Sara M.; Gonzalez, David A.; Roy, Eric A.; University of Waterloo; Bryden, Pamela J.; Wilfrid Laurier University

Exemplified by the end-state comfort (ESC) effect, young adults plan actions in advance to minimize the cost of movement (Rosenbaum et al., 1990). In children, the development of general cognitive control processes lead to improvements in anticipatory planning that forms the foundation for adult-like reaching by age 9 to 10 (Wunsch et al., 2013). Observing the other end of the lifespan, to our knowledge ESC has not been explored in older adults. The overturned glass task (Fischman, 1997) was used to investigate ESC with 5- to 12-year-olds, young ( $M_{\text{age}} = 24.38$ ) and older ( $M_{\text{age}} = 72.50$ ) adults ( $N = 116$ ). Engagement of participants in this study was in compliance with ethical standards. Participants picked up a glass as if to pour water in pantomime without a stimulus, pantomime using an image/glass as a guide and actual grasping. Five- to 6-year-olds displayed less ESC than older age groups. Seven- to 8-year-olds displayed less ESC than young adults, who approached ceiling. These findings support adult-like patterns of ESC by age 9 to 10 (Wunsch et al., 2013). Interestingly, 5- to 6-year-olds displayed the most ESC in pantomime without a stimulus. It is argued that familiarity with the task influences planning. Pretend play is prominent between ages 3 and 5 (Singer & Singer, 1992); therefore, children may be more familiar with planning to re-orient a glass in pantomime (i.e., pretend) compared to actual grasping. Beyond familiarity, age-related improvements in ESC can be attributed to the development of overall proficiency in state estimation (King et al., 2012). For older adults, more ESC was observed in actual grasping than pantomime without a stimulus. It can be argued that older adults are reliant on feedback to continuously and consciously modify movements to meet action requirements (Roy et al., 1996); therefore, physical interaction with an object is required to plan according to ESC. An advantage for tool use is consistent with differences in healthy aging and disorders like apraxia. Overall, findings have implications for understanding the development course of ESC.

**Cognitive-motor interference during walking in children with developmental coordination disorder**

Schott, Nadja, El-Rajab, Inaam; University of Stuttgart

Whereas typically developing children produce relatively automatized postural control processes, children with DCD exhibit an automatization deficit. Dual tasks with various cognitive loads seem to be an effective way to assess the automatic deficit hypothesis. The aims of the study were to (1) examine the effect of a concurrent task on walking in children with DCD and (2) to evaluate if easy cognitive tasks can lead to performance improvements in the motor domain. We examined dual-task performance of a cognitive and a sensorimotor task (walking) in 20 children with DCD (boys,  $n = 12$ ; girls,  $n = 8$ ;  $M_{\text{age}}, 8.10 \pm 1.07$  years) and 39 typically developing children (boys,  $n = 18$ ; girls,  $n = 21$ ;  $M_{\text{age}}, 8.44 \pm 1.19$  years). Based on the idea of the paper-and-pencil Trail Making Test, participants walked along a fixed pathway (TWT-A), stepped on targets with increasing sequential numbers (i.e., 1-2-3; TWT-B), and increasing sequential numbers and letters (i.e., 1-A-2-B-3-C; TWT-C). The dual-task costs (DTC) were calculated for each task. Additionally, the following items were assessed: Movement Assessment Battery for Children, test and checklist (MABC-2), and the Trail-Making Test (TMT). In the primary walking task condition (trail tracing), the differences were not statistically significant ( $p = 0.215$ ) between children with and without DCD; however, we found significant differences for the seated condition of the trail tracing task (TMT 1;  $p = .003$ ). A concurrent cognitive task increased times significantly in all three groups, with the effect greater in children with DCD. Increased cognitive task complexity resulted in greater slowing of gait: gait DTCs as well as handwriting DTCs were least for the simplest conditions and greatest for the complex conditions in children with DCD more so than in comparison children. Additionally, gait DTCs were significantly lower than handwriting DTCs. These results support previous studies suggesting that children with DCD are more cognitively dependent and may have an automatization deficit, especially in the fine motor control task.

### **Relationship between fundamental motor skills, perceived motor competence, physical activity, and cognitive functioning in young children**

Schott, Nadja, Ruf, Dorothee Marie, University of Stuttgart

**Background.** The aim of the current study was to explore the relationship between fundamental, organized physical activity, perceived motor competence, and cognitive functioning. **Methods.** Participants were 54 children ( $M_{\text{age}} = 9.28 \pm 0.69$  years, 48% boys) from one primary school. Motor skills were measured from a bottom-up perspective using the Test of Gross Motor Development-3 (TGMD-3) and from a top-down perspective using the Pictorial Scale of Perceived Competence and Social Acceptance for Young Children (PCSA) and the Movement Assessment Battery-2 Checklist (MABC-2-C). The children's neuropsychological performance was assessed with the Trail-Making Test (TMT). Data were analyzed using multiple linear regression analysis to determine whether the PCSA, the MABC-2 Checklist, physical activity, cognitive functioning, age, and gender were predictive of the children's TGMD-3 performance results. **Results.** Boys had only higher actual and perceived ball skill abilities; boys and girls did not differ in all other variables. Two predictive relationships were identified based on the top-down-perspective, where the total score AB and the C score of the MABC-2 Checklist as well as the PCSA object control score were found to be significant predictors of the TGMD-3 object control score, accounting for 59.0% of its variance (including gender and TMT B error). No predictive relationships were identified between the children's self-report perceived competence for locomotion and the TGMD-3 locomotion score. However, the C score of the MABC-2 Checklist and the TMT B accounted for 16.3% of its variance. **Conclusion.** Children's perceived ball skill abilities, but not locomotor skill abilities appear to relate to actual motor competence; however, both relationships were not associated with physical activity. The perception of parents, especially regarding non-motor factors that might affect movement, e.g., lack of confidence or impulsiveness, not only predicts bottom-up assessment scores, but also might support motivation in children during assessment.

### **Training of compliance control at different ages (5–10 years) and scales of movement yields general learning with some scale specificity**

Snapp-Childs, Winona; Bingham, Geoffrey P.; Indiana University

**Introduction:** Previously, we (Snapp-Childs et al., 2013a, 2013b, 2014) developed a method that supports but requires active movement generation to allow practice for improvement of manual compliance control. We showed that the method allowed children with developmental coordination disorder to improve at a 3D tracing task to become as proficient as typically developing children who had also trained. We also showed that the training improved figure copying. In this study, we expanded the training protocol to include a wider variety of ages (5- to 10-year-olds) and we varied the scale of training (smaller or larger figures of the same shape) to assess the generality of learning. **Methods:** Fifty children (eighteen 5- to 6-year-olds, sixteen 7- to 8-year-olds, and sixteen 9- to 10-year-olds) were tested with the Beery VMI, the 3D tracing task, and a 2D letter-like figure-copying task. The children then trained on one version of the 3D tracing task (smaller or larger scale figures) until they all reached comparably good proficiency. The 3D tracing and copying tasks were tested again following training. **Results:** Performance on the 3D tracing task at baseline varied as a function of the level of difficulty, size of figure, and age. After training, differences among ages were eliminated but the level of difficulty and size effects remained although performance differences were greatly reduced. Also, training (on small vs. larger figures) now influenced performance: training with small figures gave an advantage on smaller figures, whereas training with large figures gave an advantage on larger figures. **Conclusions:** Training on the 3D tracing task, whether with larger or smaller scale figures, greatly improved performance and eliminated age differences but yielded some training-specific effects. In conclusion, the training method does yield general learning for all ages tested with some scale specificity in transfer.

### Motor skill interventions positively affect the physical activity engagement of children with coordination developmental disorder

Souza, Mariele S., Zanella, Larissa W., Universidade Federal do Rio Grande do Sul; Kim, Min J., Korea University; Valentini, Nadia C., Universidade Federal do Rio Grande do Sul

**Objective:** To analyze the impact of a motor skill intervention in the physical activity levels of Brazilian children with DCD, at risk of DCD (r-DCD), and typically developing (TD). **Method:** 47 children (6–7 years old) were assessed using the Movement Assessment Battery for Children–Second Edition and randomly assigned to intervention and control groups. A Mastery Motivational Climate was implemented for the intervention group (IG). The control group (CG) participated in physical education lessons that emphasized free activities. The study was conducted during 16 weeks / 2 lessons each week / 70 min each. To investigate the levels of physical activity we used pedometers during three lessons-blocks. **Results:** The ANOVA with repeated measures showed a significant time by group interaction ( $F(5,41) = 3.33, p = .013, \eta^2 = .29$ ). Tukey post hoc tests indicated that at pre- and posttest the IG with DCD, at r-DCD and TD were more active compared to CG ( $p$  values  $< 0.05$ ). Significant increases ( $p < 0.05$ ) in the levels of physical activity from pre- to postintervention were observed for the IG children with DCD (Pre:  $M = 2889.8$ , Post:  $M = 3940.6, \Delta = 1050.8$ ), at r-DCD (Pre:  $M = 2535.7$ , Post:  $M = 3303.9, \Delta = 768.2$ ), and TD (Pre:  $M = 2905.4$ , Post:  $M = 3896.9, \Delta = 991.5$ ). For the CG of children with DCD (Pre:  $M = 1315.4$ , Post:  $M = 1832.8, \Delta = 517.5$ ) and TD (Pre:  $M = 1058.1$ , Post:  $M = 1439.3, \Delta = 381.2$ ), positive significant changes were also observed ( $p < 0.05$ ); however, for the children at r-DCD (Pre:  $M = 1226.1$ , Post:  $M = 1271.9, \Delta = 45.8$ ), significant changes were not found. **Conclusions:** The levels of physical activity were higher for IG due probably to the climate that was set. Positive changes in the physical activity levels throughout the intervention period were only observed for children in the IG (DCD, r-DCD, and TD) and CG (DCD, TD). Children in at risk-DCD in the CG did not change in physical activity patterns. Although changes were observed in the CG, the intervention was more effective in change engagement behavior toward physical activity.

### Distance travelled and proximity patterns in mother–infant dyads during the transition from independent infant standing to walking onset

Thurman, Sabrina, Corbetta, Daniela; University of Tennessee–Knoxville

Motor abilities affect how infants interact with their environments and mothers. Research has shown that when infants begin to locomote, dramatic shifts in social-emotional behaviors such as proximity seeking and exploration occur (Campos et al., 2000). Furthermore, the way mothers interact with their infants seems to depend on their infant's own development of mobility (Belsky et al., 1980). In this project, we focus on two time periods, the onset of independent standing and walking, to identify pattern changes in distance traveled and proximity in mother–infant dyads. We followed 13 first-born infants and their mothers longitudinally from the time infants were 6 months old until they had 2 months of walking experience. Touwen's 1976 Assessment of Motor Behavior was used biweekly to record changes in infants' gross motor skills related to standing and walking independently. Dyads also participated in a 10-min laboratory free play session, from which we videocoded spatial location coordinates at 30-s intervals. From these coordinates, we derived the total distance that both the mother and the infant traveled, and the average distance the dyad maintained between them. These data were entered in a cluster analysis to detect pattern changes. Two clusters captured pattern changes in 12 out of 13 dyads. In Cluster 1, dyads displayed the shortest distances traveled at standing onset during free play; those distances increased when infants could walk at least 7 paces. This increase occurred in infants especially. Infants in Cluster 1 also had the fewest number of months of locomotor experience prior to walking. Cluster 2 included dyads with longer distance travelled when infants could stand independently, but these distances decreased for both when infants could walk at least 7 paces. There were no changes or differences in dyad distance proximity at those times. These preliminary results suggest that travel pattern changes affect mother and infant equally. These patterns may be tied to the locomotor experience of the child.

### Age-related differences in out-of-plane motion during pedaling in typical developing children

Van Zandwijk, Renate, Jensen, Jody L.; University of Texas at Austin

Other than age of skill attainment, what distinguishes typical from atypical development? For movements other than motor milestones, age of achievement is not a useful metric. For these skills we turn to variability and performance stability. In this study we examine the age-related changes in pedaling a stationary cycle. Other than being a popular activity of childhood, pedaling is becoming more common as a therapeutic intervention. In a pediatric population, however, what variation in performance can we expect as typical versus the variation associated with morphological or neurological dysfunction? In this study we document the age-associated pedaling skills of children between 4 and 10 years of age ( $n = 27$ ). The children pedaled with a resistance of 10% of their predicted maximal power output. Their movement production was assessed at five different cadences (40, 60, 80, 100 and 120 revolutions per minute) to look at scalability of the task. Across the groups, no differences were found in the sagittal plane joint angles. The foot is fixed to the pedal and the pelvis is attached to the seat. The constraints of pedaling require largely an up and down pumping action. Despite these constraints, significant differences were observed in out-of-plane motion. Four-year-olds showed significantly greater hip rotation ( $14.1^\circ$ ) than the 6-, 8- and 10-year-olds ( $8.8^\circ, 8.9^\circ$ , and  $7.6^\circ$ , respectively) as well as greater motion in the subtalar joint ( $13.2^\circ$ ) than 6- and 10-year-olds ( $6.8^\circ$  and  $6.0^\circ$ , respectively). The 4-year-olds also showed more hip abduction and subtalar supination than older children. These planar variances were no longer evident by 6 years of age. No confounding effects were found due to body size or the fit of the body to the cycle. These outcomes show that at a young age, extraneous motion is not always a diagnostic of atypical development. In our efforts to provide earlier diagnosis of atypical or delayed development, we must balance those judgments with knowledge of the developmental trajectory of movement and pattern control.



**Changes in preschoolers' physical activity participation during a mastery motivational climate intervention**

Wadsworth, Danielle D.; Rudisill, Mary E.; Hastie, Peter A.; Boyd, Korey L.; Rodriguez-Hernandez, Mynor; Irwin, J. Megan; Auburn University

While research has demonstrated that mastery motivational climates influence children's physical activity participation, changes in physical activity over the course of an intervention have yet to be examined. The purpose of this study was to determine how children's participation in physical activity during a mastery motivational climate changed across a 20-week intervention. Twelve children ( $M_{\text{age}} = 4.6$  years) participated in a motivational climate physical activity program that met twice per week for 45 minutes each session. This resulted in 40 contact sessions and 1800 min of intervention time. Actigraph accelerometers attached at each participant's waist measured time spent in sedentary behavior, light physical activity, moderate and vigorous physical activity at each session. Average time spent in each category were averaged for the week and graphed to visually show changes in physical activity participation over the 20 weeks. Differences in physical activity participation between weeks 1, 10, and week 20 were examined. The results showed that students spent significantly more time in sedentary behavior ( $p < .001$ ) and less time in moderate ( $p = .004$ ) and vigorous physical activity ( $p < .001$ ) at the beginning of the intervention compared to weeks 10 and 20. There was no difference in physical activity participation between weeks 10 and 20. At approximately 8 weeks, physical activity participation leveled off, with children spending approximately 40% in sedentary behavior, 10% in light physical activity, 34% in moderate physical activity and 26% in vigorous physical activity for the remainder of the intervention. Based on these results, it is suggested that preschool children require approximately 720 min of instruction in a mastery motivational climate to reach a plateau in physical activity participation. Further research should examine these variables with a larger and more diverse sample.

**Gender differences in fundamental motor skills in early elementary children**

Webster, E. Kipling, Pitchford, E. Andrew; University of Michigan

Objective: To examine gender differences in fundamental motor skill performance in early elementary children between the ages of 3-10 years. Methods: The Test of Gross Motor Development-3rd edition (TGMD-3) was administered to 295 children ( $M_{\text{age}} = 6.23$  years; 51.2% male). This direct observation assessment examines 13 fundamental motor skills, specifically six locomotor and seven ball skills. Each child was allowed one practice and two formal trials, while a trained administrator coded three to five performance criteria for each skill. A *t*-test for equality of means was conducted to examine differences in the individual subscales (locomotor and ball skills) along with total TGMD-3 raw score performance between boys and girls. Results: Average locomotor raw scores were 24.74 for boys and 26.28 for girls. There were no significant differences between locomotor ( $p = .140$ ) and total TGMD-3 ( $p = .092$ ) raw scores between boys and girls. There was a significant difference in ball skill performance identified between boys and girls,  $t(293) = 3.76$ ,  $p < .001$ . Boys had higher ball skill subtest raw scores ( $M = 31.4$ ) compared to girls ( $M = 25.9$ ). Conclusions: Female students were significantly less competent in ball skills compared to their male peers. Fundamental motor skill competency is a critical component for a young child to develop as it contributes to future participation in physical activity. Longitudinal evidence has identified that ball skills (i.e., object control skills) are an important predictor of later adolescent physical activity and fitness levels. Therefore, it is critical to identify groups that have deficiencies in these particular skills in order to plan appropriate interventions that may target these specific groups. Female students tend to be less active as adolescents, therefore early intervention of these important skills may be beneficial in providing female students the tools to be more active later in childhood and into adolescence and reducing this gender difference gap.

**How early is early enough? The age of onset of tummy time intervention matters in infants with Down syndrome**

Wentz, Erin E.; Ulrich, Dale A.; University of Michigan

Purpose: To explore the impact of getting an early start (i.e., before 11 weeks corrected age) with a prescribed tummy time program (goal 90 min/day) on the motor development of infants with Down syndrome (DS). Methods: Nineteen infants with DS, aged 0 to 20 weeks at study entry, from five different metropolitan areas, participated in this study. Ten participants entered the study before 11 weeks corrected age (early group) and nine entered after 11 weeks (late group). Participants were asked to accumulate 90 minutes per day of deliberate, wakeful tummy time. Daily tummy time was logged by families over the course of the study. Monthly visits were made at each participant's home to assess motor progress as determined by the Bayley Motor Scales. Infants were monitored for 12 months following study entry. Formal tummy time stopped when an infant could independently transition in/out of sitting, but monthly monitoring continued for 12 months after study entry. Results: Although no significant differences were found between the early and late entry groups at baseline,  $t(17) = 1.29$ ,  $p = .214$ , significant differences in motor development emerged as early as 1 month after baseline,  $t(17) = 2.84$ ,  $p = .011$ . Data collection continues but, for example, 7 months after baseline,  $t(11) = 3.60$ ,  $p = .004$ . Significant effect sizes ( $d$ ) between the groups emerged at 1 month after baseline and range from .94 to 1.42 in subsequent months, indicating a large effect of age of onset of tummy time. Conclusion: The findings from the ongoing work indicate that beginning a motor intervention early (before 11 weeks corrected age) may produce better motor outcomes than starting the same intervention after 11 weeks of age in infants with DS. These findings have important implications for early intervention practices.

### **Where do infants look the most when preparing to reach: To the hand holding the target object or to the object target itself?**

Wiener, Rebecca, Thurman, Sabrina L., Corbetta, Daniela F.; University of Tennessee–Knoxville

Research on social cognition has shown that infants can direct their visual attention toward the hands of actors in anticipation of their actions. For example, as mothers approach their infants to pick them up, 2- to 4-month-old infants look at the mother's hands (Reddy, Markova, & Wallot, 2013). Also, a growing number of studies on infants' understanding of social actions have found that 6- to 14-month-old infants look at the hand of the actor first in anticipation of the action outcome. It remains unknown, however, where infants direct their visual attention when preparing themselves to reach for an object handed to them by another. Do they look more at the hand holding the target object prior to the object being brought into their reaching space, or do they focus more continuously on the target object itself? This study investigated these questions in 60 5- to 11-month-old infants. The study involved holding an object out of reaching space, by hand, for an accumulated 5 s of looking, then moving it into the infant's reaching space for grasping. We analyzed where infants directed their visual attention (toy, hand, or elsewhere) via eye tracking before the toy was moved into the reaching space. Based on prior studies, the assumption could be that infants look at the hand more than the toy, when held out of reaching space, to anticipate when the hand would begin to move toward them. Analyses currently completed on the 7- and 9-month-old groups revealed that the hand holding the object was never the focus of greater visual attention, compared to looking at the toy or elsewhere. These preliminary results suggest that when infants learn to reach for the attended target, they are not particularly drawn to look at the hand holding the object. Instead, they seem capable of already focusing their visual attention mainly on the future goal of their own action—i.e., reaching for the object—and do not look so much at the hand bringing the hand to them as they prepare to reach.

### **Is the goal of reaching altering object-directed looking patterns in infants?**

Wiener, Rebecca F., Corbetta, Daniela, University of Tennessee–Knoxville

Reaching is an action performed with a goal. Carrying such action successfully requires careful planning and attention to the target. In their first year of life, infants learn to master this skill very quickly. By 7–9 months of age, infants have learned to anticipate their own action, to align their arm and hand precisely to the target object, and to prepare themselves to retrieve the object. Here we investigate if infants also learn to visually scrutinize objects differently when they are planning to reach for them, compared to a similar context where the task does not involve reaching for them. Forty-four 7-month-old infants were recruited to participate in this study. Sixteen were in a reaching condition and 28 were in a non-reaching condition. Infants were presented with different objects, held out of their reaching space for several seconds, while looking patterns were recorded via an eye tracker. In the reaching condition, the toy was then brought forward for the infant to reach, while in the non-reaching condition the trial ended after the first period of looking. Looking patterns were analyzed and compared between the two groups. Overall, infants in the reaching condition fixated the toy more than infants in the non-reaching condition. Non-reaching infants spent more time looking elsewhere in the presentation area or away from the scene all together. This result suggests that the infants with a reaching goal developed an expectation to reach for the object, and maybe were planning for it, while the non-reaching infants did not need to sustain their attention to the toys, especially given that they were not planning to interact with them. During the time spent looking at the actual objects, however, infants in both groups exhibited similar general looking patterns on the toys, as per which parts of the objects they fixated the most, suggesting that the variations in goal task between groups affected the amount of visual attention directed to the objects, but not the patterns of visual exploration on the objects.

### **Anxiety-related changes in the conscious control of gait: Implications for fall risk and rehabilitation in older adults**

Young, William R.; Williams, A. Mark.; Brunel University London

Every year, 30–60% of older adults fall. Most display anxiety about falling again. Fall-related anxiety causes profound changes in control of posture and gait (e.g., postural stiffening, less efficient gaze behaviors). Fearful of falling again, older adults may consciously control their movements. Consequently, cognitive resources are diverted away from external factors and the automaticity of well-practiced movements, such as walking, can be disrupted, which raises fall risk. One suggestion is that anxious individuals will “reinvest” cognitive effort towards controlling their actions by reverting to explicit (declarative) cues used at the onset of skill learning. However, the literature surrounding this theory of reinvestment is built on evaluating performance of ontogenetic skills. Gait, however, is a largely implicit and phylogenetic skill, learned in the relative absence of declarative, verbal rules. Therefore, it is inappropriate to conceptualize anxiety-related tendencies to consciously control posture and gait as “reinvestment.” Instead, it is likely that older adults with falls-related anxiety will start to “over-think” their movements, and new explicit cues for movement are formed. The purpose of the current project was to examine explicit cues for movement in 40 older adults and to identify whether relationships exist between such self-generated explicit cues (measured through interview), state anxiety, and self-reported reinvestment. We also asked each participant to perform an adaptive gait task: stepping over a series of obstacles along a 7-m walkway. Results show a relationship between self-reported state anxiety, reinvestment, and the reporting of declarative movement cues. The declaration of movement cues corresponded to gait parameters that might be considered “stiffening.” The presence of emergent movement cues suggests that increased conscious control of movement cannot be described as “reinvestment,” but rather “investment” in to newly generated movement rules that predicate exclusively conservative movement strategies.

**Motor skill intervention: The impact in ball skill, manual dexterity, balance, and daily life of children with developmental coordination disorder, at risk and typically developing**

Zanella, Larissa W., Souza, Mariele S., Universidade Federal do Rio Grande do Sul; Kim, Min J., Korea University; Valentini, Nadia C., Universidade Federal do Rio Grande do Sul

Objective: to investigate the impact of a motor skill intervention in ball skills, manual dexterity, balance, and daily activities of children with developmental coordination disorder (DCD), at risk of DCD (r-DCD), and typically developing (TD). Methods: 48 children (5–7 years old) were assessed using the MABC-2 (test and checklist) and randomly assigned to intervention (IG:  $N = 24$ ) and control (CG:  $N = 24$ ) groups. A mastery motivational climate was implemented for the intervention groups; the CG participated in regular physical education classes. The study was implemented by 32 lessons / 2× per week / 70 min each lesson. Results: At the pretest, 29.2% of the children were identified as with DCD, 18.8% at r-DCD, and 52.1% as TD. At the posttest, 27.1% of the children were identified as with DCD, 6.3% at r-DCD and 66.7% as TD. Significant interactions were found for group × time for ball skills (BS:  $p = 0.014$ ) and total score (MABC-2:  $p = 0.007$ ). Nonsignificant interactions were observed for manual dexterity (MD:  $p = 0.079$ ), balance (B:  $p = 0.236$ ), and MABC checklist at sections A ( $p = 0.625$ ) and B ( $p = 0.686$ ). Post hoc tests showed improvement in for IG of children with DCD for MD ( $p = 0.019$ ), MABC-2 total score ( $p = 0.025$ ), and checklist section B ( $p = 0.020$ ). Children with DCD in the CG showed declines over time in BS ( $p = 0.026$ ). Children r-DCD at the IG showed superior performance at the posttest in B ( $p = 0.028$ ) and section A of the checklist ( $p = 0.028$ ) compared to children r-DCD in the CG. Children TD in the IG showed positive changes over time BS ( $p = 0.039$ ). Children TD in the CG although showed positive changes in B ( $p = 0.020$ ) showed also decline in BS ( $p = 0.034$ ) over time. Discussion: The intervention was effective in providing opportunities to children with DCD, at r-DCD, and DT improve their ball skills and manual dexterity, as well in some of the daily activities.

## Sport and Exercise Psychology\*

### Analysis of self-talk and imagery technique on emotional climate of paralympic athletes in Nigeria

Adegbesan, Olufemi A., Chidi, Amaechi S., Oladejo, Esther M., Oyekunle, Adebisi O., University of Ibadan; Mohammed, Sanusi, Nigeria Football Federation

There is a growing attention in literature for the development of comprehensive approaches to investigate variables involved in the regulation of emotion that are detrimental to athletes' performance. Many athletes have been reported to experience emotions that are dysfunctional and these has led to performance slump because they lack the strategies that should be employed when such a discrepancy exists between current and desired emotions. Therefore, this study analyzed the influence of self-talk and imagery technique on paralympic athletes' emotional climate. Descriptive research design was used and (64) male and female paralympic athletes in teams and individual sports with mean age of (19.26, *SD* 3.32) participated in the study. Data were collected on Sport Imagery Questionnaire ( $r = .82$ ) Sport Self-talk Scale ( $r = .73$ ) and Emotional Sport Climate Scale ( $r = .78$ ). The instruments exhibit acceptable internal consistency at the total score level. Parametric statistical analysis of Pearson's correlation coefficient and regression model were used. Positive relationship of ( $r = .68$ ;  $p < .000$ ) was observed between the self-talk and emotional climate variables. Similar result was also observed between imagery and emotional climate variables ( $r = .62$ ;  $p < .000$ ). Further results revealed that both self-talk and imagery techniques had a joint significant contribution ( $F(1,62) = 246$ ;  $p < 0.05$ ) on the paralympic athletes' emotional climate. While 78% of both the self-talk and imagery techniques variables were explained in the variance of emotional climate. Evidence suggests that performance enhancement psychological strategies when used appropriately create the most appropriate emotional climate for paralympic sport men and women during competitions. Therefore, sport psychologists and coaches should recognize the best sport performance enhancement psychological management strategies that can serve as emotional regulation strategies in the course of paralympic athletes' performance profiling sessions

### Combinations of autonomy support and control in physical education: Do students benefit or suffer?

Aelterman, Nathalie, Vansteenkiste, Maarten, Haerens, Leen; Ghent University

Grounded in self-determination theory (SDT; Deci & Ryan, 2000), recent work with sport coaches and physical education (PE) teachers shows that autonomy-supportive and controlling behaviors are only modestly negatively related. This suggests that at least some teachers may score simultaneously high or low on both dimensions. Because autonomy support and control can co-occur in different doses, the aim of the present study was to investigate which distinct subgroups of teachers can be identified, thereby relying on cluster analysis on students' perceptions of teaching behavior. Further, students' need satisfaction and frustration, quality of motivation and several outcomes, including student-reported learning and feelings of resentment, and teacher-rated performance, were tested for differences across profiles. Participants were 14 PE teachers (93% men;  $M_{\text{age}} = 35.50 \pm 13.82$  years) and 641 students (68% boys;  $M_{\text{age}} = 13.27 \pm .68$  years) from 41 different classes out of 13 secondary schools. Results revealed that four profiles could be retained, explaining 57% and 65% in student-perceived autonomy support and controlling teaching, respectively. These profiles represented a relatively autonomy-supportive group, a relatively controlling group, a group high on both dimensions and a group low on the two. Pairwise comparisons indicated that students who perceived their teacher as relatively autonomy-supportive also reported the most desirable pattern of outcomes, whereas students who perceived their teacher as relatively controlling displayed the least beneficial pattern. Interestingly, although the combination of high perceived autonomy support and perceived controlling teaching behavior had some similarities with the relatively autonomy-supportive group, differences manifested particularly with respect to need frustration and maladaptive outcomes. These findings suggest that perceiving the teacher as controlling is detrimental to students even when paired with high autonomy support. Implications and directions for future research will be discussed. *Flemish Research Foundation*

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\*The abstracts are alphabetically arranged by the first author's surname within each of the three sections—Motor Learning and Control, Developmental Perspectives: Motor Control/Coordination/Rehabilitation, and Sport and Exercise Psychology. A *funding source*, if provided, is given in italics at the end of an abstract.

### Effects of a combined mental and physical (MAP) training intervention on depressive symptoms, rumination, mindfulness, and aerobic fitness in major depressive disorder

Alderman, Brandon L.; Olson, Ryan L.; Brush, Christopher J.; Shors, Tracey J.; Rutgers University

Major depressive disorder (MDD) is one of the most common global mental health disorders and is characterized by a number of behavioral, emotional, and cognitive symptoms. Despite the evidence base supporting conventional treatments, there is a need to develop complementary and alternative approaches to treat MDD. Inspired by animal laboratory studies demonstrating that mental and physical training increases neurogenesis and neurophysiological measures associated with improved learning and adaptive coping (Curlik & Shors, 2012; Shors et al., 2012), we translated these neuroscientific data into a clinical intervention known as *MAP training*. The mental training incorporates focused-attention (FA) meditation and the physical training incorporates aerobic exercise. The aim of the present study was to examine the efficacy of a combined 8-week MAP training intervention on depressive symptoms, ruminative thoughts, mindfulness, and  $\text{VO}_2$  peak in individuals with and without a clinical diagnosis of MDD. Sixty-nine participants (36 typical healthy, 33 with MDD; age =  $20.9 \pm 2.9$  years) completed the 8-week MAP intervention, which included two 30-min FA meditation and two 30-min aerobic exercise sessions per week. Findings revealed significant improvements from pre- to postintervention on measures of depressive symptoms ( $p < 0.001$ ,  $\eta^2_p = 0.55$ ), dispositional mindfulness ( $p < 0.001$ ,  $\eta^2_p = 0.19$ ), and rumination ( $p < 0.001$ ,  $\eta^2_p = 0.23$ ). These improvements occurred, however, without a significant change in aerobic fitness,  $p = 0.68$ ,  $\eta^2_p = 0.003$ . The findings suggest that an 8-week MAP training program may be successful at reducing depression through improvements in ruminative thoughts and enhanced mindfulness. The nonsignificant effect on  $\text{VO}_2$  peak was surprising, but suggests that incorporating more exercise per week (i.e., meeting current PA recommendations) may result in even greater mental health benefits. Future studies aim to investigate mechanisms and independent or synergistic effects of MAP training components.

### Emotion regulation predicts ease of imaging

Anuar, Nurwina A., Williams, Sarah E., Cumming, Jennifer; University of Birmingham

The revised applied model of imagery use (Cumming & Williams, 2013) proposes that various individual characteristics will influence not only a person's imagery use but also their imagery ability. One characteristic could be an individual's emotion regulation which involves reappraisal (i.e., decreasing the emotional impact by changing how we think about the scenario) and suppression (i.e., inhibiting certain behaviors that elicit emotions). Imagery ability and emotion regulation relate to how well individuals remember past events and image details of future events (D'Argembeau & Van der Linden, 2006). This suggests that athletes' emotion regulation may directly predict their capacity to generate different images in relation to their sport as imagery ability. This is important as imagery ability can determine imagery's effectiveness (Cumming & Williams, 2012). Using the Sport Imagery Ability Questionnaire (SIAQ; Williams & Cumming, 2011) and sport-specific Emotion Regulation Questionnaire (ERQ; Uphill, Lane, & Jones 2012), the present study investigated whether athletes' emotion reappraisal and suppression could predict skill, strategy, goal, affect, and mastery ease of imaging. Participants ( $N = 648$ ; 372 female;  $M_{\text{age}} = 20.79$ ,  $SD = 4.36$ ) completed the SIAQ and ERQ. Five separate hierarchical multiple regression analyses were conducted controlling for age, gender, and sport type. When predicting all types of imagery ability, a significant overall model was found accounting for between 6% and 9% of the variance. Reappraisal significantly predicted skill ( $\beta = .24$ ,  $p < .001$ ), strategy ( $\beta = .13$ ,  $p = .001$ ), goal ( $\beta = .14$ ,  $p < .001$ ), affect ( $\beta = .21$ ,  $p < .001$ ), and mastery ( $\beta = .28$ ,  $p < .001$ ) imagery ability. However, suppression did not predict any of the SIAQ subscales. Findings support the revised applied model as personal characteristics such as emotion reappraisal, positively predict imagery ability. This result suggests that higher of imagery ability is present in individuals who more frequently change how they think about situations to reduce their emotions.

### The effects of spirituality on body image in female athletes

Avans, Diana E., Morris, Alexa, Nelson, Savannah; Vanguard University

This study focuses on the correlation between body image, spirituality, and female collegiate athletes. The purpose of this study was two-fold. Is there a relationship between spirituality and body image scores and is there a difference between athletes attending a Christian or non-Christian school. There are few studies regarding the effect of spirituality and body image. Some have shown that spirituality improves body image, some have shown no effect. Female athletes from secular and Christian universities, individual and team sports, participated in this study. Athletes completed the Spirituality Experience Index (SEI) and the Multidimensional Body-Self Relations Questionnaire (MBSRQ). The SEI measures spiritual support (SS) and spiritual openness (SO). Spiritual Support (SS) and Body Areas Satisfaction (BAS) had a significant, moderate/weak correlation ( $r = 0.266$ ,  $p = 0.005$ ). An independent  $t$ -test was used to determine differences based on school type and spirituality. There was a significant difference based on school type for the Spiritual Support Subscale and Spiritual Openness Subscale. Secular school athletes scored significantly higher on the SO scale ( $M = 39$ ,  $SD = 9.2$ ) while those at Christian schools scored significantly higher on the SS scale. MANOVA was used to determine if there was a difference by sport and school. A significant effect by sport was found ( $\Lambda = 1.568$ ,  $p = .036$ ). Follow-up univariate tests found significant differences for SS, AE, and BAS subscales. Bonferroni comparison tests showed the following differences for SS; volleyball scores were higher than softball ( $p = .0001$ ), tennis ( $p = .040$ ), and basketball ( $p = .001$ ). Results for AE showed volleyball higher than softball ( $p = .018$ ). Several of the individual body image subscales had revealed significant correlations. Spirituality had a small effect on body image in female athletes. Research is needed to determine how each area of body image is developed and if spirituality can play a factor in improvement.

### **Psychological responses to lower extremity injuries prior to an isokinetic task**

Balles, Ashley K.; Gaines, Stacey A.; Fiddler, Ryan E.; Hearon, Christopher M.; Texas A&M University–Kingsville

Sport participation presents an inherent risk of injury. Many college athletes experience an athletic injury to the lower extremity at some point within their college career (Hootman, Dick, & Agel, 2007). Positive psychological adjustment regarding an injury is an important component of a successful rehabilitation program (Quinn & Fallon, 2008). Confidence, fear, and social support have previously been examined as important variables psychological recovery from an injury that, in turn, positively affect physical performance after an injury (Arden et al., 2012). The purpose of this study was to determine how psychological responses to injury, namely sport resumption confidence, fear of re-injury, injury perception and social support, change throughout the rehabilitation process. Injury severity and performance on an isokinetic dynamometer task, which isolated the injured joint, were also examined. Participants ( $N = 21$ ; 62% female) completed psychometrically sound measures designed to assess confidence, fear, injury perception, and social support across three groups of Division II college athletes: healthy ( $n = 9$ ), injured ( $n = 6$ ), and released from rehabilitation ( $n=6$ ). Athletes in the injured and released groups had suffered lower extremity injuries (e.g., ankle, knee). Prior to completing the survey, participants were told they would be completing the task with their injured limb/joint. ANOVA was utilized to compare group differences on study variables. There was a significant difference between groups with regard to fear ( $p < .01$ ) and confidence ( $p < .05$ ) where healthy athletes reported the highest confidence and lowest fear across groups. There were no group differences found with regard to social support. Additionally, multiple regression analyses indicated that social support acts as a moderator in the relationship of confidence, fear, and injury severity with injury perception. This study extends sport injury research by identifying changes in key psychological variables across the healthy-injured-rehabilitated continuum of the collegiate sport experience.

### **Understanding the social interactions and relationships with youth and staff at residential summer camp**

Bean, Corliss, Kendellen, Kelsey, Forneris, Tanya; University of Ottawa

Residential summer camp has been identified as an important environment for many youth across North America (American Camp Association, 2005; Garst, Browne, & Bialeschki, 2011). Researchers have highlighted that providing a context that fosters supportive relationships at camp can positively influence the personal and social development of youth campers (Garst et al., 2011) and staff (Ferrari & McNeely, 2007). Camp Smitty is a residential summer camp for youth that has been administered by the Boys and Girls Club of Ottawa since 1924. The purpose of this study was to explore both youth and staffs' perceptions of the social interactions and relationships within this context. A total of 30 interviews were conducted (15 youth, 15 staff) at the end of a ten-day camp session. Results of the inductive thematic analysis (Braun & Clarke, 2006) led to the identification of four main themes: youth-youth interactions, youths' perceptions of staff, staff-staff interactions, and challenges between staff. Within the theme of youth-youth interactions, three subthemes emerged including youth meeting new people, establishing diverse peer relationships, and working with people they may not necessarily like. Under the second theme of youths' perceptions of staff three subthemes were identified including perceiving staff as welcoming, competent, and effective at ensuring that all camp activities were fun. Under the third theme of staff-staff interactions two subthemes emerged which were the camp environment fosters meaningful relationships and provides a context that enables senior staff to mentor junior staff. Finally, within the theme of challenges between staff there were two subthemes. The first was experiencing moments of interpersonal conflict and the second was the presence of power dynamics within the staff hierarchy. The findings from this study have important practical implications for the training of residential camp staff in order to provide a positive and meaningful camp experience for both youth and staff.

### **Self-reporting of mental toughness by distance runners is elevated by self-presentational concern**

Beasley, Vista L., Eklund, Robert C.; University of Stirling

With the popularization of this term in the 1980s, "mental toughness" has become a desired image in physical training environments. Per Leary and Kowalski's self-presentation model, one's increased desire to convey an image (i.e., impression motivation) may evoke certain behaviors (i.e., impression construction). As self-presentation concern (SPC) about physical appearance is linked to health-damaging behaviors, SPC about appearing mentally tough may likewise be related to injury-inducing behaviors (e.g., training at excessive volumes/intensities). As an initial foray of this proposal, this study examines the effect of situational SPC on mental toughness self-reports. Middle-distance/distance runners on U.S. collegiate teams ( $n = 67$ ; age = 19.96) were assigned to an experimental (i.e., High, Prototype) or control group. Experimental group members read a passage, designed per the model to increase situational SPC; they were directed to imagine goal-relevant evaluation (e.g., scholarships, team selection) based on mental toughness questionnaire scores. All participants then completed the Risk, Pain, and Injury Items Tough Scale and Sport Mental Toughness Questionnaire (SMTQ) subscales (Confidence, Constancy, Control). Prototype group members received false information about elite runners' SMTQ scores. Statistical analyses revealed covariates (e.g., gender, ability, dispositional SPC, social desirability) were equivalent across groups. Increased situational SPC accounted for variance of SMTQ Confidence and Control scores (10.9%, 9.1%). The High group's mean SMTQ Confidence and Control scores were significantly higher than the control group's ( $d = .82$ ,  $d = .73$ ); differences in their mean Constancy scores approached significance ( $p = .052$ ,  $d = .73$ ). Therefore, mental toughness self-reporting seems vulnerable to imagined situational SPC. Future study can examine the relationship of actual situational SPC about appearing mentally tough with SMTQ/RPII self-reports and alternative prototypes, in conjunction with behaviors and chronic injury occurrence.

**Disentangling how perceptions of role performance are related to role acceptance and group cohesion**

Benson, Alex J.; Surya, Mark W.; Eys, Mark A.; Wilfrid Laurier University; Bray, Steven R., McMaster University

We aimed to understand how convergence between self-ratings and coach ratings of role performance relates to athletes' perceptions of role acceptance and group cohesion. Our sample consisted of athletes ( $n = 141$ ) and coaches ( $n = 14$ ) who were current members of Canadian Interuniversity Sport basketball teams. Using two separate polynomial regression and response surface analyses, we examined the relationship between athlete and coach ratings of performance as a predictor of role acceptance and perceptions of group integration (GI-T). Given that each polynomial regression equation accounted for significant variance in role acceptance ( $\Delta R^2 = .28$ ,  $F(1, 135) = 10.73$ ,  $p < .001$ ) and GI-T ( $\Delta R^2 = .09$ ,  $F(1, 135) = 2.57$ ,  $p = .03$ ), we interpreted the surface test values to determine the magnitude and curvature of the slopes along the line of perfect agreement (athlete ratings = coach ratings) and the line of incongruence. Unexpectedly, the degree of convergence in rating scores did not account for variance in either outcome of interest. However, athlete and coach ratings had a positive, additive effect on perceptions of role acceptance ( $b = 0.92$ ,  $t = 3.16$ ,  $p < .01$ ). As it pertains to cohesion, when athlete and coach ratings were in agreement, there was a convex relationship between GI-T rating scores ( $b = 0.19$ ,  $t = 2.22$ ,  $p < .05$ ). That is, performance ratings only began to positively predict GI-T as performance ratings exceeded the sample mean. Taken together, applying polynomial regression and surface analyses allowed us to simultaneously assess how the degree of convergence in performance ratings as well as the magnitude of these rating scores are linked to perceptions of role acceptance and GI-T. We discuss these findings in context of the team dynamics literature and elaborate upon the advantages of polynomial regression and response surface analysis when using multi-source feedback and/or constructs where convergence in scores is theoretically meaningful. *Social Sciences and Humanities Research Council of Canada, Joseph-Armand Bombardier Canada Graduate Scholarship*

**College athletes' perceptions of success, motivational climate, and social support availability**

Berecz, Anna; University of Alaska Anchorage

The aim of the present study was to examine whether team players differ from individual athletes on the related concepts of achievement motivation, perceptions of motivational climate, and coping strategies. Most previous studies focused on team or individual sports only, even though these two kinds of sports differ substantially in that individual athletes compete independently. The sample consisted of 126 currently active student athletes at the University of Alaska Anchorage and included both individual ( $n = 55$ ) and team ( $n = 71$ ) athletes. Participants filled out five questionnaires measuring goal orientation, perception of motivational climate, coping strategies employed, perception of social support availability, and performance anxiety. Data analyses showed, contrary to what was hypothesized, that team players were significantly more ego-oriented and perceived the climate to be significantly more performance oriented compared to individual athletes. In accordance with previous research (e.g., Abrahamsen et al., 2008), the present study found a significant positive correlation between the perception of social support availability and mastery climate. Additionally, there was a significant negative correlation between performance climate and perceived social support availability. Performance climate was also positively correlated with symptoms of worry at a statistically significant level. When separating individual athletes from team players, individual athletes' perceptions of performance climate were significantly and positively related to both somatic anxiety and worry. On the other hand, team players' perceptions of performance climate were significantly related to symptoms of worry only. Overall, the results of the present study indicate that there is a difference in team and individual athletes' perceptions of their motivational climate and what point of reference they use to measure their success. Future research should examine factors that can affect the perception of motivational climate, such as coaching style. *UAA University Honors College*

**Sibling comparisons and perceived sport competence in young athletes**

Blazo, Jordan A.; Smith, Alan L.; Kashy, Deborah A.; Michigan State University

Research is scant on the potential role of siblings in shaping the youth sport experience. The proximity and length of the sibling relationship affords multiple opportunities for social comparison and associated self-evaluations (Gamble et al., 2010; Harter, 1999; McHale & Crouter, 1996). Importantly, these comparisons are affectively charged, categorized by warmth, conflict, and power differences (Furman & Buhrmester, 1985). To begin forming an understanding of the role of siblings in sport, we investigated the association between sibling sport-referenced comparisons, relationship qualities, and perceived sport competence. We hypothesized that greater tendency to make sibling-referenced comparisons would associate with higher sport competence perceptions and that this association would be moderated by markers of sibling relationship quality (i.e., warmth, conflict, and power; Wheeler & Suls, 2005). Young sport-involved sibling dyads ( $N = 47$  dyads) completed established assessments of study variables. Participants included 25 female and 22 male ( $M_{\text{age}} = 10.94 \pm 1.49$  years) older siblings who were predominately first-born children (83%). There were 23 female and 24 male participants ( $M_{\text{age}} = 8.45 \pm 1.01$  years) who were mostly second-born children (79%). Preliminary analyses revealed interdependence of data within sibling pairs on sibling warmth, power, and the tendency to compare, but not sibling conflict or sport competence. Accordingly, we conducted dyadic analysis to address our hypotheses. Our primary hypothesis was not supported, however a three-way interaction of birth position (younger or older sibling), tendency to compare, and sibling warmth significantly predicted sport competence,  $t(75.04) = -2.11$ ,  $p < .05$ . Younger siblings with a greater tendency to make sibling comparisons and higher warmth perceptions reported higher sport competence perceptions. This suggests that sibling-based comparisons and relational warmth may be salient for younger siblings, while older siblings utilize alternative sources of competence information. *Michigan State University College of Education Research Fellowship*

### **“Try not to show up the oldies”: Identifying age-related stereotypes about exercise through active participation**

Bocksnick, Jochen G.; Dyck, Mary; University of Lethbridge

The current investigation addressed two seemingly independent but related issues. First, it provided insight into age-related stereotypes among kinesiology undergraduates. Second, it explored how students' responses to their participation in an exercise class for older adults could identify age-related beliefs. Using qualitative methodology, 77 undergraduates provided a written reflection of an exercise class for older adults. All students were part of an undergraduate curriculum course on adapting physical activities for diverse populations. In small groups, ranging from 3 to 8 students, 41 kinesiology students participated in a 45-min exercise session with a group of older adults ( $M_{\text{age}} = 70$  years), who were part of an ongoing physical fitness program. Another 36 students viewed a 13-min video, which consisted of a representative sample of exercise activities drawn from the same activity program. The written data were subjected to paradigmatic and structural analyses. The authors evaluated the texts first independently before analyzing them jointly. Both student groups (i.e., active and observing participants) expressed age-related exercise stereotypes. These beliefs, however, were more pronounced among those who had actively participated in the exercise classes than those who viewed the video. The active group had the opportunity of contrasting their implicit pre-class expectations regarding older adults' performance capabilities with their lived experience of participating with the older adults. Possessing realistic performance expectations of future clients is a fundamental necessity for kinesiologists to effectively deliver group and/or individual exercise activities. Consequently, we encourage including hands-on experiences with older adults when educating future practitioners.

### **Teaching sportpersonship and responsibility in physical education: A multilevel analysis**

Bolter, Nicole D., Boise State University; Kipp, Lindsay E., University of Kentucky; Johnson, Tyler G., Boise State University

One of the National Standards for K-12 Physical Education (SHAPE & Human Kinetics, 2014) states that students should display personal and social responsibility and respect toward themselves and others. The present study sought to (a) examine teachers' behaviors related to sportpersonship as predictors of students' responsibility and prosocial and antisocial behaviors and (b) compare student and teacher perceptions of teacher behaviors. The sample included 837 middle school students in 6th and 8th grade physical education classes and their 27 teachers. Youth completed a survey about their teachers' behaviors focused on sportpersonship (SCBS, Bolter & Weiss, 2012, 2013), their prosocial and antisocial behaviors (PABSS, Kavussanu & Boardley, 2009), and their personal and social responsibility (PSRQ, Li et al., 2008), while teachers reported on their own instructional behaviors (teacher version of SCBS). Intraclass correlation coefficients (ICC) showed variation in students' antisocial behavior (14.3%), personal responsibility (10.2%), and social responsibility (5.8%) attributed to classroom differences. Thus, multilevel modeling with student-level (SCBS, gender) and teacher-level predictors (e.g., grade taught, teacher experience) was used to account for classroom-level dependencies. Results revealed that grade, student gender, and student perceptions of teachers' modeling good sportsmanship and prioritizing winning over good sportsmanship explained a significant amount of variance in students' responsibility and antisocial behavior. Results from purpose 2 showed that teachers reported significantly more reinforcing and modeling good sportsmanship compared to student reports of teachers' behaviors, indicating students may not realize teachers' attempts to model and reinforce sportperson-like actions. Findings support past research that modeling is a key mechanism for affecting youths' sportpersonship and responsibility (Weiss et al., 2008). Results can inform teachers how to help students meet national standards for displaying respect and responsibility.

### **Physical risk-taking and goal orientation in relation to intrinsic motivation among skateboarders**

Boyd, Michael; Kim, Mi-Sook; Bollas, Elijah; Enomoto, Jimmy; Hoang, Ngo; Lam, Tony; Lausteer, Brendon; Santa-Iglesia, Jacqueline; San Francisco State University

The study was designed to examine the multivariate relationship between physical risk-taking/goal orientations and intrinsic motivation among a sample of extreme sport enthusiasts. Male skateboarders ( $N = 94$ ), 18–30 years of age, were recruited for participation from several skate parks in and around the City of San Francisco. Participants completed response measures, voluntarily and anonymously, including the Perception of Success Questionnaire (POSQ; Roberts, Treasure, & Balague, 1998) and the Behavioral Regulation in Sport Questionnaire (BRSQ; Lonsdale, Hodge, & Rose, 2008), both modified to the skateboarding experience. The Physical Risk-Taking Subscale (Franken, Gibson, & Rowland, 1992) was also distributed to participants either individually or in small groups. Canonical correlation revealed a significant and meaningful relationship between two sets of variables. Results indicated that high loadings on both physical risk-taking and task orientation, on the first canonical variate, corresponded positively with loadings on a second variate including intrinsic motivation (IM) to experience stimulation, IM toward accomplishments, and IM to know. Ego orientation for skateboarding failed to demonstrate any significant contribution to the multivariate relationship. The findings underscore the psychological relevance of physical risk-taking and task orientation with regard to the salience of intrinsic motivation in the extreme sport of skateboarding.



### **Learning to like exercising: An experimental approach to alter (non)exercisers' automatic evaluations**

Brand, Ralf; Antoniewicz, Franziska; University of Potsdam

The dual process view of human information processing distinguishes controlled (impulsive, type-2, propositional) from automatic (reflective, type-1, associative) cognitive evaluations that are both able to influence subsequent behavior. To target the automatic basis of behaviors has been called one of the next public health challenges. However, there is a lack of experimental studies that inform us about how automatic evaluations (AE) of exercise can be altered and positively influence subsequent exercise behavior. We have conducted an experiment with 65 undergraduate students, in which the effect of a brief evaluative conditioning task (ECT) on our participants' AE of exercise was investigated. In this task, exercise- and nonexercise-related pictures were systematically paired with pictures containing positive vs. negative vs. neutral affective valence. Using a Single-Target IAT score as the dependent variable, this first experiment showed that the ECT was able to produce more positive AEs of exercise directly after treatment. In a subsequent experiment, 74 undergraduates were randomized to three experimental conditions and the ECT's effects on participants' spontaneous behavioral choices were monitored. In contrast to what we expected, the treatment did not lead to significant differences between two experimental (learning positive vs. negative AEs) and the control group with regard to self-selected intensities in a cycling ergometer-task. Visual inspection of the data however suggests that this could be due to statistical bottom and ceiling effects, making it impossible to corrupt participants' already negative or to raise their already positive AEs of exercise. We propose that intervention studies with placed assignments of participants should be conducted next. Nonexercisers with negative AE of exercise should learn more positive AEs, and their behavioral choices should then be compared with a control group's choices.

### **Enjoyment and affective responses to high-intensity interval training and continuous exercise at high and moderate intensities**

Brown, Denver M.Y.; Bray, Steven R.; McMaster University

High-intensity interval training (HIT) affords similar health benefits to those associated with longer duration exercise (Gibala et al., 2008). However, the strenuous demands of HIT may lead to aversive experiences. Some studies show that HIT is more enjoyable and leads to more positive feeling states compared to continuous exercise performed at either moderate (CMI) or vigorous (CVI) intensities (Jung et al., 2014), whereas others show the opposite effect (Oliviera et al., 2013). The purpose of this study was to investigate affective responses to exercise contrasting HIT with CMI and CVI. Participants ( $N = 65$ ) performed an exercise test to determine their peak aerobic power ( $W_{max}$ ). On the following visit, they were randomized to groups that exercised for 20 min on a cycle ergometer. The HIT group performed a  $10 \times 1$  HIT protocol, alternating 1-min bouts of exercise at  $70\% W_{max}$  and  $12.5\% W_{max}$ . The CVI group performed continuous exercise at  $80-90\% HR_{max}$  and the CMI group performed continuous exercise at  $41.25\% W_{max}$ . Affective responses (Feeling Scale; Hardy et al., 1989) were recorded at 30-s intervals throughout each exercise bout, and Enjoyment (PACES; Kendzierski et al., 1991) was reported following completion of the exercise session. A Group  $\times$  Time mixed ANOVA of affective responses revealed no significant main or interaction effects ( $p > .10$ ). Affective responses to HIT showed systematic fluctuations; however, between-group effects showed CMI led to greater positive affect than CVI ( $\eta^2 = .07$ ) and HIT ( $\eta^2 = .07$ ), which were identical ( $\eta^2 = .00$ ). A one-way ANOVA of the Enjoyment scores also showed no significant effects ( $p > .10$ ); however, between-group effect sizes showed greater Enjoyment following CMI ( $d = .53$ ) and CVI ( $d = .31$ ) compared to HIT. Collectively, findings indicate affective responses to HIT may not be more positive than those experienced during CMI or CVI when exercise task duration is controlled. Although HIT provides periodic recovery periods, affective states during HIT are also not as positive as those experienced during CMI.

### **Autonomous priming increases intrinsic motivation and attitudes towards high-intensity interval training**

Brown, Denver M.Y., Teseo, Amanda, McMaster University; Dimmock, James A., Jackson, Ben, University of Western Australia; Bray, Steven R., McMaster University

Prior research has shown autonomous motivational priming (AMP) is associated with increases in enjoyment and effort during moderate-intensity exercise (Banting et al., 2011). The current study examined the effect of AMP on intrinsic motivation, attitudes, and intentions about engaging in high-intensity interval training (HIT). Active, but untrained, undergraduate participants ( $N = 42$ ) performed a graded exercise test to determine their peak aerobic power ( $W_{max}$ ). At a subsequent testing session (post-48 hr), participants completed a  $10 \times 1$  HIT exercise protocol, alternating 1-min bouts of hard ( $70\% W_{max}$ ) and light ( $12.5\% W_{max}$ ) exercise for 20 min. Prior to beginning the HIT protocol, participants completed the intrinsic motivation inventory (IMI; Ryan, 1982) and were randomized to groups that performed either an autonomous or neutral priming task (Srull & Wyer, 1979). Immediately after HIT, participants completed a follow-up IMI and measures of attitudes and intentions towards engaging in HIT. Ratings of perceived exertion (RPE) and heart rate were similar for both groups during HIT ( $p > .50$ ). Consistent with previous research, results showed participants in the AMP condition reported significantly greater enjoyment ( $F(1, 39) = 7.64, p = .009, \eta^2 = .16$ ) and perceived competence ( $F(1, 39) = 8.66, p = .005, \eta^2 = .18$ ) on the postexercise IMI compared to the neutral priming group. Participants in the AMP condition also reported more positive attitudes towards HIT ( $F(1, 40) = 6.64, p = .014, \eta^2 = .14$ ); however, there was no difference between the groups for intentions to engage in HIT. HIT is a time-efficient, but physically demanding, form of recreational exercise that may not be intrinsically motivating. These findings highlight AMP as a method of enhancing affective and motivational experiences during HIT.

### Examining social identity and intrateam moral behaviors in competitive youth ice hockey using stimulated recall

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Sport teams provide a salient context for youth to establish their personal and social identities. Importantly, social identity—identity formed through membership in groups—may play an important role in regulating intrateam moral behavior in youth sport (Bruner, Boardley, & Côté, 2014). The aim of this study was to qualitatively examine social identity and intrateam moral behavior in competitive youth ice hockey using stimulated recall. Twenty-four ice hockey players ( $M_{\text{age}} = 13.27$  years,  $SD = 1.79$ ) who engaged in high, median, or low frequency of antisocial teammate behavior (determined through prescreening with the Prosocial and Antisocial Behaviour in Sport Scale [Kavussanu & Boardley, 2009]) were recruited from eight teams in Canada. The stimulated recall interviews involved participants being asked to recall their thinking during prosocial/antisocial interactions with teammates, prompted by relevant video sequences from a recorded team practice session. Content analysis of interview data revealed how athletes' reporting high, median, or low frequency of intrateam antisocial behavior all felt prosocial interactions with teammates enhanced social identity. In contrast, the perceived influence of antisocial teammate behavior on social identity differed depending on the athlete's reported frequency of intrateam antisocial behavior. More specifically, athletes reporting high frequency of such behavior believed it did not detrimentally affect social identity, whereas those reporting median or low frequency felt intrateam antisocial behavior negatively impacted social identity. Taken together, the findings highlight important links between intrateam moral behavior and social identity that have potential implications for team functioning in youth sport teams.

### Dose-response and time-course effects of acute resistance exercise on core executive functions

Brush, Christopher J.; Olson, Ryan L.; Osovsky, Steven; Alderman, Brandon L.; Rutgers University

A very large and expanding body of research has focused on the relation between exercise and cognitive health. Recently, increasing attention has been paid to the effects of resistance exercise (RE) on cognition; however, the contribution of a number of potential moderators and mediators of this relationship remains unknown. The aim of this study was to evaluate the effects of an acute bout of RE on core executive functions. Core executive functions were assessed using the Stroop and Simon (Inhibition), n-back (2) and verbal running span (Updating), and dimension switching and plus-minus (Shifting) tasks. A secondary purpose of this research was to determine possible dose-response and time-course effects of RE on these core executive functions. Using a within-subjects design, 29 participants (14 males, 15 females;  $M_{\text{age}} = 20.6 \pm 2.0$  years) completed a control condition and RE bouts performed at 40%, 70%, and 100% of their individual 10-repetition maximum (10-RM) targeting major muscle groups. Heart rate and rating of perceived exertion were assessed throughout to confirm exercise intensity. The executive function test battery was administered at 15 min and 180 min postexercise, to assess both immediate and longer-term effects. Preliminary analyses showed a significant Condition  $\times$  Time interaction for the verbal running span task, such that performance improved from immediately postexercise to the 3-hr assessment. However, these improvements across time were only observed for the exercise conditions,  $t_s > 2.9$ ,  $p_s < .03$ . No other significant main effects or interactions of Condition or Time were found for the core executive functions. These results suggest that a single bout of RE may have a selective effect on core executive functions. However, core executive functions may remain relatively unaffected by RE in typical college students. *Rutgers Aresty Research Center*

### Motivational content in commercially available exercise DVDs

Cardinal, Bradley J.; Kirk, Katelyn E.; Kuo, Brian; Locklear, Rosalee L.; Rogers, Kim A.; Oregon State University; Cardinal, Marita K., Western Oregon University

This study's purpose was to describe the motivational content used by exercise leaders on commercial exercise DVDs. The psychological capital model served as the theoretical framework for data organization and interpretation. Eight developmental dimensions comprise the model (i.e., goals and pathways design, implementing obstacle planning, experiencing success or modeling others, persuasion and arousal, building assets or avoiding risks, affecting the influence process, building efficacy or confidence, and developing positive expectancy). These developmental dimensions are either fostered or inhibited by the exercise leader. Ten exercise DVDs released between 2011 and 2014 were obtained from multiple sources. They were transcribed verbatim and then deconstructed by separating out the motivational content from all other content (e.g., directions, instructions). All motivational statements in the transcripts were coded into one of the eight developmental dimensions of the psychological capital model. The directional nature of the content was also recorded (i.e., negative or positive), with consensus being reached by two independent coders. The mean percentage of motivational content per DVD was 26.9% ( $SD = 11.31$ ), with the range being 10% to 49%. There were 1,397 unique motivational statements, of which significantly more were positive ( $M = 85.7\%$ ,  $SD = 14.0$ ) than negative ( $M = 14.3\%$ ,  $SD = 14.00$ ),  $p < .001$ ,  $C = .63$ . The instructors' use of the eight developmental dimensions differed significantly,  $p < .0001$ ,  $C = .55$ . Two of the three most-used types of motivational statements develop efficacy (i.e., persuasion and arousal, and experiencing success/modeling others), whereas the two least-used develop resiliency (i.e., building assets/avoiding risk, and affecting the influence process). In summary, about one-fourth of the verbal statements used by the exercise leaders on these DVDs were motivational; however, one in seven statements were demotivating (i.e., negative). Many of the negative comments observed diminish exercise efficacy and hope. Resiliency building statements were rarely used.

**The predictive utility of personality traits on exercise dependence**

Chen, Chiao-ying, Chi, Li-Kang, National Taiwan Normal University

Previous studies have indicated the significant predictive utility of Neo Five Factor personality traits on exercise dependence. However, lack of study to examine the possible difference between open-skilled exercisers and close-skilled exercisers. The purpose of this study was to compare the predictive utility of the big-five personality on exercise dependence between open-skilled and close-skilled exercisers. Participants were 129 exercisers (61 males, 68 females, the average age was 24.52 years) from different city sports centers in Taipei. Seventy-eight of them were close-skilled exercisers and 51 of them were open-skilled exercisers. After receiving the consent form, the participants were asked to complete a questionnaire to examine their personality and the level of their exercise dependence. By using multiple regression analysis, there were two results from this study. First, the open-skilled exercisers with “openness” of personality significantly predicted the “mood disturbance” of exercise dependence, and agreeableness significantly predicted decreased vigor. Second, “neuroticism” of personality of close-skilled exercisers can significantly predicted by “decreased vigor” of exercise dependence. Overall, the results of this study conclude that the NEO Five Factor of personality traits is able to predict the exercise dependence, and the predictive utility is differed between open-skilled and close-skilled exercisers.

**Exercise involving different skill types and physical fitness are associated with working memory aspect of executive function**

Chen, Feng-Tzu; Wu, Chih-Han; Song, Tai-Fen; Chang, Yu-Kai; National Taiwan Sport University

Individuals that engage in exercise regularly or train for achieving higher fitness have demonstrated on related assessments that they are positively associated with greater cognitive functions, particularly executive functions. While the positive relationships among exercise, fitness, and executive functions has been evidenced by several narrative reviews and meta-analyses, but previous studies typically emphasize aerobic exercise, cardiovascular fitness, and the inhibition aspects of executive functions. The current study attempts to further the knowledge base by investigating whether exercise involving different skills may influence diverse factors of physical fitness (i.e., cardiovascular fitness, muscular fitness, and body composition) and working memory aspects of executive functions, as well as the association between physical fitness and specific executive functions. Forty-five late-middle aged adults were recruited and assigned equally into one of three groups: an open-skills group (e.g., basketball, tennis, badminton), a closed-skills group (e.g., swimming, running), and a control group (i.e., irregularly participating in exercise) based upon their previous exercise habits within the past 6 months. Working memory was assessed using a Sternberg working memory task. Our findings revealed that both exercise groups not only exhibited greater cardiovascular and muscular fitness and less body composition, but also demonstrated more correct rates on the Sternberg working memory task. The superior executive functions were present regardless of the subjects' exercise modalities and were found in two conditions of the working memory task. In addition, not only higher cardiovascular fitness, but also more muscular fitness and less body composition, were positively linked with increased abilities in the specific executive functions. These findings suggest that individuals who engaged in exercise and achieved greater physical fitness benefits showed different degrees of working memory enhancement.

**The predictive utility of peer relationship and coach autonomy-support behaviors on high school student-athletes' dropout intention and team satisfaction**

Chen, Jo-Yun, Chi, Li-Kang, National Taiwan Normal University

The purpose of this study was to examine the predictive utility of peer relationship and coach autonomy-support behaviors on high school student-athletes' dropout intention and team satisfaction. The participants were 218 high school student-athletes (120 males, 98 females,  $M_{age} 16.37 \pm .99$ ) recruited from 12 high school in Northern Taiwan. After received the informed consent, participants were requested to complete The Sport Friendship Quality Scale (Weiss & Smith, 1999) and Sport Climate Questionnaire (Deci, 2001) to assess their perceptions of peer relationship and coach autonomy-support behaviors. The results of multiple regression analyses indicated that coach autonomy-support behaviors and positive peer relationship positively predicted team satisfaction. The explained variances were accounted for 29.5% and 7.1% respectively. Specifically, high school student-athletes reported greater team satisfaction when they perceived greater positive peer relationship and coach autonomy-support behaviors. In addition, coach autonomy-support behaviors negatively predicted student-athletes' dropout intention and negative peer relationship positively predicted dropout intention. The explained variances were accounted for 5.5% and 3.2% respectively. The implication and application of the findings were discussed.

### **The mediating role of perceived coach autonomy-support behavior in the relationships between attachment styles, well-being, and perceived competence among high school student-athletes**

Chen, Szuyu, Chi, Likang; National Taiwan Normal University

The purpose of current study was to explore the mediating role of perceived coach autonomy-support behavior among the relationship between attachment styles, well-being and perceived competence. Participants were high school student-athletes ( $N = 205$ ; 100 males, 105 females) with variety of team sports, and the average age was 16.78 years. After receiving a consent form, participants were asked to complete a questionnaire assessing attachment styles, coach autonomy-support behavior, well-being, and perceived competence. The results of correlation analysis indicated both avoidant and anxiety attachment styles were negatively correlated with perceived coach autonomy-support behavior, well-being, and perceived competence. In terms of examining the mediation effect of coach autonomy-support behavior, bootstrap mediation analyses were utilized. The results revealed both predictive utilities of avoidant and anxiety attachment styles on well-being and perceived competence. Overall, the findings of current study suggest coach autonomy-support plays an important role while explaining the relationships between attachment styles, well-being, and perceived competence; thus, high school coaches should aware of this impact on student-athletes.

### **Do emotions impact putting performance?: A prefrontal asymmetry study**

Chen, Tai-ting, Wang, Kuo-Pin, Chang, Yi-Ting, National Taiwan Normal University; Huang, Chung-Ju, University of Taipei; Hung, Tsung-Min, National Taiwan Normal University

Positive or negative emotions prior to sport performance could be both an antecedent and consequence of sport performance. Successful control of emotion could be a key for superior performance. Although questionnaires have provided some insights into emotional changes during sports competition, inability to monitor real time emotional changes during motor task execution limits their usage. EEG prefrontal asymmetry has been related to positive/negative emotion. Purpose: The aim of this study was to investigate emotion in golfers as measured by prefrontal EEG asymmetry in putting performance after a failed putting performance. Methods: 20 skilled, university golfers were recruited, and requested to perform 40 putts at an individualized difficulty level of 50% putting success rate. Trials immediately after a failed putt were selected for analysis. Good performances were those trials that made a hole whereas bad performances were those that failed. EEG data 2 seconds prior to the putting of the selected trials were segmented into two, and one second epochs for subsequent analysis. Average power spectra were calculated at frontal alpha bands (F3 and F4) and the frontal asymmetry score of F4-F3 was derived for statistical analysis. Results: Two-factor analysis of variance (ANOVA), 2 (performance: good, bad)  $\times$  2 (time: T1, T2) demonstrated a significant effect of performance  $\times$  time interaction. Follow-up simple main effect analysis revealed the following. (1) Good performance exhibited larger frontal asymmetry score at T1 than that of T2, (2). Larger frontal asymmetry score was observed for good performance than that for poor performance at T1. Larger frontal asymmetry score is an indication of a more positive emotional state. Conclusions: The results suggest that positive emotion, 2 seconds prior to the putting execution in particular, is an antecedent of better golf putting performance. These findings shed some light on the application of EEG for emotional regulation during sport performance.

### **An experimentally based intervention program to enhance multiple aspects of PE teachers' classroom motivating style**

Cheon, Sung Hyeon, Kangwon National University; Reeve, Johnmarshall, Korea University

Several carefully designed, experimentally based teacher intervention programs have now confirmed that PE teachers can learn how to be more autonomy supportive during instruction. Adopting a self-determination theory framework, we sought to extend this literature by testing whether a single intervention program could be designed and delivered to help PE teachers become both more autonomy supportive and more structured. Thirty-five secondary PE teachers (10 females, 25 males) were randomly assigned either to participate in a 3-wave intervention (experimental group) or to teach in their normal way (control group) during a 17-week semester. The intervention featured a 3-hr informational workshop (wave 1), a 3-hr "how-to" workshop (wave 2), and a 2-hr group discussion (wave 3). At T1, T2, and T3, all teachers completed the Situations in School questionnaire to report four aspects of their motivating style—autonomy support, teacher control, structure, and chaos, as well as measures of job satisfaction and harmonious passion (using 1–7 scales). ANCOVA-based repeated-measures analyses (controlling for gender) tested for the hypothesized condition  $\times$  time (2  $\times$  3) interaction effect. Teachers in the experimental (vs. control) group showed greater T2 and T3 autonomy support ( $M_s$ , 4.7, 5.9, 6.2 vs. 5.3, 5.3, 5.4;  $F(2, 64) = 24.35$ ,  $p < .001$ ,  $\eta^2 = .43$ ) and lesser control ( $M_s$ , 4.5, 4.0, 3.8 vs. 4.8, 4.9, 5.2;  $F(2, 64) = 7.77$ ,  $p < .001$ ,  $\eta^2 = .20$ ) as well as greater T2 and T3 structure ( $M_s$ , 5.0, 5.5, 5.7 vs. 5.3, 5.3, 5.4;  $F(2, 64) = 12.15$ ,  $p < .001$ ,  $\eta^2 = .28$ ) and lesser chaos ( $M_s$ , 3.6, 3.5, 3.2 vs. 3.9, 4.3, 4.6;  $F(2, 64) = 5.98$ ,  $p = .004$ ,  $\eta^2 = .16$ ), and greater T2 and T3 job satisfaction ( $M_s$ , 4.8, 5.6, 5.8 vs. 4.8, 4.8, 5.0;  $F(2, 64) = 4.01$ ,  $p = .023$ ,  $\eta^2 = .11$ ) and passion ( $M_s$ , 5.3, 6.1, 6.3 vs. 5.4, 5.5, 5.3;  $F(2, 64) = 7.91$ ,  $p < .001$ ,  $\eta^2 = .20$ ). Hence, PE teachers can learn how to be both autonomy supportive and structured, and these intervention-induced changes in motivating style produce meaningful teacher benefits (greater job satisfaction, passion). *National Research Foundation of Korea Grant funded by the Korean Government (NRF-2014S1A5A8017649)*

### **The adaptation experienced by Taiwanese professional baseball players in the United States**

Chi, Likang, Chen, Meichi, Chen, Szuyu; National Taiwan Normal University

The purpose of this study was to identify the adaptation experienced by Taiwanese baseball players who play professional baseball league in the United States. Semi-structured interviews were conducted to explore the adaptation experience with seven current overseas players (age, 21–29 years; experience, 2–6 years) and one sport agent. The players competed at different levels: Rookie, Short A, 1A, Advantage A, 2A and MLB. Grounded theory principles were used for data collection and analysis. The results showed that the challenges encountered by Taiwanese baseball players in the United States included five main themes: performance pressure, post-relocation loneliness, lifestyle differences, self-reposition, and training/competition. Performance pressure included self-expectation, the worries of demotion and transaction. Post-location loneliness pertained to cross-cultural encounters, language barriers and the lack of company of families and friends. Lifestyle differences including dieting habits, inconvenient mobilization and inhabitant challenges. Self-reposition referred to the discrepancy between ideal and reality and the changes of elite status brought shock these overseas players and they had to try to find their position in the brand new professional baseball world. The English-speaking training environment and America-training style combined with competition loads and competition culture contributed to the training and competition challenge. These five main themes connected to each other and the performance pressure played the central role. The findings highlighted the complexity among these five themes and the potential areas sport psychologists could work on. Recommendations are provided to smooth the adaptation process for Taiwanese baseball players in the United States.

### **Effects of exercise involving open-skills and group characteristics on the Stroop Test performance: An intervention study**

Chi, Lin, Ta Hwa University of Science and Technology; Ho, Ming Yu, Hsiuping University of Science and Technology; Wu, Chih-Han, Chang, Yu-Kai, National Taiwan Sport University

A growing body of research across both human and animal models has demonstrated that exercise is positively associated with cognitive functions. However, a majority of previous studies focuses on aerobic types of exercise, the type of exercise that is possibly linked to better cardiovascular fitness. Additionally, existing studies are limited to establishing the casual relationship of exercise on cognition because of applying crossed-sectional designs. The present study aims to advance the current understanding by investigating the effects of basketball intervention on cognitive functions using a three-month longitudinal design. The basketball exercise was chosen because this type of exercise involves open-skills and group interaction characteristics. Twenty-five college students were recruited and assigned into either a basketball ( $n = 13$ ) or a control group ( $n = 12$ ). Participants in the basketball group were required to participate in basketball exercise, led by an instructor with a professional sports background, for 60 min per sessions, twice per week, for three months, wherein those in the control group received an educational course. Cognitive function was then assessed using a Stroop Test and testing was done both prior to and after the three-month intervention. Findings revealed that while certain main effects of time regarding cardiovascular fitness and flexibility were revealed, no main effects affecting either group were observed. However, there was an interaction observed between the groups and time in relation to motor fitness, with the basketball group exhibiting higher scores following the intervention. Regarding the Stroop Test, interactions between the groups and time were also revealed in both Stroop-congruent and Stroop-incongruent conditions, with the basketball group exhibiting shorter reaction time following the intervention. These data suggest that similar to the aerobic types of exercise that previous studies have primarily targeted, exercise that involves multiple faceted characteristics, including coordination and group interaction, could also benefit cognitive functions.

### **A self-determination theory perspective on burnout: Perceived coaching behaviors and satisfaction/thwarting of psychological needs**

Cho, Seongkwan, Florida State University; Choi, Hunhyuk, Dankook University; Eklund, Robert, University of Stirling; Tenenbaum, Gershon, Florida State University

The study aims were (a) to examine the relationship between perceived coaching behaviors and athlete burnout, and (b) to investigate the mediation effects of psychological need satisfaction/thwarting and self-determined motivation on this relationship. The conceptual model guiding the research assumed that coaching style (autonomous-supportive vs. controlling) affects psychological needs (satisfaction vs. thwarting), and these in turn affect burnout through the mediation of the five motivational constructs of motivation postulated by self-determination theory (SDT: intrinsic, identified, introjected, external, and amotivation). Four hundred and eleven Korean active collegiate athletes from 19 sports participated in the study ( $M_{age} = 21.37$  years,  $SD = 1.24$ , and  $M_{exp} = 12.31$  years,  $SD = 2.14$ ). The participants completed seven questionnaires: a demographic questionnaire, the Korean version of Athlete Burnout Questionnaire, Basic Psychological Needs Scale, Psychological Need Thwarting Scale, Sport Behavioral Regulation Scale, the Korean version of Controlling Coach Behaviors Scale, and the short version of the Sport Climate Questionnaire. The final model that fit the data indicated that controlling style was positively related to need thwarting (.49), and need thwarting was negatively related to intrinsic motivation (-.33) and positively related to amotivation (.59); all in line with expectations. In contrast, autonomy-supportive coaching style was positively related to needed satisfaction (.69), and need satisfaction was negatively related to amotivation (-.71) and positively to intrinsic motivation (.81), identified and introjected regulations (.90 and .86, respectively). Of the motivational dimensions, only amotivation had a causal path (.86) to burnout. Thus, only amotivation can be considered as a mediator between coaching style, psychological needs, and the burnout phenomenon. The findings shed more light on the burnout phenomenon by linking perceived coaching styles to need satisfaction inherent in self-determination theory.

### **Mediation effects of perceived coaching behaviors on the relationships between dualistic model of passion and the coach–athlete relationship in collegiate athletes**

Cho, Seongkwan, Florida State University; Choi, Hun-Hyuk; Huh, Jin-Young; Park, Seong-Moo; Dankook University

The purpose of this study was to examine the mediation effects of perceived coaching behaviors (i.e., autonomy-supportive and controlling coaching) on the relationship between passion and coach–athlete relationship in collegiate athletes. Participants ( $N = 297$ ) completed the series of questionnaires to measure athletes' passion (i.e., harmonious and obsessive passion), perceived autonomy-supportive and controlling coaching behaviors, and coach–athlete relationship. The data were analyzed using SPSS 18.0 for descriptive statistics and AMOS 16.0 to conduct the structural equation modeling. The bootstrapping method was utilized to test the mediation effects. The results showed that harmonious passion positively predicted autonomy support and negatively predicted perceived controlling coaching behavior, whereas obsessive passion positively predicted controlling coaching behaviors and negatively predicted perceived autonomy support. The autonomy-supportive coaching behaviors positively predicted the coach–athlete relationship, whereas the controlling coaching behaviors negatively predicted the coach–athlete relationship. Finally, there were the full mediation effects. That is, the autonomy–supportive coaching behaviors mediated the relation between the harmonious passion and coach–athlete relationship, whereas controlling coaching behaviors mediated the relation between the obsessive passion and coach–athlete relationship.

### **Acute exercise and neurocognitive development in preadolescent and young adults: An ERP study**

Chu, Chien-Heng; Song, Tai-Fen; Chen, Feng-Tzu; Chang, Yen-Shan; Chang, Yu-Kai; National Taiwan Sport University

The aim of this study was to determine the influence of a single bout of acute exercise on neurocognitive functions in young adults and preadolescent children by determining the modulatory role of age and the underlying neuroelectrical mechanism between acute exercise and interference suppression. Twenty preadolescent children and young adults were recruited. Participants attended the exercise and control treatment sessions in a counterbalanced order. Exercise treatment session involved aerobic exercise performed at moderate intensity for 20 min as the exercise. The control treatment session encompassed reading for the same duration of time. After both sessions, participants were immediately escorted to a soundproof room after each intervention, and an EEG was recorded during a Stroop Test for all participants. Findings revealed acute exercise improved reaction times on the Stroop Test in both Stroop-congruent and -incongruent conditions, and greater beneficial effects were observed in young adults. Additionally, greater P3 amplitudes following acute exercise in preadolescent children and young adults were observed. Lastly, findings revealed that conflict SP amplitude was significantly smaller in the exercise session compared to the control session for preadolescents, but not for young adults. These findings suggest that age influences the beneficial effects of acute exercise on interference suppression, with young adults experiencing more of a benefit than preadolescent children, who showed limited facilitation from acute exercise. Furthermore, young adults displayed a larger P3 amplitude and an unaffected conflict SP amplitude following acute exercise; nevertheless, preadolescent children demonstrated a larger P3 amplitude and reduced conflict SP amplitude, after the cessation of acute exercise. The findings confirming the event-related brain potential differences induced by acute exercise are among the first to demonstrate that there are specific mechanisms that differentiate the effects of acute exercise on subjects ranging from preadolescence to adulthood.

### **The relationship between mindfulness and golf putting performance**

Chuang, Hsin-Yun, Chi, Li-Kang; National Taiwan Normal University

Golf putting is a closed skill sport in which athletes are more likely to have psychological factors become interferences. In recent years, *mindfulness* is an important psychological characteristic that has been applied on athletes (Bernier, Thienot, Codron, & Fournier, 2009). The purpose of this study was to examine the relationship between mindfulness and golf putting performance. Participants were 68 elite golf players (33 males and 35 females) who competed in Taiwan Standard Chartered Bank National Winter Ranking Golf Tournament. Participants' average age and golf experience were 17.90 and 6.74 years respectively. After finished the second round of the tournament, participants were asked to complete the Mindfulness Inventory for Sport (Thienot, Jackson, Dimmock, Grove, Bernier, & Fournier, 2014), which assessed their mindfulness in golf. Participants' putting performance in the second round was also recorded. Pearson correlation was conducted to examine the relationships between three subscales of mindfulness and putting performance. The results of this study indicated that “awareness” and “refocusing” were positively correlated with putting performance. In contrast, “non-judgment” was negatively related to putting performance. The implications and applications of this study were discussed.

### **Comparison of the Stroop color–word interference effects on elderly open-skill and closed-skill exercise participants: An ERP analysis**

Chuang, Lan-Ya, National Taiwan Normal University; Huang, Chung-Ju, University of Taipei; Hung, Tsung-Min, National Taiwan Normal University

Evidence has shown the beneficial effects of exercise on the inhibitory capacity of executive functions in the elderly. Recently, some efforts have focused on the moderating effects of exercise mode to this relationship. One of these studies adopted the Flanker task to explore the relationship between exercise mode and inhibition. However, the Flanker task and Stroop task may involve different attentional networks. Thus, this study primarily intended to investigate the influence of different modes of exercise on inhibition in the elderly via both behavioral parameters and event-related potential (ERP) parameters. Data from 75 older participants aged between 65 and 75 years old were analyzed. All participants were either regularly participating in open-skill exercise, closed-skill exercise, or not regularly participating in any physical exercise. The Stroop task was employed and ERP data collected, with ANOVA indicating more rapid responses to stimuli in both regular exercise groups than that of the no-regular-exercise group. In addition, the open-skill exercise group demonstrated a smaller N2 and larger P3a than the no-regular-exercise group, which may be interpreted as decreased cognitive control in preparation for inhibition of semantic interference in the Stroop task and greater focal attention. In general, these findings indicate the benefits of exercise but also further highlight the positive effects of open-skill exercise for the elderly.

### **An exploration of executive function among older adult athletes and non-athletes**

Coleman, Lyndsie M.; Brustad, Robert J.; Babkes Stellino, Megan; Akbar, Abdullah; Lalonde, Amanda; University of Northern Colorado

Cognitive decline is an inevitable part of the aging process and is regulated predominantly by morphological alterations to the frontal and prefrontal cortexes of the brain, resulting in behavioral changes to certain executive functions including slower response times and decreased performance on tasks requiring working memory, cognitive flexibility, and inhibition (Bixby et al., 2014). Previous research suggests fitness levels and physical activity interventions positively influence cognition (Ploughman, 2008) and meta-analysis results indicate that exercise interventions improve executive functions more than other cognitive functions among older adults (Colcombe & Kramer, 2003). Blasing, Puttke, and Shack (2010) found that physical activity interventions requiring physical and mental exertion (e.g., soccer or dance) were more effective at enhancing executive function than activities requiring physical exertion alone. Di Russo et al. (2010) found that disabled athletes who participated in open sport environments where movements are externally regulated and require adaptation (e.g., basketball) showed greater improvements to executive functions when compared to closed sport environments (e.g., golf). The purpose of this study was to compare executive functions among older adults who participate in various physical activities including sport (basketball and tennis), aerobic activity only, and sedentary controls. Participants ( $N = 58$ ) who ranged in age from 55 to 84 years completed the BRIEF Adult Self-Report (Gioia, Isquith, Guy, & Kenworthy, 2000) and three computerized tests that evaluated working memory, cognitive flexibility (switching) and inhibition performance. Results indicated significantly better performance on the working memory task among the sport group participants when compared to the non-sport group. Findings support previous research indicating improved cognitive function among active older adults and suggest that sport participation may have a greater impact on executive functions as opposed to aerobic physical activity and inactivity.

### **Self-efficacy mediates the relationship between prepregnancy and pregnancy leisure-time physical activity**

Connolly, Christopher P., Washington State University; Pivarnik, James M.; Feltz, Deborah L.; Mudd, Lanay M.; Lapinski, Maria K.; Lewis, Mark G.; Michigan State University

Leisure-time physical activity (LTPA) performed prior to pregnancy predicts LTPA levels during pregnancy. The influence of LTPA self-efficacy on this relationship has not been assessed. This study sought to determine whether LTPA self-efficacy mediates the relationship between LTPA behavior prior to and during pregnancy. Pregnant women ( $n = 302$ ) completed an online or paper survey on their prepregnancy and pregnancy LTPA and LTPA self-efficacy. Self-efficacy was assessed via a 7-point Likert-type scale for both moderate and vigorous-intensity LTPA. Moderate-intensity LTPA was dichotomized as meeting guidelines [moderate LTPA = 150 min/week] or not. Vigorous-intensity LTPA was dichotomized as performing any [vigorous LTPA > 0 min/week] or not. Bivariate correlations, regression analyses, and Sobel tests were performed to test for mediation according to the Baron and Kenny (1986) approach. 41.1% of women met moderate LTPA guidelines and 62.9% participated in vigorous LTPA prepregnancy, but the rates fell to 27.2% and 30.1%, respectively, during pregnancy. Mean self-efficacy score for moderate LTPA ( $5.4 \pm 1.6$ ) was higher than vigorous LTPA ( $4.3 \pm 1.9$ ). Self-efficacy for moderate-intensity LTPA was correlated with meeting LTPA guidelines prior to ( $r = 0.21$ ;  $p < 0.01$ ) and during ( $r = 0.30$ ;  $p < 0.01$ ) pregnancy. Likewise, self-efficacy for vigorous-intensity LTPA was correlated with vigorous LTPA participation prior to ( $r = 0.26$ ;  $p < 0.01$ ) and during pregnancy ( $r = 0.41$ ;  $p < 0.01$ ). As expected, prepregnancy LTPA behavior was correlated with pregnancy LTPA ( $r = 0.43$ ;  $p < 0.01$  for meeting LTPA guidelines;  $r = 0.44$ ;  $p < 0.01$  for vigorous LTPA participation). LTPA self-efficacy significantly mediated prepregnancy to pregnancy relationships for meeting LTPA guidelines ( $z = 2.61$ ;  $p = 0.01$ ) and for vigorous LTPA ( $z = 3.68$ ;  $p < 0.01$ ). Self-efficacy appears to be a mechanism by which prepregnancy LTPA may influence pregnancy LTPA. These findings are congruent with Bandura's social cognitive theory, namely that past experience is a strong predictor of self-efficacy, and in turn, behavior. *Michigan State University, College of Education*

### Let's get ready to rumble: Anxiety and self-efficacy in the athletic arena

Conway, Rachel M., Davis, Shawn E.; Pacific University

In that a major component of athletic events is winning, it has become increasingly important to understand the mechanisms that facilitate a competitive win. Previous research has shown strong relationships between athletes' precompetitive anxiety, self-appraisal, and sport performance; however, no research has specifically studied potential moderation effects within these relationships. To examine such effects, participant request emails were sent to a systematic sampling of NCAA affiliated athletic coaches nationwide to distribute to their student-athletes. Four hundred thirty-two student-athletes, aged 18 to 22 ( $M = 19.64$ ,  $SD = 1.33$ ; 68.5% female, 31.5% male) completed an online survey. Results indicate positive relationships between self-appraisal and both trait and state anxiety, as well as a negative relationship between anxiety and self-confidence. Results also indicate a predictive relationship between state anxiety and self-appraisal that is moderated by varying levels of trait anxiety. Findings suggest that while there is a predictive relationship between situation-specific apprehension and self-appraisal, individuals reporting higher levels of anxiety proneness have a stronger relationship between their situational apprehension and self-appraisal levels. Also, the findings suggest that as levels of anxiety proneness increase, the predictive relationship between situation-specific apprehension and self-appraisal changes. For those reporting low and medium levels of anxiety proneness, a positive predictive relationship between situation-specific apprehension and self-appraisal was found, whereas there was no predictive relationship found for those reporting high levels of anxiety proneness. By determining the interactions between self-appraisal, trait anxiety, and state anxiety, the researchers strive to increase awareness of the processes underlying precompetitive anxiety and sport performance. This awareness, in turn, will likely influence positive change in the development of support programs for athletes at the competition level.

### Persistence and dropout among female collegiate rowers: A self-determination theory approach

Coon, Audrey L., Bolter, Nicole D.; Boise State University

Collegiate women's rowing has grown considerably in the past three decades. With an average roster of 50.2 athletes (Acosta & Carpenter, 2014), women's "crew" is an attractive sport for colleges and universities to expand participation for women and achieve compliance with Title IX. Despite efforts to provide opportunities for female rowers, many programs experience significant attrition each season. Thus, research is needed to determine the factors that enable rowers' persistence in the sport. This study was informed by self-determination theory (SDT; Deci & Ryan, 2000) and Vallerand's (1997) hierarchical model of intrinsic and extrinsic motivation, which suggest that coaching behaviors predict the satisfaction of psychological mediators that determine athletes' motivation and persistence or dropout from sport. Accordingly, the purpose of this study was to examine the individual and social contextual factors that explain rowers' continued participation or dropout. NCAA Division I, II, and III female rowing athletes ( $N = 119$ ) completed self-report questionnaires focused on their perceptions of autonomy-supportive coaching behaviors, basic needs satisfaction (i.e., perceived competence, autonomy, relatedness), and motivational orientation at two time points over two competitive seasons. At Time 2, 97 athletes were still active rowers (i.e., persisted) and 22 athletes had dropped out. Binary logistic regression analyses revealed that athletes' amotivation at Time 1 significantly predicted dropout at Time 2,  $\chi^2(4, 119) = 20.09, p < .005$ . From Time 1 to Time 2, paired sample  $t$ -tests indicated a significant increase in perceived competence,  $t(74) = 2.04, p < .05$ , and a significant decrease in coach relatedness,  $t(74) = -2.14, p < .05$ . Results of this study provide support for the theoretical predictions of SDT, suggesting greater amotivation is predictive of dropout from sport. Understanding what leads rowers to persist or drop out may inform coaching practices and future program offerings to ensure athletes' long-term participation in the sport.

### The role of mindfulness during yoga in predicting change in self-objectification and related outcomes

Cox, Anne E.; Ullrich-French, Sarah; Cole, Amy N.; D'Hondt-Taylor, Margo; Washington State University

Self-objectification theory describes how women internalize sexual objectification of their bodies. This internalization, called self-objectification, can result in negative psychological and behavioral outcomes (e.g., body shame, disordered eating). Although exercise is proposed to mitigate self-objectification and related negative consequences, there are mixed results regarding the relative effectiveness of aerobic versus strength training modes of exercise. Conversely, research on yoga illustrates a consistent link with lower self-objectification and positive psychological outcomes. This could be due to the emphasis on the body's function and sensations during yoga, which is cultivated through mindful practice (i.e., attention to and awareness of the present moment). Higher mindfulness during yoga practice could act as a mechanism to explain why yoga may be an effective mode of exercise for impacting self-objectification and related consequences. In this study, we examined individuals participating in 8-week yoga classes to explore how mindfulness during exercise may associate with change in self-objectification, body image variables, and reasons for exercise in participants ( $N = 148$ , 80% female). MANOVAs revealed significant ( $p < .05$ ) decreases in self-objectification ( $\eta^2_p = .22$ ) and increases in physical self-worth ( $\eta^2_p = .26$ ), health/fitness-related reasons for exercise ( $\eta^2_p = .04$ ), and state mindfulness of the mind ( $\eta^2_p = .07$ ) and of the body ( $\eta^2_p = .04$ ) across the 8-week classes. Mindfulness during yoga predicted significant ( $p < .05$ ) decreases in self-objectification ( $R^2 = .04$ ) and increases in health/fitness ( $R^2 = .07$ ) and mood/enjoyment reasons for exercise ( $R^2 = .04$ ) over the 8-week period. Positive body image and mindfulness during exercise were fostered through the practice of yoga and more importantly, mindfulness during yoga explained changes in variables related to self-objectification. The implications for positive body image and exercise motivation through mindful exercise are discussed.



**Being physically active during menstruation: Using the theory of planned behavior to predict the intention and behavior**

Croteau, Camille M., Wilson, Kathleen S., California State University–Fullerton

As of recent years, the physical activity (PA) level of females in the United States has increased (Schultz, 2004). In females specifically, kinesiologists have examined the physiological effects of exercise (i.e., female athlete triad; Nattiv et al., 2007) and how menstrual hormones affect performance (Janse de Jonge, 2003). However, as females tend to be less active than their male counterparts (Troiano et al., 2007), there is need to examine correlates of PA specific to females. This study explored the components of the Theory of Planned Behavior (TPB: attitudes, subjective norms, and perceived behavioral control) as predictors of intention to be active and PA during menstruation. Females ( $N = 167$ ;  $M_{\text{age}} = 24.5$ ) participated in a cross-sectional survey. The online survey included the following measures: demographics, TPB questions (Spink et al., 2012), Godin's Leisure Time Exercise Questionnaire (GLTEQ; Godin & Shepard, 1985), and a modified version of GLTEQ that asked about PA during menstruation. Results of a dependent  $t$ -test showed that females reported less PA during menstruation than typical ( $p < .001$ ). Two multiple regressions were performed. First, TPB constructs (affective and instrumental attitudes, perceived behavioral control (PBC), and subjective norms) were used to predict intentions for PA during menstruation. The constructs of the TPB significantly predicted intention ( $R^2 = .59$ ,  $p < .001$ ). The significant predictors included affective attitudes ( $\beta = .19$ ,  $p = .009$ ), PBC ( $\beta = .30$ ,  $p < .001$ ), and norms ( $\beta = .45$ ,  $p < .001$ ). A hierarchical regression was used to predict self-reported PA during menstruation. Step 1 included typical PA, which was significant ( $R^2 = .76$ ,  $p < .001$ ), followed by intention and PBC on step 2, which also was significant ( $R^2$  change =  $.058$ ,  $p < .001$ ). Both typical PA ( $\beta = .77$ ,  $p < .001$ ) and intentions ( $\beta = .29$ ,  $p < .001$ ) predicted PA during menstruation. These findings suggest that PA during menstruation differs than other times and that the TPB may be appropriate to understanding both intentions and PA of females during the menstrual cycle.

**The effects of valence and style of feedback provision on need satisfaction, self-talk, and persistence among tennis players: An experimental study**

De Muynck, Gert-Jan; Vansteenkiste, Maarten; Delrue, Jochen; Aelterman, Nathalie; Soenens, Bart; Haerens, Leen; Ghent University  
Self-determination theory (SDT; Deci & Ryan, 2000; Vansteenkiste, Niemiec, & Soenens, 2010) assumes that athletes will be optimally motivated when their psychological needs for autonomy (experience of volition), competence (experience of effectiveness), and relatedness (experience of closeness) are fulfilled. Although there is abundant correlational research providing evidence for this claim (e.g., Carpentier & Mageau, 2013; Mouratidis, Lens, & Vansteenkiste, 2010), experimental research is more scarce. Grounded in SDT, we aimed to examine whether the valence (i.e., positive versus negative) and style (i.e., autonomy-supportive versus controlling) of providing normative feedback would impact on tennis players' self-talk, achievement goal pursuit, motivational experiences, and continued persistence. Tennis players ( $N = 120$ ;  $M_{\text{age}} = 24.5$ ,  $SD = 9.86$ ) participated in a three-phase experimental study, in which valence and style of feedback were manipulated. Negative, relative to positive, feedback was found to decrease feelings of autonomy and competence, elicit negative self-talk and hamper both intrinsic motivation and persistence in tennis players. Controlling, relative to autonomy-supportive, communication further diminished feelings of autonomy, intrinsic motivation and persistence and increased performance-avoidance goal pursuit. In addition, some evidence was found for the buffering role of tennis players' own coach, as the perception of autonomy-supportive coaching cancelled out some of the detrimental effect of negative feedback and controlling communication in the experimental task. Finally, mediation analyses indicated that the effects of both valence and style of feedback provision on negative self-talk, intrinsic motivation, and persistence could be accounted for by, respectively, tennis players' need for competence and need for autonomy. Overall, this study points to the importance of need-supportive feedback whereby positive feedback is delivered in conjunction with autonomy-supportive communication style. *Flemish Research Foundation*

**The nature of contribution in university athletes: Motives, enablers, and barriers**

Deal, Colin J., Camiré, Martin; University of Ottawa

Contribution, defined as an individual's use of their assets to better themselves or others, is a marker of successful development in emerging adulthood. Contribution is predicted to occur in thriving youth whom exhibit the 5 Cs of positive youth development of positive youth development. Sport is often cited as a setting in which young athletes learn and develop assets necessary to contribute. Thus, with their prolonged involvement in sport, the purpose of this study was to examine the contributions of varsity athletes, as well as the enablers and barriers that influence their contributions. Ten varsity athletes from two Canadian universities were recruited to participate in semistructured interviews ( $M = 72$  min,  $SD = 14$ ). Athletes were drawn from basketball, rugby, soccer, and swimming, and included males ( $n = 3$ ) and females ( $n = 7$ ) from 1st to 5th year of eligibility. The interview guide consisted of four major sections: contributions & motivation, enablers, barriers, and student-athlete experience. Participants reported contributions from single events to ongoing, intensive contributions. Athletes that reported greater contributions discussed a supportive culture within the athletics department. Teammates served as role models with their own intensive contributions and further enabled contribution by providing tangible opportunities to contribute. Coaches and administration supported these contributions and assisted establishing connections. Although athletes reported extrinsic motivations (e.g., resume building); long-term contributions were sustained primarily because of intrinsic motivations (e.g., pleasure from the experience and learning opportunities). Participants acknowledged time committed to academic and athletic activities was reported as a barrier to contribution; however, the supportive culture allowed most to overcome the time constraints. These findings suggest varsity athletes' contributions benefit the athlete as well as the recipient and aspects of varsity sport may be leveraged to further facilitate these ongoing, intensive contributions.

### Relationship status and mental and physical functioning in former professional football athletes across a ten-year study period

DeFreese, J.D., University of North Carolina at Chapel Hill; Kerr, Zachary Y., Datalys Center for Sports Injury Research and Prevention; Baucom, Donald H., Guskiewicz, Kevin M., University of North Carolina at Chapel Hill

The mental and physical health of former professional football athletes (FPFAs) is an important public health concern. Thus, further understanding of these outcomes informs the knowledge base on the impacts of contact sport participation. The presence of a romantic partner is a key contributor to human health and functioning (Newman & Roberts, 2013) and merits further exploration relative to markers of FPFA mental and physical health over time. The current study examined how relationship status was associated with FPFA mental and physical functioning over a ten year study period. We hypothesized that 1) the presence of a romantic relationship for FPFAs would be positively associated with higher levels of mental and physical functioning at both study waves and that 2) status changes would be associated with changes in functioning. American FPFAs ( $N = 1131$ ;  $M_{\text{age}} = 62.4$  years) completed self-report assessments of study variables following their playing careers. The majority ( $n = 972$ ; 86%) of participants endorsed being in a committed relationship with indicated no changes in their relationship status ( $n = 983$ ; 87%) across waves, nine years apart. Regression analyses showcased wave one relationship status as a positive contributor to mental ( $\beta = 0.07$ ,  $p < 0.05$ ) but not physical well-being ( $\beta = 0.03$ ,  $p > 0.05$ ). Findings trended similarly for mental functioning ( $\beta = 0.06$ ,  $p = 0.05$ ) at wave two. Changes in relationship status across waves did not predict changes in either mental or physical outcomes. Exploratory group difference analyses revealed wave two mental functioning scores differed by relationship change categories ( $F = 2.82$ ,  $p < 0.05$ ), with those who remained single across study waves exhibiting the lowest scores. Study results, while mixed relative to the positive link between FPFA relationship status and perceptions of mental functioning, support continued research on potential moderators of this association (e.g., relationship quality). Such work will inform relationship-based interventions designed for promotion of lifespan FPFA mental and physical health.

### Associations among markers of the parent-child relationship and parent experiences of burnout and engagement in organized youth sport

DeFreese, J.D., University of North Carolina at Chapel Hill; Dorsch, Travis E., Flitton, Travis, Utah State University

Research has showcased burnout and engagement as important markers of athlete psychological health and well-being (e.g., DeFreese & Smith, 2013; Lonsdale et al., 1997). Despite their importance to athletes across the lifespan, few empirical efforts have examined burnout and engagement relative to other sport-based social actors. Indeed, extant research suggests a psychosocial impact on parents as an outcome of the organized youth sport participation of their children (Dorsch et al., 2009). To enhance understanding of the psychosocial experiences of parents in organized youth sport, the purpose of the current study was to examine associations among markers of the sport-based parent child-relationship and youth sport parent burnout and engagement. Parent participants ( $N = 238$ ) aged 26–66 years ( $M = 43.42$ ,  $SD = 6.53$ ) completed valid and reliable assessments of their perceptions of the parent-child relationship (via warmth and conflict), burnout (via exhaustion, reduced sense of accomplishment and devaluation), and engagement (via confidence, vigor, dedication and enthusiasm) in sport. 81 fathers and 156 mothers (1 non-respondent), drawn from a national sample of youth sport leagues, reported an average of 2.23 ( $SD = .96$ ) children ( $M_{\text{age}} = 12.27$ ,  $SD = 3.21$ ) participating in youth sport. Regression analyses showcased warmth ( $\beta = -0.31$ ,  $p < 0.001$ ) but not conflict ( $\beta = 0.03$ ,  $p > 0.05$ ) as a significant negative contributor to global burnout and all dimensional scores (except exhaustion), whereas warmth ( $\beta = 0.46$ ,  $p < 0.001$ ) but not conflict ( $\beta = 0.11$ ,  $p > 0.05$ ) was a significant positive contributor to global engagement and all dimensional scores. Conflict ( $\beta = 0.19$ ,  $p < 0.05$ ) was also a significant contributor to dedication scores. Results offer preliminary insight into the impact of parent-child warmth on parents' experiences of burnout and engagement in organized youth sport. Such work has important implications for future research and practice efforts designed to promote positive psychosocial experiences for both youth sport parents and their children.

### Factors affecting development of high performance wheelchair basketball players

Dehghansai, Nima; Lemez, Srdjan; York University; Wattie, Nick, University of Ontario Institute of Technology; Baker, Joseph, York University

Numerous studies have focused on able-bodied athlete development and expertise (e.g., Memmert, Baker, & Claudia Bertsch, 2010; Baker & Horton, 2004; Baker & Cote, 2003). Unfortunately, the same degree of attention has not been given to Para sport athletes (Campbell & Jones, 2000). The majority of studies that have examined Para sport have focused on kinetics and physical performance (e.g., Goosey-Tolfrey & Butterworth, 2002; Malone, Gervais, & Steadward, 2002) with very little attention directed to understanding athletes' development and their journey to expertise. This study examined athlete-history variables to understand factors that contribute to successful development in Para sport and provide insight into this largely neglected cohort of elite athletes. A total of 54 (34 males, 20 females) high performance wheelchair basketball athletes completed a modified version of the Development History Athlete Questionnaire. The average age athletes started participation in wheelchair basketball was  $M = 13.70$ , and on average, athletes started deliberate practice just under 2 years later ( $M = 15.59$ ). At first, athletes devoted 8.04 hr of deliberate practice weekly and training duration has increased to 14.09 hr per week now. Furthermore, number of hours devoted to deliberate practice had a positive relationship with level of competition; junior athletes at the provincial level averaged 7.45 hr of practice per week and juniors at international level averaged 13.13 hr per week. Similar trends were apparent in senior athletes, with provincial athletes averaging only 5 hr per week compared to 17.82 hr per week for international level competitors. Further, there were differences in training hours between athletes born with disability compared to athletes who acquired their injury postbirth. The knowledge obtained in this study will be an important stepping-stone for further investigations to understand the journey to expertise in Para sports.

### **The Situation in Sport Questionnaire: A new measure to tap into coaches' motivating style from the perspective of self-determination theory**

Delrue, Jochen, Vansteenkiste, Maarten, University of Ghent; Vande Broek, Gert, University of Leuven; Haerens, Leen, Aelterman, Nathalie, University of Ghent; Franssen, Katrien, Decroos, Steven, Reynders, Bart, University of Leuven

Although the benefits of coaches' motivating style for athletes' performance and development has been documented in previous studies relying on athlete reports of motivating style, few studies have involved coaches. Relying on self-determination theory, the present study aimed to develop and validate a new measure that taps into coaches' motivating style, thereby making use of vignettes rather than more generic items. Specifically, coaches indicated whether they engaged in autonomy-supportive, controlling, structuring and chaotic practices in response to 17 ecologically valid vignettes. After extensive pilot testing, the Situation in Sport Questionnaire was validated in a sample of Belgian coaches ( $N = 209$ ;  $M_{\text{age}} = 40.27$  years). Multidimensional scaling and factor analyses provided insight in the structure of the scale, which was most parsimoniously described along two dimensions representing coach autonomy support relative to control and coach structure relative to chaos. Further, the two retained dimensions and four separate styles related in predictable ways with available external validation measures (e.g., mastery and performance climate) as well as hypothesized antecedents among teachers (e.g., coach motivation) and testifying to the convergent and divergent validity of the newly developed questionnaire. It is discussed how this new instrument may be used as a diagnostic tool to screen coaches, a reflection tool to promote self-awareness among coaches, and an evaluation tool to examine the effectiveness of a coach training. *Flemish Department of Sports*

### **Stakeholders' perceptions of parent involvement in young adults' intercollegiate athletic careers: Policy, education, and desired-student-athlete outcomes**

Dorsch, Travis E., Utah State University; Lowe, Katie, Dotterer, Aryn M., Purdue University; Lyons, Logan, Barker, Analise, Utah State University

The transition from high school to college is a salient ecological shift for emerging adults that has important implications for shaping student success and well-being (Elias & MacDonald, 2007). This process is even more complicated for student-athletes, who perceive great pressure to succeed athletically and academically (Wylleman & Lavallee, 2004). Parent involvement is an integral, but potentially problematic, aspect of this transition as young adults gradually shift from reliance on parents to self-dependence, a developmental process known as *individuation* (Arnett, 2004; Tanner, 2006). In light of this important developmental process, the need exists for evidence-based parent education that complements previous National Collegiate Athletic Association (NCAA) programmatic interventions focused on student-athletes (e.g., Making the Jump). In light of the potential knowledge held by NCAA coaches and administrators regarding parent involvement and its impact on student-athlete development and well-being, the present research was designed to address their perceptions of core design components, barriers to feasibility, and expected outcomes of evidence-based parent education. 25 coaches and 4 senior administrators from Utah State University and Purdue University took part in face-to-face, semistructured interviews designed to tap into their experiences of parent involvement in NCAA athletics. Interviews were audio recorded, transcribed verbatim, and data were synthesized to create a grounded theory outlining (a) types of negative parent involvement, (b) policy considerations for NCAA administrators, (c) barriers to implementing parent education, (d) potential components of parent education at the NCAA Division I level, (e) barriers to achieving positive parent involvement, and (f) desired outcomes for NCAA student-athletes. Data were also examined across demographic factors that may impact the implementation of evidence-based parent education. Findings were used to design a Parent Guide and Administrator Manual for institutions wishing to implement evidence-based parent education programming. *National Collegiate Athletic Association*

### **Parent education in organized youth sport: Recommendations from parents, coaches, and administrators**

Dorsch, Travis E., Osai, Keith V., Tulane, Sarah, Carlsen, Chalyce P.; Utah State University

Ninety percent of North American youth participate in organized sport during childhood and/or adolescence (Jellinek & Durant, 2004; USDHHS, 2010). Parents are also active participants, exhibiting a range of involvement behaviors over the course of a child's athletic development. As such, organized youth sport provides a common context for family interaction, whereby parent behavior can shape the child's developmental experience. As parents continue to invest a growing percentage of family resources into the athletic development and success of their children, the quality and quantity of parental involvement in youth sport has become an important cultural discussion. Although researchers have a systematic understanding of this parent involvement in organized youth sport, there remains a disconnect in the transfer of that knowledge to parents. Therefore, there is a critical need to provide parents an educational platform informed by evidence-based principles of parenting in organized youth sport. In light of this, the purpose of the present research was to assess community readiness and best practices for implementing a league-wide parent education program. Through qualitative interviews with league administrators ( $n = 11$ ), coaches ( $n = 13$ ), and parents ( $n = 12$ ) we sought key stakeholder perceptions of core design components of, and barriers to, parent education programming in organized youth sport. Interview data were inductively analyzed and a grounded theory (Corbin & Strauss, 2008) of parent involvement in organized youth sport is offered. In combination with evidence-based parenting strategies offered in the extant sport literature, data from the present research were used to structure and implement a pilot parent education program in Cache Valley, Utah. This research offers educational and leadership opportunities for organizations (e.g., Little League Baseball, Pop Warner Football) at the national and community level. In addition, it may unencumber coaches and league directors who carry the fiduciary burden of controlling parent behavior in organized youth sport.

### **Individual, relationship, and context factors associated with parent support and pressure in organized youth sport**

Dorsch, Travis E., Utah State University; Smith, Alan L., Michigan State University; Dotterer, Aryn M., Purdue University

Parent involvement in youth sport is regarded as both adaptive and concerning (Fredricks & Eccles, 2005; Jellineck & Durant, 2004), pointing to a need to better understand parenting in the developmental context of sport. To advance this understanding, we examined multiple reporters' perspectives of process, person, and context factors (Bronfenbrenner, 2005) that may influence sport parent involvement. Specifically, we examined (a) the concordance among self, partner, and child reports of study variables; and (b) warmth and conflict in the parent-child relationship, parent positive and negative affect, and mastery and performance dimensions of the coach-created motivational climate as predictors of parent involvement (support, pressure) in youth sport. Congruence among family ( $N = 201$ ) reports on reliable and valid measures of these constructs was assessed via multitrait-multimethod analysis. Associations among parent, spouse, and child reports were largely significant and in hypothesized directions, yet were of modest magnitude and suggested low reporter agreement (Cohen's  $\kappa$  range = .00–.51). Multivariate multiple regression analyses with perceived warmth, conflict, positive and negative affect, and mastery and performance motivational climate predicting perceived parent support and pressure showed significant multivariate relationships for parent, spouse, and child reports ( $R_d$  range = .04–.22). Canonical loadings showed that warmth, positive affect, and mastery climate positively associate with support, whereas conflict, negative affect, and performance climate positively associate with pressure from fathers and mothers. Conflict and positive affect positively associated with support and pressure in some functions, suggesting complexity in interpretations of parent involvement. Collectively, these findings support the adaptive role of parent-child warmth, positive parent affect, and coach-created mastery motivational climate in youth sport; however, low concordance of reporter perceptions must be considered when pursuing family-related questions in sport. *Purdue University Bilsland Dissertation Fellowship*

### **Parent involvement in young adults' intercollegiate athletic careers: Developmental considerations and applied recommendations**

Dorsch, Travis E., Utah State University; Lowe, Katie, Dotterer, Aryn M., Purdue University; Lyons, Logan, Utah State University

The transition from high school to college is a salient ecological shift for student-athletes, who perceive pressure to succeed both athletically and academically (Wylleman & Lavallee, 2004). Because parents to play an important supportive role for athletes during emerging adulthood (Arnett, 2004; Côté, 1999), it is surprising that researchers have yet to fully explore the impact of parent involvement on student-athlete development during the college transition. In an effort to address this gap, the present research was designed to highlight specific aspects of parent involvement that predict positive developmental outcomes in student-athletes. Student-athlete participants ( $N = 514$ ) ranging in age from 18 to 25 years ( $M = 19.76$ ,  $SD = 1.43$ ) were recruited from two NCAA Division I universities. Student-athletes reported on four aspects of parent involvement (support-giving, contact, academic engagement, athletic engagement) and seven aspects of student-athlete development via an online survey (academic self-efficacy, athletic satisfaction, depression, engagement in risky behaviors, emotional independence, functional independence, attainment of adult criteria). Results indicate that (a) parent academic and athletic engagement were positively associated with student-athlete academic self-efficacy and athletic satisfaction, (b) parent athletic engagement was negatively associated with student-athlete depression, (c) support from parents, contact with parents, parent academic engagement, and parent athletic engagement were strong negative predictors of emotional independence, (d) support from parents and parent academic engagement were strong negative predictors of functional independence, and (e) support from parents was a strong negative predictor and athletic engagement a strong positive predictor of student-athletes' attainment of adult criteria. Findings from the present research have the potential to guide the NCAA's development of campus-level parent programming, while enhancing parent involvement and student-athlete development.

### **The influence of attractivity on the perception of coaches' trustworthiness**

Dreiskaemper, Dennis; Koester, Silke; Halberschmidt, Barbara; University of Münster

The perception of trustworthiness can be influenced by different factors (Mayer, Davis & Schoorman, 1995). Likewise, trustworthiness is an important component in the coach-athlete relationship (Zhang & Chelladurai, 2013). The attractivity of a person can lead to an affective perception bias when evaluating her or his trustworthiness (Todorov, Pakrashi, & Oostenhof, 2008). The aim of this study was to investigate the effect of attractivity on the perception of volleyball coaches' trustworthiness by athletes. In an IAT study, prevalidated pairs of adjectives (*trust* and *distrust*) and ranked photos of male and female volleyball coaches were used as stimuli. The experiment was built with Inquisit 4.0 and by example of Greenwald, Schwatz, and McGhee (1998). In the experiment,  $N = 77$  volleyball players with average expertise took part (age: 26.21 years,  $SD = 7.35$ , 49.4% female). It took participants significantly longer to categorize adjectives and pictures if attractivity and distrust stimuli were on the same screen side than when attractivity and trust stimuli were on the same side ( $60.12 = F(1,76) = 152.60$ ,  $p < .001$ ,  $.45 = \eta^2 = .67$ ). Experimental order or side effects were excluded. There were found significant correlations between the response time bias and the expertise of athletes. No gender effects were identified. The results indicate that there is an attractivity bias in judging the trustworthiness of coaches. Those implicit attitudes may influence the relationship between athletes and coaches, which might have consequences, for example, for cohesion, goal orientation, or competitiveness of teams. Further research should deal with possible effects of trustworthiness perception on team factors such as this.

**Effects of video game avatar size on body image dissatisfaction and food choice**

Dwyer, Patrick, Raudenbush, Bryan, Wheeling Jesuit University

The size of an avatar, and an individual's identification with that avatar size, have been found to influence aspects of mood and performance. For example, participants who played a video game with a particular size avatar (underweight, average, overweight) rated their performance differently, with those having an overweight avatar showing decreased positive mood and decreased self-evaluated performance. The present study was designed to assess video game avatar size on subsequent body image and food choice. Both male and female participants ( $n = 42$ ) played 20 min of WWE 13 on an X-box gaming console. During play, they were assigned an avatar characterized as "underweight," "average," or "overweight." Participants indicated, from a set of figure drawings, their current and ideal figures on a scale ranging from 10 to 90. A dissatisfaction score was obtained by calculating the difference between those two ratings. Controlling for BMI, a significant avatar size  $\times$  sex interaction was found for dissatisfaction score. For males, the "underweight" avatar was associated with the greatest desire to be larger (i.e., ideal figure larger than current figure); for females, the "overweight" avatar was associated with the greatest desire to be smaller (i.e., ideal figure smaller than current figure). Participants were then placed in a mock cafeteria scenario where they could pick a meal from among 70 foods. Controlling for hunger level and BMI, as females experienced larger avatars they tended to decrease their choice of foods in a variety of categories (such as gram weight, calories, and carbohydrates). Future studies should examine the long-term effects of video game play with varying avatar sizes, as well as how such avatars may then influence individuals to alter their workout and health behaviors.

**Does a single bout of "green exercise" enhance the affective experience and future exercise behavior?: A pilot study**

Dyke, Ford B.; Buchanan, Taylor L.; Crawford, Beverly Z.; Miller, Matthew W.; Auburn University

An enhanced affective experience during a bout of exercise is positively correlated with future exercise engagement. Thus, it is important to explore means by which to enhance the affective experience of exercise. One way to do so may be to exercise in the presence of nature (i.e., engage in "green exercise"). This is because green exercise may be more pleasant than exercise completed in "artificial environments" (e.g., urban streets). Thus, individuals who engage in a bout of green exercise may exhibit more future exercise than those who engage in a bout in an artificial environment. The purpose of the present study was to test this hypothesis. Specifically, we investigated (1) whether a bout of green exercise yielded enhanced affect relative to exercise completed in an artificial environment, and (2) whether individuals who engaged in a bout of green exercise subsequently engaged in more exercise than individuals who engaged in a bout of exercise in an artificial environment. Forty low-active adults completed one 10-min bout of walking, at a self-selected pace, in either a green or artificial environment. Participants' affect before, during, and after exercise was assessed via the Feeling Scale, and their exercise behavior in the week subsequent to the bout was indexed with accelerometry (their exercise in the week prior was also assessed to check for pretest differences). A manipulation check questionnaire revealed the green environment was perceived as more natural than the artificial environment ( $p < .001$ ). Although group differences (green versus artificial) were in the predicted directions, they were not significant. Specifically, affect did not significantly differ at any time point ( $ps = .174$ ), and post-bout exercise behavior did not significantly differ ( $p = .416$ ). Thus, results failed to support the hypothesis, but it is possible that a higher-powered study (e.g., larger  $n$ ) could have yielded significant results.

**Testing the relationships among self-compassion, quality of life, and physical activity for women diagnosed with breast cancer**

Ebbeck, Vicki, Souza, Brian J., Mitchell, Erin, Rogers, Kim, Oregon State University

Fredrickson's (2004) broaden-and-build theory (BBT) posits that positive emotions such as self-compassion (SC) build personal resources that enhance emotional and physical well-being. Women diagnosed with breast cancer participated in this study designed to test a BBT-based structural equation model contextualized to physical activity (PA). Recent research reveals that PA could significantly reduce the risk of breast cancer and mitigate common side effects of treatment, although the documented challenge is getting oncology patients and cancer survivors to engage in regular PA. Therefore, our purpose was to gain knowledge of key constructs associated with PA and how they are interrelated, to inform future intervention efforts. Valid and reliable self-report measures were anonymously completed online by 221 women ages 22–87 years ( $M = 55.3$ ;  $SD = 13.5$ ). We found support for our hypothesis that SC would be positively related to quality of life (QOL) by "building" the personal resources of physical activity resilience (PAR), or the ability of bounce back from stress, and physical activity authenticity (PAA), or being true to one's physically active self. SC predicted PAR ( $\beta = .95$ ) and PAA ( $\beta = .55$ ). PAR ( $\beta = .50$ ) and PAA ( $\beta = .53$ ), in turn, predicted physical activity psychological needs satisfaction that led directly to PA ( $\beta = .73$ ), and PA influenced QOL ( $\beta = .57$ ). A direct path also existed from SC to QOL ( $\beta = .38$ ). All paths were significant at the  $p < .001$  level and the model accounted for 70.3% of the variance in QOL. The data provided an acceptable fit to the model:  $\chi^2(253) = 425.04$ ,  $p < .001$ ; RMSEA = .06; CFI = .93; SRMR = .07 (Hu & Bentler, 1999). Consistent with the BBT, SC had indirect effects on QOL by "building" resources that help promote PA and, to a lesser degree, a direct effect on QOL. Our results suggest that strategies to promote SC in women with breast cancer are warranted.

### Cyber partners for astronauts: Boosting motivation to exercise harder with exergames

Ede, Alison; Hill, Christopher R.; Winn, Brian; Pivarnik, James M.; Kerr, Norbert L.; Jeffery, William; Deere, Samantha J.; Spencer, Benjamin D.; Michigan State University; Ploutz-Snyder, Lori, Universities Space Research Association; Feltz, Deborah L., Michigan State University

Exercise at high intensities is necessary to minimize negative health outcomes during space missions. The current project uses group dynamics principles to improve motivation of adults, similar in age and fitness to astronauts, to exercise at higher intensities through exergames. Based on Koehler effect principles (i.e., social comparison and indispensability), individuals have been shown to work harder with a superior software-generated partner (SGP) in exergames. Participants in the current study were male ( $N = 19$ ) and female ( $N = 25$ ) chronic exercisers ages 30–62 years, in one of four conditions: (a) individual control, (b) co-acting partner (i.e., exercising with an SGP), (c) conjunctive teammate (i.e., working as a team dependent on the weaker member), and (d) choice of co-acting SGP or conjunctive teammate. The exercise program involved alternating days of a 30-min continuous workout at or above 75% of maximum heart rate, and a 4 × 4-min interval workout at or above 90% heart rate on a cycle ergometer for 6 days. Days 1 and 2 included practice tests to ensure target intensities elicited the correct heart rate. Days 3 and 4 involved baseline tests (alone) of each workout. On Days 5 and 6, participants in partnered conditions met the SGP and cycled together. Participants were allowed to change intensity during each workout, and effort was measured by average watts cycled. Difference scores were calculated to assess changes in effort from baseline to experimental days. All conditions resulted in increased effort from Day 3 to 5 ( $M = 6.56$  watts,  $SD = 7.83$ ) and from Day 4 to 6 ( $M = 4.78$ ,  $SD = 6.17$ ). However, there were no differences in effort between control or partner conditions. For the last interval workout, increases in effort above target were positively correlated ( $p < .05$ ) with self-efficacy ( $r = .49$ ), enjoyment ( $r = .47$ ) and positive feelings toward the SGP ( $r = .36$ ). Preliminary findings suggest group dynamics principles may not be necessary for chronic exercisers to maintain optimal effort in acute exercise bouts, but it remains to be tested across longer periods. *NASA/National Biomedical Research Institute, MA03401*

### Young athlete development in high performance sport organizations: The case of USA Luge

Erickson, Karl T., Michigan State University; Warren, Daniel J.; Agans, Jennifer; Lerner, Richard M.; Tufts University

High performance talent development systems, particularly those that must recruit athletes directly into performance development streams at young ages, face unique challenges in appropriately meeting both the talent and psychosocial developmental needs of young athletes. The USA Luge Association is a prime example of one such organization. While the integrated development of young athletes in mainstream sport has received much research attention (e.g., Holt, 2008), the experiences of young athletes in such high performance streams has been studied to a comparatively lesser degree. The present study was an in-depth contextualized investigation of the personal development experiences of young athletes in the USA Luge Associations Junior Developmental Team program (athletes aged 11–14). This study incorporated both ethnographic-style observations by an embedded observer during an intensive residential training camp and semi-structured qualitative interviews with participating athletes (13 of 15 athletes in program; 6 female). Integrated analysis of the athlete interviews and embedded observation notes led to a multi-part contextualized process representation of young athletes' positive development experiences in the Junior Developmental Team program. The positive development experience process was composed of three primary elements (with associated sub-elements): 1. entry into luge and factors influencing that process, 2. the positive development process consisting of the experiences of individuals interacting with a nested multi-level context through time, and 3. the outcomes reported by athletes as a result of the development process. Some challenges to participation and development and general program structure considerations were also noted. An integrated "big-picture" of the developmental experiences of young athletes in the high performance luge environment was then constructed, with implications for healthy recruitment, development, and retention of young athletes in high performance streams generally, and particularly for small-market Olympic sports. *Social Sciences and Humanities Research Council of Canada*

### Effects of an 8-month physical activity intervention on brain-derived neurotrophic factor (BDNF): The Physical Activity and Alzheimer's Disease (PAAD) Study

Etnier, Jennifer L.; Karper, William B.; Piepmeier, Aaron T.; Wideman, Laurie L.; Castellano, Michael A.; University of North Carolina at Greensboro

By 2030, it is predicted that 65.7 million people will have Alzheimer's disease (AD). While there is currently no cure for AD, molecular markers have been associated with the risk of developing AD as well as the severity of AD. These include the e4 allele of the apolipoprotein gene (*APOE* e4) as well as the brain-derived neurotrophic factor (BDNF) protein. Carriers of the *APOE* e4 allele have an increased risk of developing AD, resting concentrations of BDNF have been associated with the severity of AD, and both markers have been associated with cognitive performance. Given this evidence, it is vital to examine preventive measures aimed at decreasing the risk of or delaying the onset of AD and to explore the potential moderating role of *APOE* and the potential mediating role of BDNF. Thus, one aspect of the PAAD study was to assess the effects of an 8-month physical activity program on resting BDNF concentrations relative to genetic risk for developing AD (presence or absence of *APOE* e4). Cognitively normal older adults ( $n = 54$ ) participating in the PAAD study performed aerobic and resistance exercises 1 hr/day, 3 days/wk, for 8 months. Resting fasted blood samples were taken prior to, at 4 months, and after the exercise program. Results from those with complete data ( $n = 43$ ) indicated that there is no change in resting BDNF concentrations as a result of the physical activity program ( $p > .05$ ). This is consistent with past work that has been performed with older adults. Extending past research, results show no differences in BDNF concentration or in the change in BDNF concentration over time as a function of being an *APOE* e4 carrier. Though nonsignificant changes were observed, these findings are essential in the interpretation of the PAAD study as a whole, in that it may now be determined that any cognitive changes observed are not due to changes in resting BDNF concentration. Future analyses will examine the role of BDNF genotype in furthering our understanding of the role of BDNF in the relationship between physical activity and cognitive performance. *National Institute of Aging of the National Institutes of Health under award number R21AG040310*

**The moderating effect of apolipoprotein (ApoE) genotype on cerebral structural changes in response to chronic physical activity: The Physical Activity and Alzheimer's Disease (PAAD) Study**

Etnier, Jennifer L.; Karper, William B.; Shih, Chia-Hao; Park, SeYun; Zhao, Si; Kraft, Robert A.; University of North Carolina at Greensboro  
 Exercise training benefits cognitive function and cerebral structure in older adults. Magnetic resonance imaging (MRI) shows differences in brain structure as a function of apolipoprotein E (*APOE*) genotype. This is important because the *APOE* genotype is a strong risk factor for developing Alzheimer's disease (AD), with the epsilon 4 (e4) allele being predictive of AD in a dose-response fashion. As a pilot study, the purpose of the current study was to assess the extent to which changes in cerebral structure in response to exercise differ as a function of *APOE* genotype. Cognitively normal older (50–65 years) adults ( $n = 19$ ) with a family history of AD completed an MRI scan (3T Siemens, T1 weighted MP-RAGE 1-mm isotropic resolution) at the beginning (pre) and end of an 8-mo exercise program that consisted of aerobic and resistance training performed for 1 hr/wk, 3 days/wk. Thirteen participants (8 e4 carriers; 5 noncarriers) completed both MRI scans. The pre-exercise MRI scans were obtained in the first 3 months of the exercise intervention and the post-exercise MRI scans were obtained in the month after participants finished the exercise intervention. Cortical reconstruction and volumetric segmentation was performed with the Freesurfer image analysis suite. Results showed that after 5 months of exercise, participants showed significantly reduced hippocampal volume,  $F(1, 11) = 9.85, p < .01, \eta^2_p = .47$ . Importantly, an interaction between time of scan and *APOE* genotype on temporal horn of left lateral ventricle reached significance,  $F(1, 11) = 6.07, p < .05, \eta^2_p = .36$ . Specifically, *APOE* e4 carriers showed enlarged temporal horn of left lateral ventricle over the 5-month period. In contrast, *APOE* e4 non-carriers showed reduced temporal horn of left lateral ventricle over this same period of time. These findings suggest that the effects of exercise are brain structure specific and are varying in people with different *APOE* genotypes. Future research designed to further our understanding of how exercise affects brain structures is warranted. *National Institute of Aging of the National Institutes of Health under award number R21AG040310*

**The moderating effect of apolipoprotein (ApoE) genotype on cognitive performance in response to chronic physical activity: The Physical Activity and Alzheimer's Disease (PAAD) Study**

Etnier, Jennifer L.; Labban, Jeffrey D.; Dudley, William N.; Karper, William B.; Henrich, Vincent C.; Shih, ChiaHao; Piepmeier, Aaron T.; Park, SeYun; University of North Carolina at Greensboro

Evidence supports the cognitive benefits of exercise for older adults. Although not unequivocal, correlational and prospective evidence indicates that these benefits may be greater for those carrying a genetic risk factor (the epsilon 4, e4, allele of apolipoprotein E, *APOE*) for Alzheimer's disease (AD). The purpose of this study was to assess the extent to which *APOE* genotype moderates the effects of exercise on cognitive performance. Cognitively normal adults (50–65 years) with a family history of AD participated in an 8-month exercise program (aerobic and resistance training, 1 hr/day, 3 days/wk). Cognitive performance was measured at baseline, prior to the exercise program (pre), at 4 months (mid), and at 8 months (post). Cognitive outcomes were separated into four domains: attention, memory, executive function, and information processing. Growth curve analysis was used to model change in cognitive outcomes across the exercise intervention, with *APOE* e4 carrier status and baseline cognitive performance included as predictors of change. Expectedly, baseline cognitive performance was significantly correlated with performance at pre-test, but not with change over time. Carrier status was not broadly correlated with either performance at baseline or with change over time. Significant-to-marginally-significant improvements in cognitive performance were observed for 3 of 4 attention measures (PASAT2,  $p = .10$ ; PASAT4,  $p < .01$ ; Digit Span Backwards,  $p < .05$ ), 6 of 7 memory measures (AVLT: Trial1 Recall,  $p < .01$ , Trial6 Recall,  $p < .01$ , Delayed Recall,  $p < .01$ , and Delayed Recognition,  $p = .08$ ; CFT: Immediate Recall,  $p < .01$ , and Delayed Recall,  $p < .01$ ), and 2 of 4 information processing measures (Trail Making A,  $p = .09$ ; Stroop Word,  $p < .01$ ). No significant improvements were observed for executive function measures. Results suggest that *APOE* e4 carriers achieve cognitive benefits in response to exercise comparable to those achieved by noncarriers. This is important because in the absence of intervention, *APOE* e4 carriers display declines in memory over time (Caselli et al., 2009, 2011). *National Institute on Aging of the National Institutes of Health, award number R21AG040310*

**Teammates' influence on athletes' goal orientation: Effects of the Positive Coaching Alliance (PCA) training model**

Ettekal, Andrea Vest; Ferris, Kaitlyn A.; Agans, Jennifer P.; Burkhard, Brian M.; Tufts University

Achievement goal theory indicates that athletes are more likely to stay in and enjoy sports if they adopt a task- rather than ego-based focus. Indeed, athletes are more likely to adopt a task focus when teammates promote a task-oriented motivational climate. Little research has investigated if athletes' task or ego goal orientations are influenced by these climates. Athletes' participation in a workshop emphasizing character development, such as the Positive Coaching Alliance (PCA) training program, has the potential to enhance the motivational climate that promotes goal orientations. We examined if links between athletes' goal orientations and perceptions of teammates' goal orientations covaried with moderating variables such as attributes of the athlete (e.g., gender), coach (e.g., experience), and sport (e.g., type), as well as participation in a PCA workshop. Data are from an ongoing longitudinal study of character development among high school athletes in various sports and involving attendance at schools receiving PCA intervention. Athletes completed self-report measures of achievement goal orientation and perceptions of the peer motivational climate prior to attending the PCA workshop; youth attending control schools completed surveys on the same schedule. Preliminary cross-sectional analyses suggest that the links between athletes' goal orientation and perceptions of teammates' goal orientation varied in relation to athlete, coach, and sport attributes (e.g., male athletes were influenced by their teammates' task orientation while female athletes were influenced by their teammates' ego orientation). The full presentation expands on these findings and discusses how PCA training and coach and sport attributes amplify effects of the motivational climate on task versus ego goal orientations. This study furthers our understanding of peer influence on athlete motivation and helps identify how skills acquired through character interventions contribute to peer motivational climate within adolescent sports teams.

### Physical activity motivators and benefits among highly physically active individuals with MS

Fasczewski, Kimberly S., Rothberger, Sara M., Gill, Diane L., University of North Carolina at Greensboro

Multiple sclerosis (MS) is a degenerative neurological disease that affects 2.1 million people worldwide (National Multiple Sclerosis Society, 2014). There is no cure; however, an expanding body of research supports the positive impact of physical activity on symptoms of MS. This research extends a previous case study on one competitive mountain bike racer with MS. The case study findings indicated high levels of self-determined motivation and self-efficacy, and suggested that physical activity had clear benefits for the individual's psychological and physical well-being. The current study further examines the motivation for, and benefits of, physical activity with a larger sample of highly active people with MS. Semistructured interviews were conducted with 8 individuals who had been living with MS for at least 5 years and were classified as highly physically active on the Godin Leisure-Time Exercise Questionnaire (Godin & Shephard, 1985). Participants were recruited from a larger online survey project on physical activity and MS, which included an option to indicate willingness to participate in a follow-up interview. Initial contact was made via email and individual interviews were conducted via phone. The interviews focused on a) motivation and strategies used to maintain physical activity, and b) the benefits and impact of physical activity (PA) in their lives. After transcription, interviews were coded independently by two coders and classified into meaningful themes. All participants were highly motivated, and the main themes were in line with self-determination theory; participants described feelings of accomplishment and competence in both their PA and daily life, as well as a sense of independence and autonomy. Similarly, all participants cited benefits, and the main themes were enhanced satisfaction with life and an overall positive outlook on life. The results provide insight into the role of PA with this unique highly active sample and have implications for promoting PA with the larger population of people with MS. *AASP Student Research Grant*

### Implementation of the Positive Coaching Alliance (PCA) Training Model with adolescent athletes: A Mixed-methods evaluation of coaches' perspectives

Ferris, Kaitlyn A.; Ettekal, Andrea E. Vest; Agans, Jennifer P.; Burkhard, Brian M.; Tufts University

Sports are an important context for the acquisition of life skills and the development of positive relationships between youth and adult mentors. Sports coaches play an influential role in athletes' character development, such as promoting respect and honesty toward other athletes, coaches, and officials. Positive Coaching Alliance (PCA), a national nonprofit, is an intervention program training coaches to promote athletes' character attributes; however, less empirical evidence exists related to coaches' ability to enact the program. PCA teaches coaches the "double-goal" method (i.e., winning through character development) through attendance at a 1-hr in-person workshop, weekly talking points to use with athletes, and provision of supplemental materials (e.g., books) for more in-depth information. This study investigates coaches' perspectives on the value of, and challenges associated with, implementation of the PCA model. Preliminary thematic analysis of coaches' post-workshop responses ( $N = 7$ ) illustrated what aspects of the PCA workshop were valuable or could be improved. Coaches valued learning strategies that promote athletes' character, maintain a positive outlook in the face of adversity (e.g., dealing with losses), and create positive athletic environments. Identifying valuable lessons within PCA workshops was associated with greater incorporation of PCA ideals in daily interactions with athletes and use of additional supplementary materials. Coaches believed PCA workshops could be further improved in order to account for the multidimensionality of sports contexts. For example, coaches believed implementation of "talking points" would be less demanding had training sessions been shorter in duration, but more frequent, included greater interaction among coaches, and targeted specific issues unique to each team. The full presentation will discuss the implications and future directions associated with effectively implementing a program aimed at shaping character attributes that function across multiple contexts of adolescent athletes' lives. *John Templeton Foundation*

### The effect of mirrors on women's body image and affective responses to yoga

Frayeh, Amanda L., Lewis, Beth A., University of Minnesota, Twin Cities

Body image concerns are prevalent among young women. Yoga has been proposed as an effective strategy for promoting positive body image (Neumark-Sztainer, 2013); however, it is possible that social-environmental variables (e.g., mirrors) within a yoga class might undermine or enhance its acute psychological benefits. The present study examined the effect of mirrors on women's state body image concerns, affect, and self-efficacy in a yoga class. A secondary aim was to examine the effect of mirrors on mindfulness and social comparison. Ninety-seven college-aged females ( $M_{\text{age}} = 20.71$ ) were randomly assigned to complete a 60-min yoga class (mean class size = 8) in either a mirrored ( $n = 49$ ) or nonmirrored ( $n = 48$ ) setting. Surveys were completed before and after class. A repeated-measures MANOVA revealed significant increases in state body satisfaction, self-efficacy, and positive affect after yoga in both conditions. Participants in the nonmirrored condition reported greater decreases in state social physique anxiety (SPA) than participants in the mirrored condition ( $p = .008$ ). Furthermore, participants in the nonmirrored condition reported fewer appearance-related social comparisons than participants in the mirrored condition ( $p < .001$ ). Within the mirrored condition, social comparison was positively associated with self-reported frequency of mirror gazing ( $r = .44, p = .002$ ), SPA ( $r = .62, p < .001$ ), and self-objectification ( $r = .39, p = .006$ ), and negatively correlated ( $p < .05$ ) with state body satisfaction ( $r = -.31$ ) and mindfulness ( $r = -.31$ ). Social comparison was also related to SPA ( $r = .64, p < .001$ ) in the nonmirrored condition, but other relationships were nonsignificant. These results suggest that, for young women, a single yoga session enhances state body image, self-efficacy, and affect, regardless of whether there are mirrors. However, the positive effect of yoga on state social physique anxiety is attenuated in the presence of mirrors, perhaps due to the higher level of appearance-related social comparisons that occur in a mirrored class.



### **Asymmetrical analysis of sport spectator experiences for senior high school students in Taiwan**

Gau, Li-Shiue; Dung, Yun; Huang, Pi-Ju; Asia University, Taiwan

Experiential marketing theory and means-end chain theory were used to develop a scale measuring spectator sport experiences with eight dimensions, each including from 3 to 5 items. Data were collected from 290 full time students (155 males) of senior high schools at Yunlin County in central Taiwan. Each item was asked in both positive and negative ways. For the positive way, for example, if watching sports can be entertaining, this makes me feel: 5 = I like it very much; 4 = I like it; 3 = I somehow like it; 2 = *It must be that way*; 1 = *I am neutral*. For the negative way, for example, if watching sports cannot be entertaining, this makes me feel: 1 = *I dislike it very much*; 2 = *I dislike it*; 3 = *I somehow dislike it*; 4 = *I can live with it that way*; 5 = *I am neutral*. The reliabilities of the eight dimensions were between 0.839 and 0.905 for the positive way and between 0.832 and 0.907 for the negative way. Using the scores from the positive way in the horizontal axis and the scores from the negative way in the vertical axis, a two-dimensional space showed the eight spectator sport experiences. Self-esteem experiences (4.09, 3.60) were located in the first quadrant, indicating that self-esteem experiences tended to be an attractive factor. Respondents liked to have players or teams to support, but they could live with it that way if there were no players or teams for them to support. This indicates that spectator sports in Taiwan for senior high school students are not popular. Additionally, entertainment and exciting experiences (4.01, 2.84), and intrinsic learning experiences (3.96, 2.98) were located in the fourth quadrant, indicating that these two experiences tended to be must-be factors. Extrinsic learning experiences (3.56, 3.33) and nostalgia and self-expression experiences (3.55, 3.48) were located in the second quadrant, indicating that these two experiences tended to be indifferent factors. Sensory experiences, action experiences, and social experiences were located in the middle of the space, indicating that they tended to be one-dimensional factors.

### **From community sport capital to healthy sport lifestyle, satisfaction and life quality**

Gau, Li-Shiue; Pu, Mei-Hua; Dung, Yun; Asia University, Taiwan

This study developed a model for residents in communities to explain how their perceived community sport capitals influenced their sport lifestyle, the lifestyle satisfaction, and their quality of life. Based on the capital theory and the literature of community capital, the perceived community sport capital is a multi-dimensional construct with five dimensions (each including 3 items): natural environments (natural resources), facilities (built equipment and fields), organizations (formal and informal sport groups), social support (shared culture to encourage doing exercise), and environmental consciousness (to what extent that residents love green exercise). Five items were used to measure the sport lifestyle, three items measured lifestyle satisfaction, and six items were used to measure the quality of life. It is hypothesized that perceived high community sport capital will contribute to enhance positive sport lifestyle, high lifestyle satisfaction, and consequentially increase quality of life. Data ( $N = 398$ , 217 females) were collected from 10 communities within Taiping District, Taichung City. The reliabilities of the scales were between 0.898 and 0.924. The confirmatory factor analysis showed that the model fit was good (the ratio of chi-square to degree of freedom = 2.214, NFI = 0.921, RFI = 0.906, IFI = 0.955, TLI = 0.946, CFI = 0.955, RMSEA = 0.055). All the loadings were higher than 0.702. The correlation coefficients among community sport capital, sport lifestyle, lifestyle satisfaction, and quality of life were between 0.339 and 0.630. Analysis of structural equation modeling showed that sport lifestyle and lifestyle satisfaction fully mediated the relationship between perceived community sport capital and life quality. That is, perceived community sport capitals contribute to enhance residents' sport lifestyle (path coefficient = 0.529), sport lifestyle increases lifestyle satisfaction (path coefficient = 0.626), and then lifestyle satisfaction positively affect life quality (path coefficient = 0.645). The variance explained of life quality is 45.7%.

### **Preliminary validation of the sport imagery questionnaire-team sport version**

Geikie, Tyler L., Loughead, Todd M., Munroe-Chandler, Krista J., University of Windsor

Imagery is defined as a process of creating or recreating an experience in one's mind. To date, the majority of imagery studies have been examined from an individual-level perspective (e.g., "I imagine myself being mentally tough"). However, mental models (knowledge structures that allow individuals to understand the operation of a system and what is expected from said defined system) combined with the idea of groups as information processors, allows for the possibility to conceptualize imagery from a team-level perspective. Thus, the current study explores imagery from a team-level perspective through the validation of the Sport Imagery Questionnaire-Team Sport version (SIQ-TS). The SIQ-TS includes 30 items, which assesses the frequency of athletes' imagery use from a team-level perspective as opposed to an individual-level perspective as in the original version of the SIQ (Hall et al., 1998). The original instrument is composed of five subscales each measuring motivational or cognitive function of imagery. Factor analysis using a varimax rotation (orthogonal) was employed on the data from 162 undergraduate participants playing a variety of sports. Based on these analyses, a four-factor model (24 items) emerged that was determined to be the most appropriate. Cronbach alphas for each factor was acceptable. A large proportion of the variance was explained by team motivational functions of imagery. Further, the items assessing cognitive specific imagery did not play a role at the team level. Taken together, the four-factor model provides initial empirical support for the conceptualization of imagery from a team-level perspective. Imagery may prove to be a viable approach to form mental models to enhance team sport performance.

### Causal attributions mediate the influence of self-evaluations on body-related pride

Gilchrist, Jenna, Sabiston, Catherine M., University of Toronto; Mack, Diane E., Brock University; Pila, Eva, University of Toronto

In line with recent calls for research on contextual self-conscious emotions (Tangney & Tracy, 2012) and guided by the process model of self-conscious emotions (Tracy & Robins, 2004), this study examined whether self-reports of actual and ideal self were associated with body-related pride and if these relationships were mediated by the causal attributions of stability, globality, and controllability. Participants ( $N = 270$ ;  $n_{\text{women}} = 156$ ;  $M_{\text{age}} = 20.70$ ;  $SD_{\text{age}} = 2.09$  years) read a hypothetical scenario followed by measures assessing self-discrepancy, causal attributions, and authentic and hubristic pride. Using polynomial regression and path analysis, support for the relationships between self-discrepancy components, attributions, and pride was identified ( $\chi^2(1) = 1.84$ ,  $p = .18$ , RMSEA = 0.06, CFI = 1.00, NNFI = 0.95). Ideal self was positively associated with authentic pride both directly and indirectly through controllability accounting for 29% of the variance. Actual self was directly associated with hubristic pride. Globality positively, and stability negatively, mediated this relationship, and the combined model relationships accounted for 17% of the variance. The findings with authentic pride are consistent with previous theorizing (Tracy & Robins, 2004) such that this facet of pride results from attributions to events that are considered to be within one's control. The findings pertaining to hubristic pride provide mixed support for the process model of self-conscious emotions (Tracy & Robins, 2004), which may be a function of the scenario presented. Given the adaptive outcomes associated with authentic pride (Tracy & Robins, 2007), researchers may wish to target attributions for success that are under individuals control (i.e., effort) as this is one modifiable factor that can enhance feelings of body-related pride. Investigations into other theoretical and empirical approaches may complement existing knowledge on the antecedents of authentic and hubristic body-related pride.

### Self-control strength depletion reduces self-efficacy and impairs endurance exercise performance

Graham, Jeffrey D., Bray, Steven R., McMaster University

Self-regulation, or self-control, is linked to positive behavioral outcomes, including sport and exercise performance (Baumeister et al., 1994; Dorris et al., 2012). Evidence based on the strength model suggests exerting self-control consumes internal resources leaving people depleted and temporarily vulnerable to self-control failures (Baumeister, 2014). However, conflicting evidence has also emerged, calling into question potential biological and psychological mechanisms that could account for the effects of depleted self-control on behavior (Inzlicht et al., 2014). Self-efficacy is a well-supported determinant of behavior, including behaviors dependent upon self-regulation (Bandura, 1997). Yet, few attempts have been made to evaluate the role of self-efficacy in the self-control depletion–behavior relationship. We investigated the effects of self-control strength depletion on self-efficacy and performance of an endurance exercise task. University students ( $N = 37$ ) completed two endurance handgrip trials separated by a Stroop task, which was either incongruent (causing depletion) or congruent (no depletion/control). Task self-efficacy for performance on the second endurance trial was measured after the Stroop task. Participants in the depletion condition reported lower task self-efficacy than controls ( $p = .001$ ,  $d = 1.29$ ). Depleted participants also showed a greater reduction in performance from their first trial (change in time to failure) on the second endurance trial ( $p = .02$ ,  $d = 0.80$ ). Further analyses revealed that self-efficacy mediated the relationship between self-control depletion and handgrip performance (95% C.I. [3.88, 20.74],  $k^2 = 0.29$ ). This is the first study to investigate effects of self-control strength depletion on task self-efficacy. Although the incongruent Stroop task requires no physical (i.e., muscular) effort to perform, self-control depletion leads to internal perturbations (possibly fatigue) that undermine self-efficacy for physical task performance. Results and implications are discussed in light of theorized determinants and consequences of self-efficacy drawn from social cognitive theory.

### Effects of performance feedback on self-efficacy and exercise performance are moderated by self-control strength depletion

Graham, Jeffrey D., Bray, Steven R., McMaster University

Self-control is a key determinant of physical endurance. According to control theory (Carver & Scheier, 2011), performance feedback influences self-control such that when people underperform they increase effort, whereas those who over perform withdraw effort. This perspective clashes with social cognitive theory (Bandura, 1997), which proposes that positive performance increases self-efficacy and leads to better performance. The main purpose of this study was to investigate the effects of performance feedback on self-efficacy and performance of a muscular endurance task. A secondary objective was to investigate the effects of feedback under conditions of self-control strength depletion (Baumeister, 2014). A single blind, randomized, 2 (depletion/no depletion)  $\times$  3 (no/positive/negative feedback) design was used. Participants ( $N = 79$ ) performed two isometric endurance handgrip trials separated by a congruent (no depletion) or incongruent (depletion) Stroop task. After the Stroop task, participants received positive or negative normative feedback or no feedback (control) about their endurance performance. A 2  $\times$  3 ANOVA of the change in performance from trial 1 to trial 2 produced several significant effects. Of primary interest, there was a significant interaction between feedback and depletion ( $p < .001$ ). In the no depletion conditions, positive feedback led to lower self-efficacy and negative performance change whereas negative feedback led to increased self-efficacy and performance. However, in the depletion conditions, the reverse was seen with regards to self-efficacy and change in performance. Results support the effects of positive vs. negative performance feedback on effort allocation and performance drawn from control theory. Results also support social cognitive theory, as self-efficacy acted as a motivator and positively influenced subsequent behavior. The unique contribution of these findings relate to how positive vs. negative performance feedback influences self-efficacy and physical endurance performance differently when in a depleted state vs. not.

**Moderating effects of feedback sign and self-control strength depletion on resistance exercise performance**

Graham, Jeffrey D., Bray, Steven R., McMaster University

Research based on the strength model (Baumeister, 2014) shows self-control depletion leads to decreases in physical endurance (e.g., Bray et al., 2008). Recent evidence suggests that positive and negative performance feedback have differential effects on subsequent physical endurance performance depending on prior self-control exertion (Graham & Bray, 2015). We investigated the effects of self-control depletion and performance feedback on physical performance using resistance exercise. A single blind randomized 2 (depletion/no depletion)  $\times$  2 (positive/negative feedback) design was used. University students ( $N = 21$ ) performed one set of maximum repetitions on each of bench press (at 60% of 1 RM) and leg extension (at 40% of 1 RM) followed by either an incongruent (causing self-control depletion) or congruent (no depletion) Stroop task. Following the Stroop task, participants received bogus normative feedback (positive or negative) regarding their performance on the first sets of exercise. After receiving feedback, participants performed a second set of maximum repetitions on each exercise. Results of a 2  $\times$  2 ANOVA for the total number of reps performed showed a main effect for self-control depletion ( $p < .01$ ), with the self-control depletion groups performing fewer repetitions than controls ( $d = 1.30$ ). There was also an interaction ( $p = .01$ ) showing that in the no-depletion condition reps increased following negative feedback whereas reps decreased slightly following positive feedback. However, in the depletion conditions, reps decreased to a greater extent following negative feedback when compared to positive feedback. Although data collection is still underway, these preliminary results suggest feedback is interpreted differently by people when they are depleted vs. not. Negative feedback seems to be motivating for people when not depleted, but demotivating when depleted. Conversely, positive feedback is motivating when depleted, but demotivating when not. Findings have theoretical and practical implications for how and when feedback is presented to athletes. This research was supported by NASPSPA. *NASPSPA Graduate Student Research Grant*

**Relax and refocus: Is biofeedback the key?**

Gregg, Melanie, Petersen, Brennan, University of Winnipeg; Nelson, Kendra, University of Manitoba

Biofeedback is learning to control one's body responses by monitoring muscle tension, heart rate, perspiration, etc. Through biofeedback training athletes learn to develop strategies (e.g., deep centered breathing) to gain voluntary control over these bodily outputs that are not typically consciously controlled. Self-regulation acquired through biofeedback training may transfer to sport and into other areas of life. Often the objective when working with athletes is to improve function from typical to better to best. 15 university-level athletes were recruited to participate in the study; 9 were randomly assigned to the biofeedback training condition, 6 were assigned to the control condition (one participant withdrew). All participants completed 10 training sessions. Sessions 1 and 10 were full stress tests including measures of skin conductance, respiratory rate, heart rate, and the brain's electrical activity; when elevated all of these indicate increased arousal. Thermal levels were also measured and a decrease in temperature indicates elevated levels of stress. Session 6 included a short version of this assessment. All other sessions for the biofeedback group participants included respiratory training to learn to control breathing rates when faced with stressful situations in sport. The control participants completed the same number of sessions but watched motivational videos. Participants also completed a pre- and posttest measure of their ability to cope with adversity, level of confidence, and freedom from worry. To test whether increased self-regulation resulting from biofeedback training transferred to sport and life outside of sport, coaches also rated athletes on these psychological variables. Someone from outside of sport (e.g., employer) rated the athletes' abilities in these areas too. Skin conductance,  $F(1.67, 20.01) = 5.38, p = .02$ ; respiratory rate,  $F(1.04, 12.43) = 41.96, p < .001$ ; and brain electrical activity,  $F(1, 12) = 19.88, p < .001$ , all significantly improved from pre- to posttest. No differences were found for temperature or heart rate. *Manitoba Health Research Council*

**Can athlete's perceptions of coaching staff cohesion predict collective efficacy?**

Guerin, Emily A., Tomayer, Jennifer A., Loughhead, Todd M., Munroe-Chandler, Krista J.; University of Windsor

Coaching staff cohesion is "the degree of teamwork among head and assistant coaches that is derived from personal and professional factors and assists in developing a pleasing work environment and fulfillment of the individual" (Martin, 2002, p. 26). Given coaching staff cohesion has been found to be related positively to team cohesion (Zakrajsek et al., 2007), it is possible that it may impact on a number of different variables (e.g., collective efficacy; Martin, 2002). Thus, the purpose of the present study was to determine if athletes' perceptions of coaching staff cohesion predicted collective efficacy on a varsity track and field team. Participants ( $N = 57$ ) completed a modified version of the Coaching Staff Cohesion Scale (CSCS; Martin, 2002) and the Collective Efficacy Questionnaire for Sports (CEQS; Short et al., 2005). Results from multiple regression analyses demonstrated significant positive relationships between the dimensions of coaching staff cohesion and the dimensions of collective efficacy. Specifically, the dimensions from the CEQS (i.e., ability, effort, preparation, persistence, and unity) positively related to both dimensions of the CSCS (i.e., shared values and staff unity). The results suggest that coaching staff cohesion could be one source to enhance collective efficacy for a varsity track and field team. Research in this area is important as a more cohesive coaching staff may provide a more positive environment for the development of collective efficacy, which may positively impact a team's performance.

### Associations between screen time, physical activity, and depression in adolescents: A four-year longitudinal REAL study

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Depression is a prevalent psychiatric disorder among adolescents. Available evidence suggests that physical activity (PA) is inversely related to depression while screen time (ST) is positively related; however, mixed results have been noted and research has primarily relied on cross-sectional data. We examined how changes in ST, PA, and depression are associated with each other over 4 years. Participants ( $N_{\text{baseline}} = 640$ ) were 10 to 16 years old at baseline ( $M_{\text{age}} = 13.25$ ,  $SD = 1.08$ , 59.7% females) and were part of the Research on Eating and Adolescent Lifestyles (REAL) study. Among a battery of measures, participants were asked to complete assessments of ST, PA, and depression at 4 points over 4 years (approximately 1 year apart at each occasion). Latent growth modeling with varying time scores was used to analyze the data. Depression increased over time (linear;  $p = .10$ ). ST increased (linear;  $p < .05$ ) and that increase slowed over time (quadratic;  $p = .05$ ). PA decreased over time (linear;  $p < .05$ ). A second model controlling for sex, body mass index, parents' education, and geographic region indicated that greater baseline ST was associated with higher baseline depression, and a slower increase in rate of change of depression. Higher baseline depression was associated with less baseline PA and a slower increase in ST and depression and a greater slowing down of the increase in ST. Increases in ST were associated with increases in depression whereas the slowing down increase in ST was associated with less depression over time. Increases in PA were marginally associated with reductions in depression ( $p = .07$ ). Overall, the results suggest that increases in ST and decreases in PA (albeit marginally significant) are associated with increases in depressive symptoms in adolescents. Thus, interventions targeting reductions in ST and increases in PA should be evaluated to determine if they are helpful in the prevention or treatment of depression in this high-risk population.

### The role of risk perception in relation to message framing strategies to promote the behavior of action planning for physical activity

Gunter, Rebecca; Hall, Sarah D.; York University; Sweet, Shane; Duncan, Lindsay; McGill University

This research examines the role of risk perception in relation to message framing strategies to promote the behavior of action planning for physical activity (PA). Risk, in this instance, refers to the idea that performing a certain behavior may lead to uncertain outcomes. As such, action planning for PA (i.e., planning where, when, how) could be perceived as a "risky" behavior as failing to carry out a plan may result in feelings of disappointment, guilt, shame, and lack of self-confidence, among others. We therefore hypothesized that loss-framed messages (outlining the risks of failing to action plan) would be more persuasive for individuals with high risk perceptions regarding action planning whereas gain-framed messages (outlining the benefits of action planning) would be more persuasive for individuals with low risk perceptions. Participants ( $N = 146$ ) were assigned randomly to one of two message framing conditions (gain, loss). Based on a tertiary split, participants ( $n = 80$ ) were then compared on high-risk perceptions vs. low-risk perceptions of action planning behavior. Intention to action plan was measured before and after message exposure; changes in intentions to action plan were compared across conditions. A 2 (time)  $\times$  2 (risk perceptions)  $\times$  2 (message frame) repeated-measures ANOVA was calculated for intentions to action plan. A significant increase in intention over time, ( $F(1, 296) = 4.67$ ,  $p = .031$ ,  $\eta^2_p = .016$ ), was superseded by a significant time  $\times$  risk interaction, ( $F(1, 296) = 4.03$ ,  $p = .046$ ,  $\eta^2_p = .013$ ). Post hoc analyses found a greater increase in intentions to action plan for individuals with high-risk perceptions compared to those with low-risk perceptions following message exposure. This research may inform intervention strategies to promote action planning for physical activity in inactive populations. Preliminary results from the pilot data presented above indicate that using persuasive messages to target individuals with high-risk perceptions of action planning behavior may yield more success in altering intentions to plan for PA.

### Working harder: The relationship between psychological climate and effort in exercise

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Psychological climate is a multidimensional construct that covers aspects of psychological safety and meaningfulness of an environment (Brown & Leigh, 1996). Brown and Leigh (1996) suggested that aspects of psychological climate include leader behaviors towards members (supportive management), clarification of roles, self-expression, meaningful contribution, recognition, and challenge of the tasks required. Recently, psychological climate has been related to effort exerted by elite hockey players (Spink et al., 2013). While psychological climate has been examined in work and sport settings, it has not been examined in the exercise setting. Therefore, the purpose of this study was to examine the effects of psychological climate on effort in university students enrolled in group exercise classes for credit. Twenty male and fifty-nine female university students ( $N = 79$ ;  $M_{\text{age}} = 21.5$  years), who were enrolled in activity courses participated in this study. These credit courses were instructor-led group exercise classes that ran twice a week for the duration of the semester (16 weeks). At the end of the semester, students completed a measure of psychological climate (21 items; Spink et al., 2010) and effort (6 items; Bruner et al., 2011). Both measures were adapted for exercise classes. A multiple regression with five psychological climate subscales (supportive management, role clarity, contribution, self-expression, and challenge; Spink et al., 2010) predicting effort was performed. The overall regression model was significant ( $F(5,73) = 5.16$ ,  $p < 0.001$ ). The psychological climate variables explained 26.1% of the variance in effort with role clarity ( $b = 0.29$ ,  $p = 0.04$ ) and self-expression ( $b = 0.25$ ,  $p = 0.003$ ) being the two significant predictors of effort in group exercise classes. This study extends previous research on psychological climate to the exercise setting by demonstrating that one's perceptions of the psychological environment affects how hard one works in that setting. Future research should continue to examine psychological climate in the exercise setting.

### **Intrateam competition among ice hockey referees**

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Optimal sport performance can be facilitated by physical prowess (e.g., speed/strength; Malina, Bouchard, & Bar-Or, 2004) and expert perception (e.g., anticipation/decision making; Starkes & Ericsson, 2003). In team sport, performance is also influenced by group dynamics, or how efficiently a team functions (Carron & Eys, 2012). One process that can negatively influence proper functioning is intra-team competition. Although less apparent than inter-team competition, intra-team competition (Carron, 1980; Harenberg & Reimer, 2014) can manifest itself in various ways (e.g., contests for roster positions, playing time, advancement). This type of competition extends to sport officials, who often work as teams to adjudicate contests, but also compete against each other for prestigious game assignments. As officials are a necessity in sport, and influence contests in many ways (e.g., safety, fairness), a better understanding of the group-related processes involved is warranted. This paper is part of a larger study on group dynamics among sport officials, although the purpose herein is to specifically illuminate the concept of intra-team competition. Participants were 17 male ice hockey officials ( $M_{\text{age}} = 30.1$ ,  $SD = 5.7$ ) with 12.9 years ( $SD = 6.6$ ) of experience, who currently perform in the four-official system (i.e., two referees and two linesmen). Following Patton's (2002) guidelines, respondents engaged in semistructured interviews, which were coded using Charmaz's (2006) initial, focused, and theoretical coding scheme. Results indicated that despite the acknowledged salience of intra-team competition for advancement, officials were united in maximizing the team's—rather than the individual's—performance. Interestingly, while referees frequently cited feeling supported, the level of support varied. In the discussion, we contextualize the results, offer recommendations for optimizing performance while negotiating the intricacies of intra-team competition, and suggest methods to reduce competition (e.g., having a transparent selection process).

### **The impact of physical activity and social engagement on cognition in Alzheimer's disease**

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Alzheimer's disease is the most common form of dementia, characterized by progressive neural decline that results in severe impairment to memory and other cognitive abilities. Currently one in nine Americans over the age of 65 years suffers from Alzheimer's disease, and this incidence is projected to rapidly increase as the population ages (Thies et al., 2013). With no imminent cure, there is urgent need for interventions that reduce the burden of dementia. Two key modifiable risk factors for dementia are physical inactivity and social isolation (Barnes & Yaffe, 2011). Thus, an intervention that combines physical activity with social engagement may be an optimal way to mitigate cognitive decline associated with Alzheimer's disease. The purpose of this pilot study was to determine the longitudinal impact of an exercise–social community program on the cognitive abilities of 15 individuals with Alzheimer's disease (Mini Mental State Exam =  $22 \pm 4.1$ ), using their care partners as a comparison group. Specific aspects of cognition were measured in both the individual with Alzheimer's disease and their care partner at baseline and 3 months later using validated tests of memory (10-item face recognition), processing speed (simple reaction time), and executive functions (go no-go). At baseline, individuals with Alzheimer's disease had poorer memory ( $p < .01$ ;  $d = 1.3$ ) and slower processing speed ( $p < .05$ ;  $d = 1.0$ ) but performed equally well on the executive functions test compared to their care partners. Three months later, preliminary data from six individuals with Alzheimer's disease revealed marginal improvements in memory performance ( $p = .10$ ;  $d = .7$ ) and no change in processing speed or executive functions for either group. These preliminary results showing a marginal improvement in memory and a lack of decline in processing speed and executive abilities over 3 months suggests that exercise–social programs warrant further study as a potential avenue to slow the decline of cognitive symptoms in Alzheimer's disease.

### **The future of refereeing: Technology rather than referee instruction and training or vice versa?**

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The cost to set up and run goal-line technology in a football stadium for one season is 382,500€. Regardless of this huge financial investment, it is used in very few incidents. In cricket, it costs 100,000 USD per match to use video review to improve the umpiring accuracy by just 1% (Borooh, 2013). On the other hand, in our lab we consistently showed that on- and off-field referee training resulted in 15–20% improvement in performance. Interestingly, web-based training (Put et al., 2013) resulted in a 23.3% transfer to on-field offside situations. It remains a challenging question to what extent the future of refereeing can best be certified by investments either in technology or referee instruction and training. Therefore, the objective of the present study was to examine to what extent the implementation of additional assistant referees (AAR) in European football impacts overall performance and game management of the refereeing team. To determine the influence of the AAR on refereeing performances, we examined post-match feedback reports issued by match officials after UEFA matches during a 3-year trial period. In addition, we conducted an offside decision-making accuracy analysis of major tournaments over the last 12 years. Feedback reports reveal that despite their limited number of direct interventions in the management of the game, the AAR are typically involved in key incidents that may impact on the course and the final outcome of the match. The results of the offside decision-making accuracy analysis show that, since the introduction of the AAR by UEFA, the overall accuracy of offside decisions has increased considerably from 82.5% during the 2007/08 English Premier League season to 95.9% and 95.5% in the 2012 European Championship and 2013/14 UEFA Champions Leagues ( $p < .001$ ). In summary, the implementation of AAR has enhanced match management and also improved the accuracy of offside decision making. Improvements in refereeing performances can be obtained, at a lower cost, by investing in referee instruction and training rather than in technology.

### **Influence of stress on decision making in sport**

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This study examined the take the first (TTF) heuristic and decision making in basketball under stress. Participants ( $N = 55$ ) performed a basketball video decision-making task under 3 conditions of stress: no stress (counting backwards by 1), mental stress (mental serial subtraction), and physical stress (running on a treadmill at moderate intensity). The study involved 24 total trials, with 8 trials performed under each stress condition. For each trial, participants were exposed to 30 s of stress and then watched a video depicting an offensive situation in basketball where they had to decide what the player with the ball should do next. At the end of each clip, participants were asked to state the first option that came to mind, generate any other appropriate options, and then decide upon the best option in that situation. Decision quality was based on the ratings of 3 basketball coaches (0 = *not at all acceptable*, 4 = *best possible*). Response time for the first option and final decision were also recorded. Heart rate variability and self-report measures indicated that the mental and physical stress manipulations created more stress than the no stress condition. Results indicated that participants used TTF extensively to make their decisions. Across all 24 trials, participants used TTF 18.93 times (78.9%), but there were no differences in TTF frequency among the no stress ( $M = 6.38$ ), mental stress ( $M = 6.25$ ) and physical stress ( $M = 6.29$ ) conditions. Additionally, there were no differences among the stress conditions on final decision quality or number of options generated. However, response time was affected by the various stress conditions. Specifically, first options were generated slower following mental stress as compared to the control or physical stress conditions. Likewise, participants made significantly faster decisions when under physical stress than they did during the no stress condition. Results of this study suggest that stress, both mental and physical, may influence decision making in sport.

### **Cognitive measures correlate with mental rotation of human figures**

Heppel, Holger, University of Münster; Kohler, Axel, University of Osnabrück; Zentgraf, Karen, University of Münster

**Introduction:** The paradigm of mental rotation describes the cognitive process to turn an object in the imagination (Shepard & Metzler, 1971). When solving these kind of tasks, there are three cognitive stages: (1) encoding, (2) mental rotation into the zero degree position, (3) motor response (Cooper & Shepard, 1973). There are findings that working memory (Hyun & Luck, 2007), information processing and attention (Pannebakker, Jolicœur, et al., 2011) mediate mental rotation performance. This study correlates cognitive measures (working memory, information processing, and attention) and mental rotation performance measures. **Methods:** Different kind of stimuli were used. When presenting human figures, participants had to decide upon the laterality of the stimulus. The letter “R” should be assessed whether it was mirrored or not. Two simultaneously presented cube figures were compared with regard to their equality. A linear stepwise regression analysis with the target variables “rotation speed” and “response times” and cognitive measures as predictors has been done. **Results:** In the letter and the cube stimuli, there are no systematic relationships between predictors and the target variable. In the human stimulus, the predictor working memory shows the largest predictive validity at 0° and 45°. From 90° to 180°, the predictive validity of processing speed is steadily increasing (information processing explains 27.9 % of variance at 180° and 32.2 % of variance at rotation speed). Attention provides no contribution to the explained variance at any stimulus type. **Discussion:** The results indicate that working memory only plays a role in the processing of human figures in familiar orientations. The more rotated a stimuli is presented, the bigger is the proportion of mental rotation. The selectivity of the results could be due to an optimum level of difficulty of the stimulus type human figure, on the nature of the task (laterality decision), and/or on a special processing of human bodies. In order to elucidate these issues, these factors will be varied in future studies.

### **Handball throwing improved by dissociation of attention from gaze behavior during quiet eye training**

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Quiet eye (QE) is an effective gaze behavior in targeting sports. The QE period is defined as the interval between final fixation and actual movement onset. It has been reported that a longer QE period results in better performance. QE training for handball players may improve performance of the penalty throw. On the other hand, it would be disadvantageous for shooters if they continue gazing at the specific spot in the goal where they intend to throw a ball, because the goalkeeper could then predict the course of the ball. This real sports situation raises the question of whether paying attention to the fixated point is essential for the QE training, as well as whether dissociation of attention from gaze can improve performance. We investigated the dissociation effect of gaze and attention in skilled handball players. The attentional function of QE is controlled by an exquisite balance between top-down and bottom-up systems. A longer QE duration may enable performers to maintain top-down attention toward a specific location without gazing, and thus to fully program the shooting movement. We hypothesized that paying attention is essential if a player is to realize the beneficial effect of QE training. Participants performed a penalty-throw task during pretest, training sessions, and posttest. We compared three different training groups. The gaze group (GG) was instructed to practice both QE and pre-performance routines according to previous QE studies. The no-gaze group (NoGG) was instructed to direct attention toward the target but not to gaze at it. The control group was instructed to conduct only pre-performance routines. The posttest revealed a significantly longer QE duration for GG than for the other groups. However, during both the training session (Day 3) and posttest, NoGG showed a better performance as compared with GG. These results suggest that paying attention without gaze that is a common strategy and it must be fully learned to optimize the QE effect.

**Effects of aerobic exercise intervention on cognitive functions among individuals with low physical fitness status**

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Cumulative evidence has demonstrated that engaging in aerobic exercise frequently or attaining higher cardiovascular fitness is associated with better cognitive functions. These exercise or cardiovascular fitness-related beneficial effects on cognition have been observed in a variety of populations, including children, younger adults, and older adults; however, whether the beneficial effects associated with exercise or cardiovascular fitness could extend to individuals with weak physical fitness status remains unknown. Additionally, the majority of studies to date have merely applied cross-sectional comparisons, in which the causal effects of exercise on cognitive functions are insubstantially established. The purpose of the present study using a three-month intervention was to examine the effects of aerobic exercise on cognitive functions in individuals with low physical fitness status. Twenty-four participants with weak physical fitness status, defined as cardiovascular fitness that is less than 30% of the national norm, were recruited and assigned into either an aerobic exercise ( $n = 12$ ) or a control group ( $n = 12$ ). Participants in the exercise group were required to conduct aerobic exercise for 60 min per session, twice per week, for three months, whereas those in the control group received only an educational course. Cardiovascular fitness and the Stroop Test were administered prior to and following the three-month intervention as primary outcome measures. Results revealed that an interaction of time and group were only observed in relation to the motor fitness index, with the exercise group demonstrating better status, whereas the control group's status did not change. Regarding the Stroop Test, however, an interaction of time for these groups was observed in the Stroop-congruent, the Stroop-natural, and the Stroop-incongruent conditions, with the exercise group exhibiting a shorter reaction time. These findings suggest that a short-term aerobic exercise intervention benefits specific types of fitness indices and improves cognitive functions reflected by the Stroop Test, and that the positive effects on cognition exist regardless of the nature of the cognitive functions. Additionally, our findings imply that the beneficial effects attributed to exercise and cardiovascular fitness on cognitive functions can be extended to populations with low physical fitness status.

**A preliminary investigation of the moderating effects of aerobic fitness on the relationship between acute exercise and interference control in children with ADHD**

Hsieh, Shu-Shih, Tsai, Yu-Jung, National Taiwan Normal University; Chang, Yu-Kai, National Taiwan Sport University; Huang, Chung-Ju, University of Taipei; Hung, Tsung-Min, National Taiwan Normal University

Purpose: To test whether difference in aerobic fitness moderates interference control responses to acute aerobic exercise (AE) in ADHD children. Methods: 27 children diagnosed with ADHD ( $M_{age} = 10.22 \pm 0.97$  years) were recruited and assigned into two groups, the moderate-fit group (MF;  $n = 11$ ,  $M_{age} = 10.36 \pm 0.81$  years; fitness levels = 50% in Taiwanese children), the lower-fit group (LF;  $n = 16$ ,  $M_{age} = 10.13 \pm 1.09$  years; fitness levels < 50% in Taiwanese children), according to their performance in the 800-m run test, a standard test for aerobic fitness of children in Taiwan, and the stratification model provided by the Ministry of Education in Taiwan. An Eriksen Flanker task with two test conditions, congruent and incongruent, was utilized as a cognitive test, where the reaction time interference (RT interference; RT incongruent – RT congruent) and accuracy interference (accuracy congruent – accuracy incongruent) were measured as performance indexes. Participants performed a bout of moderate AE (approximately 72.7% of age-predicted  $HR_{max}$ ) on a treadmill. A Flanker task was administered before and after exercise. For statistical analyses, 2 (group: MF, LF)  $\times$  2 (time: pretest, posttest) ANOVAs were separately applied on RT interference and accuracy interference. Alpha of .05 was used as the level of statistical significance. Results: For RT interference, the overall RT interference in the pretest was significantly larger than in the posttest (pre:  $95.67 \pm 10.81$  ms; post:  $77.07 \pm 9.82$  ms;  $p < .05$ ) regardless of fitness group. Similar results were observed in accuracy interference, where the overall accuracy interference was larger in pretest as compared with posttest (pre:  $9.0 \pm 2.0$  %; post:  $5.2 \pm 1.0$  %;  $p < .05$ ) regardless of fitness group. Conclusion: Acute moderate AE improves interference control in ADHD children with different fitness levels regardless of the fitness level. However, this conclusion should be treated cautiously due to the lack of a control group.

**The predictive utility of coach and peer leadership behaviors on team satisfaction among high school and college student-athletes**

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The purpose of current study was two-fold. First, to examine the differences of coach leadership and peer leadership behaviors between high school and college student-athletes; second, to examine the predictive utility of coach leadership and peer leadership behavior on team satisfaction. The participants were 101 senior high school student-athletes and 115 college student-athletes from 10 sport teams with different sports. After received the informed consent, the participants were asked to complete questionnaire assessing coach leadership behavior, peer leadership behavior, and team satisfaction. The results of the ANOVA revealed significant differences between high school and college student-athletes on coach leadership behavior. Specifically, except for autocratic behavior, high school student-athletes perceived greater coaches' behavior than college student-athletes. In addition, college student-athletes perceived greater peer leadership than high school student-athletes. The results of hierarchical regression analyses indicated that both coach leadership and peer leadership significantly predicted team satisfaction. The total explain variances were account for 12.6 % and 9.6% respectively. Both coaches' and peers' social support behaviors were the better predictors in terms of predicting team satisfaction.

### Associations among athlete burnout and markers of athletic injury

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Theory (e.g., Smith, 1986) and practice suggest that athletic injury is an important correlate of athlete burnout due to potential links among the cognitive-affective and behavioral responses germane to each sport-related psychosocial experience (Cresswell & Eklund, 2005, 2006; Grylls & Spittle, 2008). Yet, extant athlete burnout research is limited by the adoption of relatively limited injury markers. Utilizing an in-depth examination of current and past injury history, the purpose of this study was to examine the association between athlete burnout and athletic injury in a sample of Division I, varsity sport student-athletes. Participants ( $N=90$ ) completed an Internet-based survey assessing demographics and self-reported perceptions of athlete burnout and athletic injury history. The number of athletic injuries was not found to be significantly associated with global burnout ( $r = 0.17, p = 0.12$ ), or its characterizing dimensions of emotional and physical exhaustion ( $r = 0.15, p = 0.15$ ), reduced accomplishment ( $r = 0.18, p = 0.10$ ) or sport devaluation ( $r = 0.08, p = 0.44$ ). Global burnout scores,  $t(88) = 2.07, p = 0.04$ , and reduced accomplishment,  $t(88) = 2.12, p = 0.04$ , were higher in participants that experienced multiple injuries to any given body segment ( $n = 37$ ) compared to those that did not experience multiple injuries to any given body segment ( $n = 53$ ). Emotional and physical exhaustion scores were higher in currently injured participants ( $n = 41$ ) compared to currently uninjured participants ( $n = 49$ ),  $t(88) = 2.596, p = 0.01$ . Global burnout scores for participants that sustained at least one collegiate athletic injury trended higher when compared to participants that did not sustain any collegiate injuries,  $t(88) = 2.05, p = 0.05$ . This study informs the knowledge based on the mental and physical health of collegiate student-athletes. It also supports the continued need for carefully designed research on the athlete burnout–athletic injury relationship as a means to inform best athlete care practices for both sport psychology and sports medicine clinicians.

### Effects of acute aerobic exercise duration on executive function in children with ADHD

Hung, Tsung-Min, Tsai, Yu-Jung, National Taiwan Normal University; Huang, Chung Ju, University of Taipei

Single bouts of moderate-intensity aerobic exercise have been linked to enhanced cognitive performance in ADHD children. However, this positive effect may be moderated by exercise duration. As such, the purpose of this study was to investigate the effects of exercise duration on executive function in ADHD children. A between-subject design was employed; 33 children with ADHD ranging from 8 to 12 years old were assigned to film-viewing ( $n = 11$ ), 20-min ( $n = 11$ ), and 40-min ( $n = 11$ ) aerobic exercise groups. A modified Eriksen flanker task and neuroelectric assessment were administered before and after completion of the intervention. Results showed that the 20-min group had larger N2 amplitude compared to the control group, though no difference in behavioral performance was found among these groups. These findings suggested that 20 min of a single bout of aerobic exercise may benefit inhibitory control in children with ADHD.

### Efficacy of a brief social cognitive behavioral counseling intervention on one-month independent exercise adherence in individuals with prediabetes: Small steps for big changes

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Exercise can prevent the progression of prediabetes to type 2 diabetes. Sadly, adherence to exercise is dismal in individuals with prediabetes. Small Steps for Big Changes is a social cognitive theory (SCT)-based counseling intervention designed to teach prediabetic individuals the necessary skills to independently exercise. Thirty-two inactive individuals with prediabetes ( $M_{\text{age}} = 51 \pm 10$ ) participated in 10 exercise sessions (7 supervised, 3 at-home) performed over 12 days (training phase). Participants received 10 min of behavioral counseling on each supervised lab visit, for a total of 70 min. Topics covered by counselors included overcoming barriers, bolstering self-regulatory efficacy, planning, self-monitoring, and increasing awareness and value of exercise benefits. Following the training phase, participants were instructed to exercise 3 days per week independently. Task self-efficacy, self-regulatory efficacy, concurrent self-regulatory efficacy (confidence to manage exercise with other valued life goals), outcome expectations and outcome value were measured before training and immediately after the training phase. Exercise adherence was assessed using self-report training logs examining the total number of exercise bouts performed and percentage of prescribed exercise bouts completed over 1 month posttraining. All SCT constructs increased following the intervention ( $ps < .03, ds < .50$ ), except outcome value ( $p = .20, d = .25$ ). After controlling for age and sex, hierarchical regression analyses revealed that SCT constructs accounted for significant variance in the total number of exercise bouts performed over 1 month ( $p = .003$ ) and the total number of prescribed exercise bouts completed ( $p = .01$ ). In both models, only concurrent self-regulatory efficacy explained significant variance ( $\beta_s > 1.17, ps < .05$ ). This study demonstrates that a brief, SCT-based intervention can bolster personal efficacy beliefs and highlights the importance of teaching individuals how to manage their exercise behavior alongside other valued life goals (i.e., work and family).



**Influence of health coaching on autonomy and wellness outcomes**

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Health coaching (HC) holds potential as a complementary medical intervention to shape healthy behavior change; however, empirical knowledge of effectiveness of health coaching is lacking. This study examined the effects of various doses of HC as a supplement to a multifaceted employee wellness program (including an educational component, access to fitness facilities and programming, health trackers, health appraisal, and small incentives). Three months of weekly HC (range = 0–13 sessions;  $M = 7.27$ ;  $SD = 3.69$ ) randomized across a 12-month period were offered to 296 college employees ( $M_{age} = 45.49$ ;  $SD = 11.13$ ) enrolled in an institutional wellness program. Perceptions of autonomy were assessed at the end of this 3-month period. Baseline, 3-month, and 6-month measures of life satisfaction, perceived competence for exercise, mindfulness, BMI and blood pressure were also assessed. Latent growth curve modeling was employed to examine average levels and change in each outcome for the collapsed sample and to explore mediating role autonomy. Analysis revealed that participants who engaged in more coaching sessions over the 3 months reported significantly higher levels of autonomy ( $B = .14$ ,  $p < .05$ ). Coaching sessions also significantly predicted a positive linear increase in mindfulness ( $B = .19$ ,  $p < .05$ ). Autonomy, in turn, significantly predicted linear increases in life satisfaction ( $B = .35$ ,  $p < .01$ ), perceived competence ( $B = .19$ ,  $p < .05$ ) and mindfulness ( $B = .22$ ,  $p < .01$ ). A positive trajectory in mindfulness was related to linear reductions in systolic blood pressure ( $B = -.20$ ,  $p < .05$ ); a positive trajectory in perceived competence was related to linear reductions to reductions in BMI ( $B = -.22$ ,  $p < .05$ ). These findings highlight (1) the need for strategies for increasing and maintaining autonomy and (2) that adding HC to wellness programming provides such a strategy.

**Examining the leadership development of youth staff members at a residential summer camp**

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Every summer, millions of youth across North America attend summer camps. An important feature of many camps is the leadership development programs they offer (e.g., counselor-in-training), which provide age-appropriate opportunities for youth to develop leadership skills (Garst, Browne, & Bialeschki, 2011). Although camps are designed to enhance the personal development of the youth campers, learning opportunities also exist for staff members. This is especially important given that most staff members are youth themselves who are still maturing into responsible citizens. To date, little research has explored how working as a staff member at camp influences their leadership development. The purpose of this study was to examine staff members' perspectives on leadership development during their time at a residential summer camp. Interviews were conducted with staff ( $n = 13$ ) at the end of a 10-day camp session. An inductive thematic analysis (Braun & Clarke, 2006) led to the identification of four main themes, representing a sequential progression experienced by the participants: (a) formal leadership training, (b) leadership development, (c) challenges associated with being a leader, and (d) leadership transfer. First, prior to working at camp, the participants discussed how they received formal leadership training in which they learned how to provide emotional support for campers. Second, the participants discussed how being a staff member at camp put them in situations where they continuously had to exhibit leadership. Third, although the participants believed they developed leadership skills at camp, they also experienced challenges such as managing campers' behavioral issues. Fourth, the participants mentioned how they believed the leadership skills they developed at camp were internalized and that they had the confidence necessary to transfer these skills by modelling appropriate behaviors in their community. Overall, the findings from this study have important practical implications to enhance the development of leadership in youth staff members at camps.

**The effects of integrated classroom-based physical activity on on-task behavior for aboriginal children in kindergarten and grade one**

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In Canada, there is a wide academic achievement gap between Aboriginal and non-Aboriginal children. The rate of high school non-completion for on-reserve Aboriginal Peoples is approximately 61% (Statistics Canada, 2006). The need to close this achievement gap is great given the growth of the Aboriginal population. This group has increased by 20% over the past five years, compared to 5% for non-Aboriginal Canadians (Statistics Canada, 2012). A variety of approaches will be necessary to address this complex problem. Increasing physical activity is one method that is worth investigating; it is relatively simple to implement in comparison to other strategies. Research over the past decade has consistently shown that physical activity improves the learning ability and academic performance of children (Erwin et al., 2012). Purpose: This study examined the effects of integrated classroom-based physical activity (ICBPA) that incorporated curricular content on the on-task behavior of kindergarten and grade one participants at an on-reserve school. Methods: This study utilized participatory action research methodology, which engaged teachers and community leaders in its design. Time on-task was assessed for nine participants through observation before and after ICBPA and before and after an inactive classroom lesson (baseline). A two way [time (pre lesson vs. post lesson)  $\times$  period (baseline vs. intervention)] repeated measures ANOVA was conducted. Results: The ICBPA interventions were effective at improving the on-task behavior of the participants. On-task behavior scores decreased from pre- to postlesson in the baseline period, while on-task behavior scores increased from pre- to postlesson in the intervention period. The two-way repeated-measures ANOVA revealed a significant time  $\times$  period interaction [ $F(1, 8) = 36.77$ ,  $p < .001$ ,  $\eta^2_p = 0.821$ ]. Conclusion: This research illustrates that incorporating physically active lessons that reinforce curricular content into the classroom may be an effective way to improve the on-task behaviors of young Aboriginal children. *Canadian Institutes of Health Research*

### The role of self-compassion in women athletes' performance evaluations: A pilot study

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Many difficult and painful sport experiences for young women athletes are partially due to their harsh self-criticism and negative performance evaluations (Kowalski & Duckham, 2014; Powers et al., 2004). One potential resource for young women athletes to manage such sport experiences is self-compassion, which is a healthy self-attitude premised on being kind and understanding toward oneself in the face of pain and failure (Neff, 2003). The purpose of this pilot study was to explore if self-compassion is related to, and explains unique variance beyond self-criticism on, young women athletes' performance evaluations. Women athletes ( $N = 82$ ,  $M_{\text{age}} = 18.77$  years) from a variety of sports and competition levels completed questionnaires before (Time 1) and after (Time 2) a competition. Time 1 included measures of anticipated performance, self-criticism, and self-compassion in sport. Time 2 included measures of performance and self-compassion in sport. Self-compassion was negatively correlated (all  $ps < 0.01$ ) with self-criticism at Time 1 ( $r = -.61$ ), and positively correlated with performance at Time 1 ( $r = .29$ ) and Time 2 ( $r = .33$ ). Hierarchical regression analysis revealed that self-compassion contributed 2.7% unique variance beyond self-criticism in women athletes' Time 2 performance evaluations (the full model accounted for 6.8% of the variance). Finally, self-compassion scores did not differ ( $p > 0.05$ ) between athletes who reported positive or negative performance evaluations at Time 2. Although previous qualitative research has found that young women rely on being self-critical in sport (Ferguson et al., 2014; Sutherland et al., 2014), our results suggest that extending compassion toward the self may be important for their performance evaluations. Given that individuals with higher levels of self-compassion can accurately estimate their performance (Leary et al., 2007), young women athletes who extend compassion towards themselves may be better equipped to manage their difficult experiences and perform in their sport.

### The impact of evidence-based parent education in organized youth sport: A pilot study

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Ninety percent of North American youth participate in organized sport during childhood and/or adolescence (Clark, 2010; USDHHS, 2010). Although parents are seen as important contributors to this participation (Fredricks & Eccles, 2005), the quality of their involvement is often criticized (Jellinek & Durant, 2004). Indeed, according to the American Academy of Pediatrics (2001), youth sport is largely driven by parents and is becoming less centered on the athletes who participate. Although extant family and sport research illuminates developmentally appropriate parent involvement behaviors, practitioners have yet to systematically disseminate this information to parents in the context of organized youth sport. Therefore, the purpose of the present study was to design, implement, and pilot test an evidence-based education program for parents in organized youth sport. Parents (39 fathers and 42 mothers) from 7 youth soccer teams in the Rocky Mountain region of the United States were randomly assigned to one of three implementation conditions (full, partial, or non-). At preseason, parents and their sport-participating children (41 boys and 40 girls) were administered T1 surveys. Parents in the full-implementation condition ( $n = 18$ ) then attended a 45-min Parent Sport Seminar and were given the Evidence-Based Guide for Parenting in Organized Youth Sport. Parents in the partial-implementation condition ( $n = 36$ ) were only given the Guide. Parents in the nonimplementation condition ( $n = 27$ ) did not take part in the Seminar and were not given the Guide. At postseason, parents and children from all seven teams were administered T2 surveys. Data reveal a positive impact of the parent education program on parent involvement behaviors (i.e., engagement, pressure, support), the parent-child relationship (warmth, conflict), and child experiences (i.e., enjoyment, motivation, perceived competence, value of sport). This parent education program, therefore, holds the potential to enhance parent involvement, parent-child interaction, and child outcomes in organized youth sport.

### Coordinative and aerobic exercise make children clever!

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Regular physical activity (PA) appears to have positive effects on cognition (Hillman, Erickson & Kramer, 2008). In children, positive effects have been found on aspects of cognitive performance with a small to medium effect size of  $d = .28$  (Fedewa & Ahn, 2011). It still remains unclear, however, how different types of exercise affect children's cognitive performance in the long run. Thus, in a 10-week afterschool exercise program, we investigated how programs involving aerobic and coordinative aspects affect working memory performance (WMP) in primary school children of the 3rd and 4th grade. The current study included 68 participants aged 9–10 years. They were randomly assigned to an aerobic exercise (AEG,  $n = 25$ ), a coordination exercise (CEG,  $n = 23$ ), and a control group (CG,  $n = 20$ ) and exercised three times a week for 45 min. In the CG students participated in assisted homework sessions. The AEG practiced at a mean intensity of 60–70% of  $HR_{\text{max}}$ . The CEG completed a coordinative training with a lower intensity of 55–65% of  $HR_{\text{max}}$ . In this group, bilateral coordination exercises were chosen to achieve an integration of executive control centers of the brain. Children's WMP was tested using the letter digit span task (LDS; Gold et al., 1997). A repeated-measures ANOVA of group (AEG, CEG, CG)  $\times$  test time (pre-, post-) was performed to test the effect of different exercise types on WMP. A significant within-subjects effect revealed an improved WMP (LDS),  $F(1,65) = 61.78$ ,  $p < .001$ ,  $\eta^2 = .487$ . The interaction effect of group  $\times$  test time was also significant,  $F(2,65) = 12.23$ ,  $p < .001$ ,  $\eta^2 = .273$ . Participants showed improvements in WMP from pre- to posttest in the two exercise groups (AEG:  $p < .001$ , CEG:  $p < .001$ ) but not in the CG. Only in the CEG participants LDS scores differed significantly from the CG after the intervention ( $p = .019$ ). The two intervention programs enhanced WMP in children. These findings demonstrate a causal effect of two different types of exercise on WMP and provide support for regular PA for improving cognition in children. *DFG, German Research Foundation*

### Perceived relatedness and ice hockey player self-definition

Ladiges, Genevieve, Kendzierski, Deborah; Villanova University

According to Kendzierski and Morganstein's (2009) Physical Activity Self-Definition (PASD) model, perceived commitment (PC), and perceived ability (PA) underlie physical activity self-definition. Recent research (e.g., Kendzierski & Whaley, 2014) indicates that self-prototype match (SPM; the extent to which one considers oneself similar to the prototypical person who does the activity) may be another such underlying variable. This study focused on a social variable, perceived relatedness (PR; how psychologically related one feels to others), which has been linked to both self-definition (e.g., Vlachopoulos, Kaperoni, & Moustaka, 2011; Wilson & Muon, 2008) and perceived commitment (Gray & Wilson, 2008). Data from 143 collegiate ice hockey players (18–25 years of age,  $M = 20.66$  years,  $SD = 1.56$  years; 53 males, 89 females, 1 did not specify) were analyzed to determine whether (a) there is a relationship between ice hockey player self-definition ( $SD$ ) and PR, and if so, (b) whether PC mediates this relationship. Additionally, (c) the predicted relationships between variables in the PASD model were examined. A significant relationship was found between PR and ice hockey player  $SD$ ,  $r = .42$ ,  $p < .01$ . As predicted, Preacher and Hayes (2008) bootstrapping method of testing for indirect effects revealed that PC mediated the relationship between PR and ice hockey player  $SD$ , 95% CI [.026, .133],  $p < .05$ , and a hierarchical regression analysis indicated that PR did not contribute to the predictability of ice hockey player  $SD$  after controlling for PC, PA, and SPM. Finally, a series of regression analyses indicated that all relationships predicted by the PASD model were found in the current sample of ice hockey players, with the exception that PA did not contribute to the prediction of ice hockey player  $SD$  when PC was also considered ( $\beta = .08$ ,  $p = .17$ ). Theoretical and applied implications of these findings for physical activity self-definition are noted. *Villanova University Psychology Department*

### Dancer perceptions of the cognitive, social, emotional, and physical benefits of partnered dancing

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Objective: To study the perceived physical, cognitive, affective, and social benefits of partnered dancing. Method: 225 dancers (71% female) were recruited through a community ballroom dance center and completed an online survey. Survey items evaluated perceived physical, cognitive, affective, and social benefits of dance. Analyses: We analyzed aggregate survey data using SPSS version 22. Differences between the means of subsamples, or groups, were tested for significance using Mann–Whitney U Tests. Linear regression was used to test if the longevity of dance training and frequency of dance participation significantly predicted perceived benefits. Results: Individuals who socially dance and/or take dance lessons reported perceived benefits in personal physical fitness, cognition, affect, and social functioning. Experienced dancers reported significantly greater self-perceived benefits in physical fitness, coordination, attention, memory, and social skills. A Mann–Whitney test indicated that self-reported improvements in mood were greater for women than for men,  $U = 3,945$ ,  $z = -3.07$ ,  $r = .20$ ,  $p = .00$ . Committed dancers (who reported dancing at least one or more times each week) were more likely than occasional dancers (who danced two or fewer times per month) to report improvements in physical fitness,  $U = 6,942$ ,  $z = 2.38$ ,  $r = .16$ ,  $p < .05$ . Longevity and frequency of dance participation significantly predicted perceived physical benefits,  $R^2 = .11$ ,  $F(2, 222) = 14.25$ ,  $p < .00$ ; cognitive benefits,  $R^2 = .04$ ,  $F(2, 222) = 4.67$ ,  $p < .01$ ; and social benefits,  $R^2 = .03$ ,  $F(2, 222) = 3.30$ ,  $p < .05$ . Conclusion: Results from this study suggest that participation in partnered dance styles is associated with perceived improvements in physical fitness, cognitive functioning, social functioning, mood, and self-confidence. The study is limited in that dancers were self-selected. Future research should randomize participants to dance interventions in order to empirically test the benefits of dance and should use a multi-method, multi-informant measurement design.

### Are sport skills life skills (Part I)? Exploring which domains athletes transfer psychological skills to, and why

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Psychological skills are specific strategies employed by athletes to enhance sport performance, increase motivation, and increase perceptions of enjoyment, and self-satisfaction. Although psychological skills are often described as life skills (e.g., Petitpas et al., 2004; Weinberg & Gould, 2007), there is limited research exploring athletes' self-directed engagement in the process of psychological skills transfer. The purpose of this study was to obtain descriptive data concerning athletes' transfer of psychological skills from sport to other achievement domains. Twelve student-athletes (3 male; 9 female;  $M_{\text{age}} = 22.75$  years,  $SD = 2.09$ ) participated in semistructured interviews regarding their use of psychological skills and strategies in sport and other life domains. Participants competed at the varsity level or higher, maintained dean's honor list standing, and were in leadership positions within their sports. All athletes had previous psychological skills training ( $M = 2.45$  years,  $SD = 1.70$ ) and used psychological skills extensively in their sport. Content analysis of the interview transcripts revealed that the athletes reported transferring psychological skills from sport to other life domains, most commonly to academics ( $n = 11$ ), work ( $n = 9$ ), volunteer activities ( $n = 4$ ), and personal relationships ( $n = 4$ ). Use of psychological skills outside of sport was associated with a variety of benefits related to improved performance, motivation, controlling emotions, and coping with stress. Athletes also discussed reasons for not transferring psychological skills from sport and the use of unconscious skill transfer. This suggests a need for future research on how psychological skills are taught in sport and the extent to which teaching strategies lead to transfer of skills beyond the sport environment.

### Quiet eye period and performance in sport: A meta-analysis

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The quiet eye (QE) is a vital pre-performance routine feature linked to the perceptual-cognitive process (Vickers, 1992). Vickers (2007) defines it as “the final fixation or tracking gaze that is located on a specific location or object in the visuomotor workspace within 3 degrees of visual angle for a minimum of 100 milliseconds.” During this period, task-relevant environmental cues are processed and motor plans are coordinated for the successful completion of the task. The QE period has been shown to differentiate experts from novices and successful from unsuccessful performances across several sports (Janelle, Hillman, & Hatfield, 2000; Vickers, 1992, 1997; Vickers & Williams, 2007; Wilson, Vine, & Wood, 2013). The main goal of this study was to review the current literature on the link between the QE period and performance. A secondary goal was to evaluate potential moderators influencing this relationship. Twenty-six studies met the inclusion criteria leading to 36 effect sizes. A large effect size ( $d = .78$ ) was revealed between experts and novices or successful and unsuccessful performances. Two moderators emerged from the results: the vision-in-action system (VIA) to measure QE and the type of sport (i.e., self-paced vs. externally paced). Studies using the VIA system to measure QE revealed a smaller effect size than studies using the eye tracker alone. Additionally, studies examining self-paced sports (e.g., golf, basketball free throw) revealed a smaller effect size than studies investigating externally paced sports (e.g., soccer, ice hockey). In total, those two predictors accounted for over 54% of the between-study variance. Discussion of these results and directions for future research are presented.

### Physical self-perceptions, body image, and intrinsic motivation in recreational aesthetic sports

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The purpose of the pilot study was to examine the relationship between physical self-perceptions and motivation in recreational aesthetic sports participants in South Korea. The participants ( $N = 108$ ) were adult recreational dance sports participants in South Korea. The PSPP (Physical Self-perception Profile), MBSRQ (Multidimensional Body-Self Relations Questionnaire) and IMI (Intrinsic Motivation Inventory) were used for the measurement tools, and correlation test was used to examine the relationship between the self-perceptions and motivation. As a result, some physical self-perceptions were positively related to intrinsic motivation. Particularly, sport competence on physical self-perceptions and interest/enjoyment (intrinsic motivation) were the highest relationship at 0.05 significance level. Sport competence, appearance, and physical condition on physical self-perceptions were negatively related tension/pressure (extrinsic motivation).

### Increasing Control Beliefs Toward Exercise: Results From an Intervention Among College Students

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Late adolescence is a stage associated with important decline in exercise behaviors. In this regard, interventions are needed to promote the maintenance of physical activity during college years. The purpose of this study was to measure the impacts of a 5-week intervention conducted among college students. The intervention was based on the theory of planned behavior (TPB). The intervention aimed to increase the participants' control beliefs and perceived behavioral control (PBC) toward participation in physical activity. During the intervention, behavioral change techniques used by kinesiologists were persuasive communication and positive feedback. Among 298 participants ( $19.3 \pm 3.8$  years old) enrolled in college physical education classes, 29 college students accepted to take part in the intervention. Questionnaires were completed at two occasions: 1) beginning of college semester, and, 2) end of the semester (3-month). Perceived barriers, perceived facilitating factors, and PBC were measured. Group comparisons ( $t$ -tests) were performed to verify if the intervention had an impact. Initially, no group differences were observed regarding the participants' control beliefs and PBC, excepted for fear of getting injured (higher for intervention group ( $t = 3.87, p < .001$ )). PBC diminished over the semester ( $t = -.26, p = .01$ ). Perceived barriers remained stable among the intervention group, comparatively with a significant increase in the control group ( $t = 2.27, p < .05$ ). Facilitating factors were also stable for the intervention group, comparatively to a significant decline for the control group ( $t = -.587, p < .001$ ). The present study demonstrated that despite moderate impacts, a TPB-based intervention can contribute to stabilize control beliefs toward regular physical activity. Diminution in perceived behavioral control can be explained by a transition in behavior context (during semester vs. end of semester). Further research should consider including all of the TPB variables in the intervention, to explain more precisely changes in physical activity behaviors.

**Singaporean college students' motivation for physical activity: What motivates them to want to be physically active**

Lim, Boon San Coral; Sim, Miao Qin; National Institute of Education / Nanyang Technological University; Evans, Rachel; independent researcher

Evidence is clear that participation in regular physical activities has short- and long-term benefits both physiologically and psychologically. Notwithstanding this, research also highlights that physical activity (PA) participation tends to decline from youth to adulthood. A key agenda in PA research then, is to understand what motivates adherence to PA. A more comprehensive approach would be to examine both sport, and exercise participation behavior. In this study, we examined the motives for PA participation among Singaporean college students, and their reported intention to be physically active in the next 2 weeks. A sample of 454 college students (16–18 years) from four colleges participated in the study. Motives for participating in sport, and in exercise—fitness, appearance, competence, enjoyment, and social—were measured. Additionally, students' intention to be physically active in the next 2 weeks was also measured. We expected students' motives for sport participation to differ from their motives for exercise participation (higher scores for sport participation for intrinsic motives [i.e., competence, enjoyment] and exercise participation for extrinsic motives [i.e., appearance, fitness]). We also hypothesized that intrinsic motives for sport participation, and extrinsic motives for exercise participation would positively predict students' intention to be physically active. Results were as hypothesized except that sport participation for enjoyment motive negatively predicted students' intention to be physically active while exercise participation for enjoyment motive positively predicted students' intention to be physically active. Results also showed sport participation for appearance motive to be a significant negative predictor of students' intention to be physically active. The findings corroborate evidence that motives for sport participation are more desirable than those for exercise for facilitation of PA adherence but also offer further insights for interventions. PA participation for social reason as a form of intervention was discussed.

**Effect of jump rope exercise program on executive function in obese preadolescents: An RCT study**

Liu, Jen-Hao, Yang, Kao-Teng, Wang, Chun-Chih, Chang, Yu-Kai; National Taiwan Sport University

Obesity has been highly associated with cognitive impairment, particularly in executive function aspect of cognitive function. Given that emerged studies have indicated that exercise is positively associated with executive function, exercise is possibly considered as potential treatment for the obese population. Unfortunately, whether the beneficial effect of exercise on executive function extends to obesity preadolescent remains understudied. Additionally, previous studies typically emphasized on aerobic type of exercise and general executive function, and knowledge regarding effects of other types of exercise and obesity related executive function are limited. The purpose of the current study was therefore to investigate the effect of an exercise program that supplied multifaceted characteristics on cognitive functions as well as obesity related cognitive function in obese preadolescent using a randomized controlled design. Seventy preadolescents aged 13 to 16 years were randomly assigned into control and exercise groups. Exercise group received a jump rope exercise program with moderate intensity, 3 days per week for 12 weeks, wherein the control group received an educational course. Primary outcome measures regarding differ types of cognitive functions assessed by Stroop Test and secondary outcome measures in terms of physical fitness and obesity status were assessed twice at prior and following 12 weeks treatment, respectively. The results revealed that obese preadolescents within the exercise program significantly enhance both general and obesity-specific aspects of executive function, improve a variety of physical fitness, and reduce obesity status. These findings suggest that the exercise program may be an effective treatment to enhance executive function, improve physical fitness, and reduce obesity status. More importantly, weight loss following the exercise intervention may be attributed to the improvement of obesity associated inhibitory control generated from the exercise in obese preadolescent.

**The effect of acute bout exercise on executive function in children with attention deficit hyperactivity disorder**

Liu, Suyen; Lee, Yuan-Hung; National Chung Cheng University

Relevant studies indicated that children with ADHD having a poorer performance on executive function tests than their peers. Previous studies have shown aerobic exercise can improve executive function. Will an acute bout aerobic exercise improve executive function on ADHD children? The purposes of this study were 1) to compare the differences of proceeding speed and inhibition ability from Stroop test between acute bout of aerobic exercise group and control group, and 2) to compare performance on sorting, conception formation, planning, organization, and cognitive shifting from Wisconsin Card Sorting Test (WCST) between these two groups. Methods: Forty grade 3–6 students were randomly assigned into two groups: 1—Experimental group: acute exercise running on a treadmill at 55%–70% of estimated maximum heart rate, and 2—Control group: watching a DVD program for 30 min. Executive function tasks (Stroop test, WCST) were performed prior to and following a treatment condition. Results: There were no significant differences found in Stroop word test, Stroop color test, and Stroop color–word interference test between the experimental and the control groups. There were not statistically significant better results on WCST test between two groups, but some items (e.g., trials administered, non-perseverative errors, and categories completed) have shown improvement after intervention. Therefore, it is inferred that acute exercise led to improve performance on the trials administered, non-perseverative errors, and categories completed. Conclusion: These results suggest that the effects of acute exercise improve their shifting and plan-forming ability. *MOST 101-2410-H-194-126-MY2*

### **Research on learning engagement factors of PE academic graduates: Research on learning engagement factors of PE academic graduates**

Lu, Changfen, Luo, Xiaobing, Zheng, Fang; Central China Normal University

The NSSE carried out since 2000 have been applied by more than 1400 universities for evaluating the learning quality in the United States. The NSGE is a questionnaire about graduates' study experience in China. In this paper, based on NSSE and NSGE, a questionnaire about learning engagement factors for PE academic graduate was designed; 221 PE academic graduates were investigated in Hubei province. Reliability analysis and factor analysis on 200 recalled valid questionnaire indicate the questionnaire has desirable reliability and validity. The main conclusions are as follows: 1. Learning engagement of PE academic graduates is at the medium level, and has no significant difference at gender and grade, but there exist significant difference at age, university type, and major. 2. There is positive correlation between six factors (learning difficulties, learning initiative and cooperation, interaction between graduate and teacher, learning experience, campus environment, and total learning results) and learning engagement of PE academic graduates, and these six factors have significant influence on learning engagement. These six factors explain 63.6% of the variance of learning engagement. 3. The importance of above six factors for learning engagement of PE academic graduates is learning difficulties > interaction between graduate and teacher > learning initiative and cooperation > learning experience > total learning result > campus environment. *National Project of Philosophy and Social Science of China (10CTY002)*

### **Barriers and facilitators to physical activity participation in populations with disability: Mobilizing the next steps**

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Physical activity is associated with several health and psychosocial benefits including decreased risk for chronic disease and improved quality of life and mental health. Despite these benefits, populations with disability demonstrate some of the lowest rates of physical activity participation. Furthermore, disability is often accompanied with increased risk for chronic disease and myriad secondary conditions such as pain and depression. Physical activity has been shown to mitigate many of these outcomes. Given the increased need for physical activity in this population, an understanding of the factors that influence physical activity participation within different segments of the disability population is a priority. Additionally, identifying similarities and differences across disability types and childhood vs. adulthood groups can facilitate tailored interventions. The purpose of this systematic review was to synthesize existing reviews of the literature on barriers and facilitators to physical activity participation in samples with physical disability. A systematic search of AMED, Embase, ERIC, Medline, PsychINFO, PSYCHnet, and PubMed databases revealed 20 relevant reviews. Systematic, critical, meta-analytic, rapid, and scoping reviews were included. When possible, review quality was also assessed. Primary themes identified included personal, social, environmental, policy/program, and body functions barriers while facilitators were often the alleviation of these barriers. These barriers and facilitators are organized to provide relevance for health care practitioners and program providers. Recommendations are made for addressing the barriers that are most amenable to change. By unifying themes of the most prevalent barriers and facilitators, and characterizing differences between groups with different types of disability, this review of reviews builds a foundation to help mobilize the design, implementation, and improvement of current and future physical activity promotion programming and interventions.

### **Psychosocial outcomes in youth sport and physical activity in Botswana: The promise of research and theory building among African populations**

Malete, Leapetswe; University of Botswana

The extant literature on youth psychosocial development through sport and physical activity provides compelling evidence on the various predictors of youth sport participation, enjoyment, and attrition. More recent efforts have been devoted to developing a better understanding of the underlying factors that shape the psychosocial development of youth sport participants. The findings show much promise, as they have led to the development of new perspectives such as the *positive youth development* model. Regrettably, African populations lag behind in these developments yet they need such evidence. However, a decade-long research on youth sport in Botswana shows similar promise. The purpose of this paper is to share evidence from selected studies done on psychosocial outcomes of youth sport in Botswana. It reports findings on predictors of aggression, antisocial/prosocial behaviors, and moral reasoning in youth sport. The studies reveal significant relationships among coaching environment, parental involvement, individual factors and psychosocial outcomes. Achievement goal orientations and self-perceptions were associated with levels of sport participation and enjoyment. Athletes' perceptions of their coaches' endorsement of aggression and cheating were significant predictors of team norm for aggression, likelihood to aggress, and perceptions of peer cheating. The findings support the use of the achievement goal theory and existing models of coaching efficacy and coaching effectiveness with this population. Further testing of existing theory and exploring new approaches through cross-cultural studies involving African populations should yield interesting results. A call is made for more broadening of the scope of sport psychology research to less studied populations and to enrich it through specific attention to its underlying multidimensional and idiosyncratic/contextual elements.

### A group-based sprint interval training program for amateur athletes

Martin, Luc J., University of Lethbridge; Anderson, Scott H., University of Lethbridge; Schmale, Matthew S., Couture, Katie M., Hallworth, Jillian R., University of Lethbridge; Hazell, Tom J., Wilfrid Laurier University

Sprint interval training (SIT) involves repeated 30-s “all-out” running efforts followed by 4 min of active recovery (walking). Although SIT improves fitness and endurance (MacPherson et al., 2011), it requires a high degree of motivation and perseverance. Research supports the use of groups to influence individual cognitions and behaviors (Estabrooks et al., 2014), and as such, the current project assessed the effectiveness of a group-based intervention with athletes involved in an SIT program. Using an experimental design, 53 athletes ( $M_{\text{age}} = 21.89$ ,  $SD = 2.90$ ; 28 females) were assigned to a “true group” condition (consistent co-exercisers and team building protocols), an aggregate condition (presence of random co-exercisers), and a control condition (training in isolation). Over the 4-week training program, it was hypothesized that athletes training in the “true group” condition would exhibit greater physiological ( $\text{VO}_2\text{max}$ , time trial performance, anaerobic power) and psychological (task/scheduling self-efficacy, motivation) adaptations in comparison to those in the aggregate and control conditions. To demonstrate benefits were derived from the intervention and not simply the presence of co-exercisers, perceptions of cohesion and groupness were also taken for the “true group” and aggregate conditions. Results indicated improvements in all subjects from baseline to 4 weeks for  $\text{VO}_2\text{max}$ ,  $t(47) = -3.98$ ,  $p < .001$ ; time trial performance,  $t(50) = 5.35$ ,  $p < .001$ ; and anaerobic power,  $t(50) = -9.81$ ,  $p < .001$ ; however, there were no significant differences in physiological changes between groups. Similarly, no significant differences were found between groups for motivation. Significant group  $\times$  time interactions were present for task,  $F(2) = 4.85$ ,  $p = .012$ , and scheduling,  $F(2) = 7.67$ ,  $p = .001$ , self-efficacy, suggesting that the aggregate and control conditions experienced greater improvement than the “true group.” Results and explanations for the lack of effectiveness of the intervention will be discussed in greater detail. *Sport Science Association of Alberta*

### The relationship between competitive anxiety in sport and error monitoring in long-distance runners

Maruo, Yuya, Masaki, Hiroaki; Waseda University

Recent studies have reported the relationship between exercise and error monitoring by recording the error-related negativity (ERN). It is also known that larger ERNs are observed for individuals high in trait anxiety. This study investigated the relationship between error monitoring and competitive anxiety in sport in university athletes. We also manipulated monetary motivation to investigate the influences of affective function on error monitoring. Using the Sports Competitive Anxiety Test (SCAT; Martens, 1977), we assessed university athletes, who belonged to a track and field club. We tested long-distance runners ( $n = 16$ ) and sprinters ( $n = 13$ ). They performed a spatial Stroop task, in which participants responded to the pointing direction of the arrow stimulus, ignoring the presented location. We tested two conditions: the motivation condition and the no-reward condition. In the motivation condition, correct trials were rewarded with 10 yen, whereas error trials were penalized with 10 yen. Participants performed four blocks of 72 trials in each condition. The electroencephalogram was recorded from 128 electrodes. The ERN was averaged time-locked to the error response on incongruent trials. A  $2 \times 2$  repeated-measures ANOVA on condition and group confirmed marginally smaller ERN amplitudes in the motivation condition than in the no-reward condition ( $F(1, 27) = 3.34$ ,  $p = .08$ ). However, neither significant difference between the two groups nor an interaction was obtained. In addition, we found a negative correlation between SCAT and ERN amplitude for long-distance runners in the motivation condition ( $r = -.64$ ,  $p = .01$ ). In the sprinter group, however, no significant correlation between SCAT and ERN was obtained regardless of condition. These results suggest that error monitoring of university athletes is decreased by monetary motivation. We also suggest that long-distance runners who are high in competitive anxiety would exhibit larger ERNs in a motivational situation. It is plausible that cognitive control differs among athletes, depending on exercise type.

### Examining the Koehler motivation effect with software-generated partners in repeated sessions of aerobic exercise

Max, Emery J.; Samendinger, Stephen; Spencer, Benjamin D.; Winn, Brian; Kozma, Gregory; Jeffery, William; Kerr, Norbert L.; Pfeiffer, Karin A.; Michigan State University; Forlenza, Samuel T., Shippensburg University; Feltz, Deborah L., Michigan State University

Most Americans are not getting enough exercise at the recommended levels to maintain health and reduce the risk of chronic disease. Motivation is a key issue in physical inactivity. Exergames employing the Koehler effect (i.e., a motivation-boosting dynamic relying on upward social comparison and perceived indispensability) with a software-generated partner (SGP) have shown promise in boosting exercise effort under short-term circumstances using strength-based activities (Feltz, Forlenza, Winn, & Kerr, 2014). The current study sought to extend these results by using continuous aerobic activity and by examining the effect over time (3 days per week over 4 weeks) to determine whether participants become discouraged over a longer time frame if they are continually the weaker link. College students and adult community members ( $N = 73$ ) were randomly assigned to one of three conditions after an initial baseline pretrial alone on an exercise bike: individual control, a moderately better same-sex/age SGP, or an SGP who shows progressively reduced effort discrepancy (SGPRD) with the participant. Participants in the experimental conditions were told they would perform all remaining sessions conjunctively with their SGP—i.e., a team score was defined by the teammate who stopped exercising first. Exercise persistence (time), self-efficacy beliefs, enjoyment, and ratings of perceived exertion (RPE) were recorded and analyzed. Preliminary post hoc contrasts indicate that riding with an SGP or SGPRD boosts persistence for male community members over 12 days, but not for students or female community members. Participants who positively regarded their SGP exercised longer over time,  $r(45) = .32$ ,  $p = .034$ . Perceptions of indispensability, a key component of the Koehler effect, trended toward being correlated with persistence,  $r(45) = .28$ ,  $p = .059$ . These results suggest that those who positively regard their virtual partner and feel indispensable to the task outcome may best sustain motivation over time in an aerobic exergame employing the Koehler paradigm.

### Staff perspectives on the development and effects of social relationships in a physical activity-based youth program

McDavid, Lindley, McDonough, Meghan H.; Purdue University

Physical activity-based positive youth development (PYD) programs help young people develop talents, build self-esteem, and learn healthy habits (Fraser-Thomas, Cote, & Deacon, 2005). Program staff are often tasked with forging close, caring, and supportive relationships with youth, as these interactions can foster positive experiences and growth (Lerner, 2005). However, few interventions exist to enhance staff interpersonal skills. This study examined staff perspectives on how they develop relationships with youth, how they believe these bonds lead to positive change, and how an interpersonal skills intervention based on self-determination theory (SDT) influenced the strategies they used to connect with youth. Ten staff members (7 women, 3 men; age = 16–23 years;  $n = 7$  received interpersonal skills training) from a physical activity-based PYD program serving youth from low-income families were interviewed. Main themes included that staff fulfilled different social roles based on the unique needs of youth, including friend, parent, and sibling. They tailored their interactions to get to know youth and provide the individualized support they needed. Secondly, while staff expected to support the youths' development, they also experienced unexpected personal growth. Staff valued the interpersonal skills they learned as a consequence of interacting with youth from backgrounds different from their own and felt these experiences would be useful in their future professions. Third, the staff who received the SDT-based training found the skills taught helped them address some of the challenges associated with connecting with youth. Many staff had little experience working with youth and that time devoted to connecting with youth was limited but, the training helped them understand their important role, and better interact with and earn the trust of youth. These findings elucidate staff perspectives on the process and challenges of developing relationships with youth, and describe concrete strategies and feedback on an intervention for enhancing these important social bonds.

### Examining motivation and need satisfaction as predictors of change in objectively measured physical activity and sedentary behavior in post-treatment breast cancer survivors

McDonough, Meghan H., Purdue University; Sabiston, Catherine M., University of Toronto

Increasing physical activity behavior and decreasing sedentary behavior can improve health and mitigate challenges faced by breast cancer (BC) survivors (Sabiston & Brunet, 2012), but few survivors are sufficiently active to accrue health benefits (Lynch et al., 2010). This study examined (1) trajectories of objectively measured physical activity and sedentary behavior following BC treatment completion, and (2) whether psychological need satisfaction (autonomy, competence, and relatedness) and motivational regulations (amotivation, external, introjected, identified, and intrinsic) predicted mean levels and changes in physical activity and sedentary behavior. Participants were recently treated BC survivors ( $N = 177$ ) age 28–79 years, 85% Caucasian. They completed self-report measures of psychological need satisfaction and motivational regulations at baseline (< 5 months following treatment completion) and 3, 6, 9, and 12 months later. Participants wore accelerometers for 1 week at each time point to assess sedentary behavior and light, moderate, and vigorous physical activity. Latent growth curve modeling was used to test hypotheses. Moderate and vigorous physical activity declined significantly (moderate  $p = -620.29$ ,  $p < .01$ ; vigorous  $p = -37.68$ ,  $p < .01$ ). Autonomy positively and external regulation negatively predicted mean levels of vigorous and moderate activity, while those with higher external regulation tended to increase vigorous ( $p = 7.58$ ,  $p < .01$ ) and moderate ( $p = 6.92$ ,  $p = .02$ ) activity more over time. Amotivation negatively predicted mean levels of light activity, and identified regulation positively predicted mean levels of sedentary behavior. The declines in moderate and vigorous physical activity suggest that interventions to increase and maintain activity may be particularly important during this post-treatment period. Supporting needs for autonomy and reducing external regulation are associated with higher levels of moderate and vigorous physical activity, but were not strong predictors of change in activity over time. *Canadian Institutes of Health Research/Canadian Breast Cancer Research Alliance*

### The influence of selection status on goal progress, sport commitment, and athletic identity during the 2013 Canada Summer Games team selection process

McEwen, Carolyn E., Crocker, Peter R.E.; University of British Columbia

Team selection processes may represent a critical change event as athletes attempt to adjust to elite sport (Stambulova, 2000). The purpose of the present study was to examine how team selection status (selection versus non-selection) influenced athletes' sport commitment, athletic identity, and athletic goal progress over the course of the 2013 Canada Summer Games (CSG) selection process. Athletes ( $n_{\text{male}} = 39$ ,  $n_{\text{female}} = 55$ ) who were trying out to represent their province during the 2013 CSG completed online measures of goal progress (Dugas et al., 2012), athletic identity (Brewer & Cornelius, 2001), and sport commitment (Scanlan et al., 1993) prior to their final selection event, and at approximately one and five weeks after receiving knowledge of their selection status. Two-way mixed factorial ANOVAs were conducted to determine changes over time based on selection status ( $n_{\text{selected}} = 70$ ,  $n_{\text{not selected}} = 23$ ). Findings indicated that there was a statistically significant main effect of time ( $F(2, 184) = 8.96$ ,  $p < .01$ ) and selection status ( $F(1, 92) = 11.34$ ,  $p < .01$ ), and a time by selection status interaction ( $F(2, 184) = 6.67$ ,  $p < .01$ ) on athletic goal progress. Contrasts revealed that selected athletes reported significantly higher goal progress than non-selected athletes. In addition, athletes reported significantly higher goal progress prior to the final selection when compared to one and five weeks after the team was picked. Furthermore, athletes who were not selected perceived their goal progress to be highest prior to selection ( $M = 6.52$ ,  $SD = 1.21$ ), lowest one week after not being selected ( $M = 5.02$ ,  $SD = 2.09$ ), while increasing five weeks after not being selected ( $M = 5.40$ ,  $SD = 1.56$ ). In contrast, selected athletes did not perceive as much variation in sport goal progress over the selection process ( $M_{\text{Time1}} = 6.74$ ,  $SD = 1.35$ ;  $M_{\text{Time2}} = 6.67$ ,  $SD = 1.67$ ;  $M_{\text{Time3}} = 6.56$ ,  $SD = 1.56$ ). No statistically significant main or interaction effects were found for sport commitment or athletic identity.



### Psychological climate and cohesion in sport: A multilevel perspective

McLaren, Colin D., Spink, Kevin S.; University of Saskatchewan

Psychological climate (PC) is a construct that captures how individual group members perceive and psychologically process their group environment (Jones & James, 1979). Emerging research in sport has highlighted a relationship between perceptions of a positive PC (one that is psychologically safe and meaningful; Kahn, 1990) and increased personal engagement (e.g., effort; Spink et al., 2013). As PC is an individual phenomenological experience that is associated with contextual and social influences (James et al., 1990), validation of this construct and its relationship with other group variables in the sport context would expand the degree of generalizability of PC in sport. Cohesion might be an appropriate group variable to examine in this regard as assessments of cohesion in sport are formed, in part, by perceptions of the group environment (Carron & Eys, 2012). The purpose of this study was to examine the PC/cohesion relationship in a sample of female team sport athletes. Participants ( $N = 180$ ) from 16 intact adult teams completed a measure of cohesion (Group Environment Questionnaire, GEQ; Carron et al., 1985) and a version of the Psychological Climate Questionnaire (PCQ; Brown & Leigh, 1996) adapted for sport (Spink et al., 2013) following a late season practice. As ICCs indicated the presence of nesting,  $.11 = ICC = .34$ , multilevel models (HLM) were used to accommodate this hierarchical data structure. Four separate analyses were conducted using the subscales of the PCQ (supportive management, role clarity, self-expression, and contribution) to predict each of the four dimensions of the GEQ (ATG-T, ATG-S, GI-T, GI-S). Results revealed that perceptions of role clarity and self-expression significantly predicted ATG-T and GI-T ( $ps < .001$ ) accounting for 16.1% and 13.3% of the overall variance, respectively. While replication is needed, these data provide preliminary evidence suggesting that select aspects of PC (self-expression and role clarity) positively relate to perceptions that one's team is united around the task aspects of the group (task cohesion).

### Effect of group constructs on athlete sport commitment

McLaren, Colin D.; Fesser, Kayla B.; Ulvick, Jocelyn D.; Crozier, Alyson J.; Spink, Kevin S.; University of Saskatchewan

Understanding why athletes maintain participation in sport has been a longstanding issue for researchers and practitioners. Commitment has been identified as a useful lens to assess the motivation underlying athletes' continued sport involvement (Sousa et al., 2007). While the prevailing commitment model in sport (sport commitment model; Scanlan et al., 1993) identifies a number of key antecedents, group factors do not feature. This is surprising given group characteristics have been associated with commitment models in other areas for many years (Mowday et al., 1979). Two group constructs that have been associated with an outcome related to sport commitment (intention to return to the team) are cohesion (Spink, 1998) and groupness (Crozier & Spink, 2014). The purpose of this study was to examine the effect of varying levels of cohesion and groupness on an individual athlete's commitment to a soccer team. Using an experimental design, adult soccer players ( $N = 68$ ) read four vignettes describing hypothetical soccer teams that differed in levels of cohesion (high [HC] vs. low [LC]) and groupness (high [HG] vs. low [LG]). While imagining themselves as a member of each of the four hypothetical teams, participants were asked to rate their level of commitment to each team using a measure adapted from Scanlan et al. (1993). The order of the vignettes was presented randomly to minimize any order effects. ANOVA results revealed a significant main effect,  $F(3, 201) = 150.54, p < .001, \eta^2_p = .69$ . Post hoc tests revealed significant differences between all of the conditions (all  $ps < .01, .57 < \text{Cohen's } d < 3.04$ ). In terms of influence, commitment was highest after reading the vignette describing the HC/HG team, followed by the HC/LG, LC/HG, and LC/LG teams. While in need of replication, these results provide preliminary evidence that group-level constructs (i.e., cohesion, groupness) influence athletes' sport commitment in the team sport setting. Further, it appears as if perceptions of cohesion and groupness have independent and additive effects on athletes' sport commitment.

### Stuck like glue: The relationship between cohesion and psychological climate

McLeland, Kathryn A., Hamamoto, Sarah K., Wilson, Kathleen S., California State University–Fullerton

Cohesion is one of the most common group constructs in the exercise field and reflects one's perceptions of one's group tendency to remain united (Carron et al., 1998). It may be speculated that the way in which one perceives his/her group may have an effect on how he/she perceives the psychological environment. This psychological environment has been called *psychological climate* (PC) and includes perceptions of safety and meaningfulness (Brown & Leigh, 1996). This study explored relationship between cohesion and PC in a group exercise setting. Participants ( $N = 69$ ) consisted of university students enrolled in 16-week activity courses for credit ( $M_{age} = 21.8$  years, 75.4% female). After 11 weeks of class, cohesion was measured using the Group Environment Questionnaire (GEQ; Carron et al., 1998) and its four subscales: Attraction to group-task and social (ATGT, ATGS) and group integration-task and social (GIT, GIS). At the end of the semester, PC was measured by 21-item questionnaire that was modified for the activity class (5 subscales: supportive management, role clarity, contribution, self-expression and challenge; Spink et al., 2013). Separate multiple regressions were performed for each of the five subscales of PC with the four dimensions of cohesion entered as the predictors. For contribution, cohesion explained 45.5% of the variance ( $F(4) = 13.14, p < .001$ ) with ATGS being the only significant predictor ( $b = 0.49, p = .002$ ). For the challenge subscale, 18.5% of the variance was explained by cohesion ( $F(4) = 3.47, p = .011$ ) with ATGS emerging as a significant predictor ( $b = 0.45, p = .016$ ). For self-expression, cohesion accounted for 31.3% of the variance ( $F(4) = 7.18, p < .001$ ) with GIS having a significant effect ( $b = .33, p = .031$ ). Lastly, cohesion accounted for 16.7% of the variance of supportive management ( $F(4) = 3.27, p = .017$ ) and 28.1% of the variance for role clarity ( $F(4) = 6.37, p < .001$ ). However, no individual predictors were significant. These findings suggest that the social dimensions of cohesion (specifically ATGS) appear to be positively associated with perceptions of PC.

### Traditional versus psychologically informed fitness testing in physical education: Affective outcomes

Mischo, Amanda B., Vazou, Spyridoula, Ekkekakis, Panteleimon; Iowa State University

Physical fitness testing in physical education (PE) is mandatory in several US states, based on the promise that testing will “assist students in establishing lifelong habits of regular physical activity.” However, in actuality, the influence of fitness testing, as commonly implemented in schools, on motivational outcomes remains largely unknown. Modifying the experience of fitness testing by translating psychological theory into practice may represent untapped potential in the effort to promote physical activity in childhood. Thus, the present within-subject experiment compared two 30-min PE lessons consisting of “practice” fitness testing (aerobic practice, curl-ups, push-ups): one simulated traditional testing (using standard Fitnessgram instructions) whereas the other (“novel”) emphasized positive peer interactions and fun elements during practice. The dependent variables were positive affect (Feeling Scale) and hubristic pride (“feel good that I look better than most kids around me”), assessed by single-item questionnaires before and after the lessons. The sample consisted of students in 4th and 5th grade (25 normal weight, 10 overweight), recruited from the same school. Physical activity during the lessons was measured by accelerometers. Body mass index (BMI) data were retrieved from school records. The two lessons did not differ in average intensity (7 METs). However, for positive affect, there was (a) a significant lesson by time interaction in favor of the novel lesson and (b) a significant main effect of BMI category, with the overweight children scoring lower overall than their normal-weight counterparts. For hubristic pride, there was a significant lesson by time by BMI interaction, such that, while normal-weight children reported higher scores after both lessons, overweight children reported a decline after the traditional lesson but an improvement after the novel lesson. These results highlight the potential impact of translating extant psychological research into practice in PE settings.

### Affective judgments of physical activity may depend on reflections of feelings during and after physical activity and the type of activity

Mistry, Chetan D., Rhodes, Ryan E.; University of Victoria

For experiences of aerobic physical activity, the peak (during) and the end (after) of the activity may be the most memorable (Hargreaves et al., 2013). When asked to report general affective judgements (AJs) of physical activity, it is unknown if individuals draw from experiences during and/or after the activity. Furthermore, it is unclear if AJs differ according to the type of the activity. The AJs of aerobic activities such as walking may mirror that of prior research on single bouts, with individuals drawing more from feelings during the bout than feelings after. The “during” of aerobic activities may be more salient than the stop-start of anaerobic activities like resistance training. The purpose of the present study was to determine if summary AJs during or after physical activity predicted general AJs for walking and resistance training. Participants were university students randomized to complete measures on either walking ( $n = 99$ ) or resistance training ( $n = 149$ ). Measures included an adapted feeling scale to assess summary reflections of basic affective valence during and after physical activity, general AJs about future physical activity, intentions to engage in physical activity and participation in either walking (W) or resistance training (RT). Hypotheses were tested using path analyses in AMOS. After controlling for pleasant feelings before the activity ( $\beta_W = 0.12, p = .056$ ;  $\beta_{RT} = 0.21, p < .05$ ), pleasant feelings during ( $\beta_W = 0.31, p < .05$ ;  $\beta_{RT} = 0.22, p < .05$ ) and after ( $\beta_W = 0.14, p < .05$ ;  $\beta_{RT} = 0.28, p < .05$ ) predicted AJs, adj.  $r^2_W = 0.16$ ; adj.  $r^2_{RT} = 0.25$ . The AJs were good predictors of intentions to walk ( $\beta = 0.36, p < .05$ ) and to resistance train ( $\beta = 0.40, p < .05$ ). In turn, intentions were significant predictors of both walking ( $\beta = 0.31, p < .05$ ) and resistance training behaviors ( $\beta = 0.66, p < .05$ ). AJs of walking may be more heavily based on feelings during the activity, whereas AJs of resistance training may equally depend on feelings during and after the activity. Memory of the peak (during) or the end (after) of physical activity may depend on the type of activity.

### Comparing opportunity and perceived capability as predictors of walking and strength training behaviors

Mistry, Chetan D., Rhodes, Ryan E.; University of Victoria

Perceived control is complex construct that may be best examined with at least two distinct factors—perceived capability (task efficacy) and opportunity to enact the task. Perceived capability is likely a less important predictor than opportunity in most cases of physical activity where other time demands and access are common barriers. Practiced behaviors (i.e., walking) that have been learned are more likely to be impacted by opportunity than perceived capability. Strength training may have more access issues and thus may also be more opportunity based. The purpose of this study was to determine if opportunity differed between strength training and walking behaviors. The secondary purpose was to determine if opportunity was a better predictor of walking and strength training intentions and behaviors than perceived capability. We further determined if opportunity was distinct from perceived capability by eliciting beliefs individuals drew from to report their opportunity for different physical activities. Participants were students enrolled in the winter term at a western Canadian university randomized to complete measures of intention, perceived capability, opportunity and participation in walking ( $n = 99$ ), or strength training ( $n = 149$ ). Opportunity to walk did not differ from opportunity to strength train,  $t(236) = -1.46, p > .05$ . Opportunity was a significantly stronger predictor of intentions to walk,  $\beta = 0.41, p < .001$ ;  $t(77) = 2.77, p < .05$ , and intentions to strength train,  $\beta = 0.26, p < .05$ ;  $t(77) = 2.51, p < .05$ , than perceived capability to walk,  $\beta = 0.03, p > .05$ , or perceived capability to strength train,  $\beta = 0.05, p > .05$ . Opportunity predicted walking behavior,  $\beta = 0.26, p < .05$ , yet perceived capability did not,  $\beta = -0.09, p > .05$ . Opportunity was not a significant predictor of strength training,  $\beta = 0.18, p > .05$ , nor was perceived capability,  $\beta = 0.14, p > .05$ . A thought elicitation procedure revealed that the top barriers or facilitators for both walking and strength training were related to time and fitting the behavior between other, important behaviors. Given that opportunity may be a robust predictor of intentions to walk and strength training, researchers should examine ways to facilitate opportunities to exercise among adults.

### **Can the regulatory and reflexive processes of the multi-process action control (M-PAC) model predict exercise adoption and maintenance?**

Mistry, Chetan D., University of Victoria; Sweet, Shane N., McGill University; Latimer-Cheung, Amy E., Queen's University; Rhodes, Ryan E., University of Victoria

Thus far, research efforts have focused largely on the effects of motivational processes on behavioral adoption, while the effects of regulatory and reflexive processes on behavioral adoption and maintenance has received less attention. The purpose of this study was two-fold. For hypothesis 1 (H1), we tested if changes in regulatory and reflexive processes of the multi-process action control model (M-PAC) predicted changes in exercise adoption. For hypothesis 2 (H2), we tested if changes in regulatory and reflexive processes predicted changes in exercise maintenance among only those who had successfully adopted exercise in the previous month. To test H1, we used a sample of inactive adults ( $N = 334$ ,  $M_{age} = 31.0 \pm 5.2$  years) with strong intentions to be physically active who were enrolled in a text messaging intervention (Mistry et al., in press). To test H2, we used a subsample ( $n = 134$ ) of participants who achieved at least 150 min of moderate-to-vigorous physical activity after 1 month in the intervention. Participants self-reported a regulatory process (action planning), a reflexive process (automaticity), and physical activity at baseline (T1), 1 (T2), and 2 (T3) months. Hypotheses were tested using structural equation modeling in AMOS. Path analyses revealed a good fit of the model for H1,  $\chi^2(98) = 396.3$ ,  $p < .001$ , CFI = 0.95, RMSEA = 0.070, 90% CI = .086, 0.11. From T1 to T2, changes in regulatory ( $\beta = 0.20$ ) and reflexive processes ( $\beta = 0.24$ ) predicted changes in exercise adoption. Path analyses also revealed a good fit of the model for H2,  $\chi^2(98) = 201.1$ ,  $p < .001$ , CFI = 0.93, RMSEA = 0.089, 90% CI = .071, 0.11. Among those who had adopted exercise by T2, changes in the maintenance of exercise from T2 to T3 were better predicted by changes in reflexive processes ( $\beta = 0.34$ ) than by regulatory processes ( $\beta = 0.19$ ). Regulatory and reflexive processes may be equally important during exercise adoption, but among those who adopted exercise after 1 month, continued exercise was reported as being more reflexive and less regulated.

### **Physical activity and its relationship with other goals or behaviors: A systematic review**

Mistry, Chetan D., Rhodes, Ryan E.; University of Victoria

Popular theories applied to understand physical activity (PA) are generally focused on behavior-specific determinants while facilitating and conflicting behaviors are given limited attention. The purpose of this review was to unite the literature examining other goals or behaviors and their relationship with PA when added to behavior-specific frameworks. We themed variables using their definitions and measures employed, determined the utility of examining other goals and behaviors within contemporary models and appraised whether they explained additional variance in PA. Ten electronic databases were searched through EBSCO with relevant keywords. Combined with manual bibliography and citation searches, 84 potentially relevant abstracts were screened, 20 of which full-text articles were retrieved. A total of 18 articles were included in the present review. Three themes emerged: 1) goals or behaviors that were assigned by the researcher and considered in isolation of PA ( $n = 5$ ), 2) goals or behaviors were assigned and considered relative to PA ( $n = 4$ ), and 3) goals or behaviors were elicited from participants and considered relative to PA ( $n = 9$ ). Across all three themes, evidence partially supported these constructs adding to our understanding of PA and its cognitions beyond that of existing constructs of contemporary theories, including social cognitive theory and the theory of planned behavior. In the first theme, 3/5 studies found support for other, facilitating goals and behaviors positively predicting PA and explaining additional variance. Studies from the second (3/4) and third themes (8/9) also supported this notion. Across all three themes, there was no evidence of other, conflicting goals and behaviors predicting PA. Although there is compelling evidence that other, facilitating goals and behaviors could help to explain additional variance in PA, further experimental research with larger, older and more diverse samples is warranted to examine how changes in other, facilitating goals and behaviors may lead to changes in PA.

### **Perseverance through mental blocking: Exploring coach-athlete dyadic relationships**

Moore, Chelsey N., Kowalski, Kent C., Kalyn, Brenda; University of Saskatchewan

Collective case study (Creswell, 2014; Stake, 1995) was used to explore the journey of coach-athlete dyads who were able to successfully maintain their training and interpersonal relationships throughout the course of the athlete enduring a mental block. Three coach-athlete dyads, plus one additional athlete, completed in-depth one-on-one interviews, discussing their coach-athlete relationship before, during, and after the mental block. All dyads were same sex, nationally ranked coach-athlete pairs, from sports involving mandatory elements that include both twisting and flipping components. Categorical aggregation of participant statements led to the formation of five main themes associated with dyads successfully overcoming a mental block (where success was defined as the athlete recovering their lost skill and the dyad maintaining their training and interpersonal relationship): 1. High levels of communication; 2. Watch what you say and how you say it; 3. Know your athlete and their goals; 4. Seek outside resources; 5. Be patient. Results suggest that an environment for success can flourish when each party is open, honest, and self-aware of their own limitations. It is suggested that future research utilize the 3 + 1Cs Model of the coach-athlete relationship in exploring how dyads can successfully overcome a mental block.

### Updating the Empowerment in Exercise Scale: Supporting psychometric evidence from a half-longitudinal study

Moore, E. Whitney G.; University of North Texas

Being empowered in exercise is expected to increase individuals' ability to overcome future barriers to exercise, because they believe that through exercising they can affect their health, lifestyle, and quality of life (Moore & Fry, 2014). The original Empowerment in Exercise Scale (EES; Moore & Fry, 2014) was expanded from 5 to 13 items to more thoroughly measure this entire construct of empowerment in the exercise context. The eight additional items were designed to more specifically measure individuals' belief that as a result of their current exercise experience they are able to a) effect positive change in their physical appearance, physiological or psychological health, or b) exercise outside of their current exercise experience. To assess the ability of these new items to more fully measure individuals' empowerment in exercise, high school students ( $N = 440$ ; grades 9–12) were surveyed during weeks 6 and 14 of a semester-long PE class (part of a larger study; Moore, 2013). A half-longitudinal (i.e., two-time-point) CFA was run with premeasures of the motivational climate (Caring Climate Scale; Newton et al., 2007; Perceived Motivational Climate in Exercise Questionnaire; Huddleston, Fry, & Brown, 2012), Ownership in Exercise Scale (OES; Moore & Fry, 2014), Satisfaction in Physical Activity (Duda & Nicholls, 1992), and empowerment. The CFA also included postmeasures of ownership, satisfaction in physical activity, and empowerment. The CFA passed configural,  $\chi^2(1495) = 2444.21$ , CFI = .90, NNFI = .89, SRMR = .06, RMSEA = .04, 95% CI [.040, .046]; weak ( $\Delta\text{CFI} = 0.001$ ); and strong invariance ( $\Delta\text{CFI} = 0.003$ ) over time. In addition, the updated EES had consistent, strong factor loadings (0.68–0.86). Lastly, the correlations between the constructs were in the hypothesized directions and magnitudes. Together, these results provide initial support for the future use of the expanded EES in the assessment of empowerment experienced by group exercise participants. Empowerment may help explain why some individuals succeed at maintaining their exercise habit despite barriers.

### Can intergroup competition with a virtual partner boost the Koehler effect?

Moss, Tayo M.; Feltz, Deborah L.; Kerr, Norbert L.; Michigan State University

Research on the Koehler effect (social comparison and indispensability) with a software-generated partner (SGP) in an isometric abdominal exergame has demonstrated an increase in physical activity persistence (Feltz, Forlenza, Winn, & Kerr, 2014). Another potential way to strengthen the effect is to enhance the relational bond between teammates by competing with an out-group. The current study investigated how incorporating a superior SPG into an exergame would affect an individual's motivation when competing against another human-SGP team in an isometric planking competition. College-aged students ( $N = 90$ ) completed two blocks of five isometric abdominal exercises for as long as they could using CyBuddy Exercise II. Participants were randomly assigned to one of three conditions (individual control IC, partner no competition PNC, partner with opposing-team PWT). Participants performed the first block alone, and after rest participants in the partner conditions performed the second block with an SGP, as a team, where the team's score would be defined as the score of the person quit first (conjunctive task demand). SGP's performance was always superior to the participant's. Those in the PWT condition were told that they and their SGP were competing against one other human-SGP team. Post hoc contrasts showed mean persistence difference scores (Block2-Block1) were significantly greater for participants in the PNC ( $M = 8.98$ ;  $SD = 38.61$ ) and PWT ( $M = 24.87$ ;  $SD = 56.57$ ) conditions compared to the IC ( $M = -39.31$ ;  $SD = 34.61$ ), but no differences between PNC and PWT,  $F(2,87) = 16.695$ ,  $p < .001$ . The perceptions of enjoyment were greater in the PWT condition ( $M = 5.12$ ;  $SD = .77$ ) compared to those in the IC ( $M = 4.71$ ;  $SD = .81$ ) and PNC conditions ( $M = 4.69$ ;  $SD = 1.54$ ). Lastly, in relation to team perception, participants in the PWT ( $M = 5.67$ ;  $SD = 1.56$ ) identified more with partner compared to the PNC ( $M = 4.75$ ;  $SD = 1.56$ ),  $F(1,58) = 5.283$ ,  $p = .025$ . Results suggest intergroup competition with an SGP shows a Koehler effect but greater enjoyment and sense of team than when no intergroup.

### Does playing male sport explain the second-quartile phenomenon for female relative age effects?

Mostenbocker, Mande D., Hancock, David J.; Indiana University–Kokomo

Governing bodies rely on laws and rules to minimize disadvantages in sport. Such actions have helped reduce gender (e.g., Title IX), racial (e.g., the NFL's Rooney rule), and competitive inequalities (e.g., rulebooks). One rarely governed inequity is relative age, referring to the age difference between athletes competing in the same age division. Typically, the oldest athletes (i.e., first-quartile athletes) in a cohort are more likely to be selected to elite teams, which is termed the relative age effect (RAE). Possibly, the lack of rules governing RAEs reflects the lack of understanding of how RAEs manifest. For instance, some researchers argue RAEs are physical advantages (e.g., Musch & Grondin, 2001), while others contend RAEs are facilitated by parents and coaches (e.g., Hancock et al., 2013a). As such, continued investigation is warranted. An unusual trend worthy of examination occurs in female sport. Specifically, recent evidence suggests that second-quartile athletes are most advantaged (Delorme et al., 2010; Hancock et al., 2013b; Weir et al., 2010). One possible explanation is that the best female athletes (who are more likely to be relatively older) play male sport at younger ages. Thus, the purpose of this study was to explore the second- quartile phenomenon in female sport by comparing female athletes who played female versus male sport. Participants were female hockey players ( $N = 97,909$ ; 7–17 years) registered in the province of Ontario during the 2008, 2010, and/or 2012 seasons. Examining each season separately, second-quartile athletes were most over-represented, while fourth-quartile athletes were most under-represented ( $p < .001$ ) regardless of whether participants were registered in female or male hockey. Additionally, with few exceptions, this pattern was pervasive across the five age divisions. This research confirms the existence of a second-quartile advantage for female athletes, but the trend did not differ from female to male hockey. Our discussion focuses on explanations for this trend, as well as future research directions. *Indiana University Undergraduate Research Program*

### The influence of transformational coaching on positive youth development

Newland, Aubrey, Newton, Maria, University of Utah; Moore, E. Whitney G., University of North Texas; Legg, W. Eric, University of Utah; Stark, Andrea, University of Minnesota

Understanding the relation of coach leadership styles to positive youth development (PYD) is crucial given the key role that coaches play in the experience of athletes (Gould & Carson, 2010). Transformational leaders (TL) influence their followers by role modeling appropriate behaviors, fostering acceptance of group goals, and providing inspirational motivation intellectual stimulation, individualized consideration, and high performance expectations (Bass, 1985; Podsakoff et al., 1990). Initial research has supported a link between TL and sport-specific PYD (Vella, Oades, & Crowe, 2013). A limitation of this study was that it failed to account for the nesting inherent in sport teams. Recent qualitative findings by Newland and colleagues (2015) suggest that coach TL may impact PYD outcomes outside of the sport context. This study examined the contribution of coach TL to PYD of 1) skills and assets developed through sport and 2) the 5 Cs (competence, confidence, connection, character, and caring; Lerner, 2004) outside of sport using multilevel modeling. Two hundred and one athletes nested within 28 competitive youth basketball teams completed questionnaires about their coaches' transformational leadership (Differentiated Transformational Leadership Inventory; Callow et al., 2009), as well as two measures related to their own PYD (YES-S, MacDonald et al., 2012; and PYD-VSF, Geldhof et al., 2014). Individual perceptions of coach TL contributed to skills and assets developed through sport ( $\beta = 0.18$ ,  $p < .001$ ) and the 5 Cs ( $\beta = 0.27$ ,  $p = .002$ ). Cross-level (individual by team) interactions of TL were present for the 5 Cs ( $\beta = .60$ ,  $p < 0.001$ ), suggesting that a player's perception of TL can magnify or diminish a player's development of the 5 Cs based on the team's perception of TL. That is, the highest PYD-VSF scores (measuring the 5 Cs) were reported by athletes who had higher than average individual perceptions of TL and who were on a team with above average team perceptions of TL. These results provide additional support for TL as an avenue to foster PYD. *AASP*

### Are sport skills life skills (Part II)? Which psychological skills learned in sport transfer beyond sport?

O, Jenny, California State University–East Bay; Law, Barbi, Nipissing University

Sport psychology practitioners often tout the transferability of psychological skills learned through sport participation to other performance domains (e.g., Kremer & Moran, 2013; Weinberg & Gould, 2015). Interestingly, however, little research exists identifying the specific skills athletes report transferring beyond sport. The purpose of this study is to obtain descriptive data concerning highly successful student-athletes' experience with psychological skills in sport and their application of those skills to other achievement domains. Twelve successful student-athletes (i.e., demonstrating both academic and athletic success; 3 male; 9 female;  $M_{\text{age}} = 22.75$  years,  $SD = 2.09$ ) from a range of independent ( $n = 5$ ) and interactive ( $n = 7$ ) sports participated in semistructured interviews regarding their use of psychological skills in sport and other performance domains. Interviews were transcribed verbatim and subjected to content analysis. Athletes described their previous experience and training with psychological skills ( $M = 2.45$  years,  $SD = 1.70$ ) and reported using psychological skills extensively, with imagery ( $n = 10$ ), goal setting ( $n = 9$ ), arousal regulation ( $n = 7$ ), and routines ( $n = 6$ ) reported most frequently. While psychological skills use was viewed as beneficial in sport and other domains ( $n = 12$ , not all psychological skills were transferred from sport to other domains with the same frequency as others. A variety of skills were transferred, with goal setting ( $n = 10$ ), imagery ( $n = 9$ ), and routines ( $n = 5$ ) cited most often. Collectively, results indicate that athletes believe psychological skills facilitate performance within sport and beyond. However, results may also indicate that certain psychological skills are being implicitly or explicitly taught/learned in sport such that subsequent between-domain transfer is perhaps less frequent and/or less pervasive. Discussion of these results will be framed within the transfer of learning research literature. *Queen's University Advisory Research Committee*

### The relationship of team cohesion to individual anxiety among recreational soccer players

Oh, Eungwang; Gill, Diane L.; University of North Carolina at Greensboro

In this research, we examined the relationship between cohesiveness and competitive state anxiety over two studies with recreational soccer players ( $n = 47$  in Study 1;  $n = 88$  in Study 2). More specifically, the contribution of cohesion (GEQ, Carron et al., 1985) to the prediction of competitive state anxiety (CSAI-2, Martens et al., 1990) beyond the contribution of competitive trait anxiety (SCAT, Martens, 1977) was examined. As expected, GEQ dimensions (ATG-T: individual attraction to the group-task; GI-T: group integration-task; and GI-S: group integration-social) were negatively correlated with cognitive and somatic A-state, and stepwise multiple regression analyses indicated that ATG-T was the strongest predictor of both cognitive and somatic state anxiety in both studies. Hierarchical multiple regression analyses were conducted to determine whether cohesion added to the prediction of cognitive and somatic A-state beyond the contribution of competitive A-trait. Competitive A-trait (SCAT) was entered first, followed by the GEQ subcomponents. Competitive A-trait contributed significantly to the regression model for cognitive A-state in both studies;  $R^2 = .11$ ,  $F(1, 45) = 5.28$ ,  $p < .05$  in study 1 and  $R^2 = .37$ ,  $F(1, 86) = 51.05$ ,  $p < .001$  in Study 2, and in the second step, ATG-T added significantly to the prediction in both studies;  $\Delta R^2 = .10$ ,  $F$  change (1, 44) = 5.25,  $p < .05$  in Study 1, and  $\Delta R^2 = .06$ ,  $F$  change (1, 85) = 9.57,  $p < .005$  in Study 2. Similarly, with somatic A-state, SCAT was a significant predictor, and after controlling for competitive A-trait, ATG-T contributed significantly in both studies;  $\Delta R^2 = .16$ ,  $F$  change (1, 44) = 10.82,  $p < .005$  in study 1, and  $\Delta R^2 = .03$ ,  $F$  change (1, 85) = 5.71,  $p < .05$  in Study 2. The findings suggest that recreational soccer participants with high ATG-T are likely to experience low competitive state anxiety. Implications of these findings for future research are discussed.

### MS Get Fit Toolkit: Evaluation of a physical activity information resource for Canadian adults with multiple sclerosis

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The MS Get Fit Toolkit was released in 2013 as a supplementary resource to Canada's physical activity guidelines (PAG) for adults with multiple sclerosis (MS). The final phase of development was its evaluation. The purpose of this study was to evaluate the effects of the Toolkit on outcome expectancies (OE), task self-efficacy (TSE), intentions, planning, and leisure-time physical activity (LTPA) behavior in comparison to the PAGs within a sample of Canadian adults with MS. Participants ( $N = 17$ ) were recruited online and randomized to one of two conditions: exposure to the Toolkit ( $n = 9$ ) or the PAG for adults with MS ( $n = 8$ ). Online questionnaires were administered to participants to assess the social cognitions and LTPA behavior at three time points (i.e., baseline, 1 week, and 1 month postexposure). A 3 (time)  $\times$  2 (condition) repeated-measures ANOVA and post hoc  $t$ -tests were used to analyze the between- and within-group differences. Between-group differences were found for only OE, the Toolkit condition exhibiting significantly higher OE than the PAG condition at 1 week ( $F = 5.58, p = .04$ ) and 1 month ( $F = 12.01, p = .01$ ) versus baseline. For TSE, the PAG condition showed significant increases for moderate-intensity LTPA between baseline and 1 week ( $t = .63, p = .02$ ), and 1 week and 1 month ( $t = 1.57, p = .01$ ). The TSE for heavy-intensity LTPA significantly increased for the PAG condition ( $t = 2.57, p = .03$ ) and Toolkit condition ( $t = 4.99, p = .01$ ) between baseline and 1 month. Intentions significantly increased in the Toolkit condition between baseline and 1 week ( $t = 1.78, p = .03$ ), 1 month ( $t = 1.00, p = .05$ ), and between 1 week and 1 month ( $t = 1.00, p < .01$ ). Action planning increased only for the Toolkit condition between baseline and 1 month ( $t = 1.32, p = .05$ ). Significant increase in total ( $t = 1.32, p = .02$ ) and strength training ( $t = .99, p = .05$ ) LTPA were revealed for the Toolkit and PAG conditions, respectively. This preliminary study suggests that the Toolkit may more positively influence LTPA cognitions among adults with MS than the PAG.

### The relationship between passion and burnout in coaching: An assessment of characteristics that influence passion and burnout levels in coaches

Paradis, Kyle F.; Pope, Paige; Hall, Craig R.; University of Western Ontario

Passion is defined as "a strong inclination toward an activity that people like, that they find important, and in which they invest time, and energy" (Vallerand et al., 2003, p. 757). The dualistic model of passion (Vallerand et al., 2003) comprises harmonious and obsessive dimensions. Harmonious passion is thought to result from an autonomous internalization of the activity into one's identity, whereas obsessive passion is thought to be a controlled internalization of the activity into one's identity. While harmonious passion has been linked to adaptive outcomes such as greater well-being (Mageau et al., 2005) and positive affect (Mageau & Vallerand, 2007), obsessive passion has been linked to a number of maladaptive outcomes such as dependence (Paradis et al., 2013), rigidity and inflexibility (Rip et al., 2006) and negative emotions (Phillipe et al., 2010). Another consequence of obsessive passion found in athletes has been athlete burnout (Curran et al., 2013). However, it would also seem probable that coaches who are also highly invested in these activities, may also be vulnerable to similar experiences of burnout. Thus the purpose of the current study was to assess various coaching characteristics as potential influences to passion and burnout levels. Participants were  $N = 360$  elite coaches ( $n = 212$  male,  $n = 148$  female) who filled out the Passion Scale (Vallerand et al., 2003) and the Maslach Burnout Inventory (Maslach et al., 1986). In addition, several demographic variables were collected from coaches as potential influencing factors on passion and burnout levels experienced. Results indicated that harmonious passion ( $\alpha = .82$ ) was significantly and negatively related to burnout ( $r = -.18, \beta = -.27, p < .01$ ), and obsessive passion ( $\alpha = .85$ ) was significantly and positively related to burnout ( $r = .31, \beta = .38, p < .01$ ). Additionally, significant differences were found in passion and burnout levels for gender, income, competition level, and hours/week coached. Implications are discussed pertaining to factors that may increase or reduce coach burnout.

### Differences in long-term memory consolidation as a function of heart rate intensity

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With an increased prevalence of sedentary behaviors in industrialized societies, a growing body of literature has begun to explore the effects of bouts of exercise on cognition. In spite of this, the implications as to how long-term memory consolidation may be influenced by activity throughout the day are still unknown. Accordingly, the purpose of this study was to examine differences in long-term memory consolidation as they relate to heart rate intensity measured between learning a declarative memory task and being tested on the task 12 hr later. A cross-sectional sample of college-aged young adults (50% female; age =  $19.4 \pm 1.3$ ) were assessed across two laboratory sessions. During the 12-hr interval between sessions, heart rate intensity was tracked using a Polar RCX3 heart rate monitor. Participants were bifurcated into groups based on memory consolidation. No differences in years of education, fitness level, body mass index, or prior night's sleep were observed between groups ( $ps = 0.1$ ). Analysis of the continuous heart rate data indicates that individuals who spent more time at sedentary heart rate intensities (quantified as a percentage of heart rate reserve [HRR]) throughout the day, demonstrated poorer long-term memory consolidation ( $ps = 0.05$ ). These findings indicate that consideration of time spent in sedentary activities may hinder long-term memory consolidation. Such findings further suggest that inclusion of physical activities throughout the day may be important for maintaining brain health and function.

**Video games, deliberate play, and sport-specific knowledge**

Parrington, Lucy; MacMahon, Clare; Wise, Lisa; Swinburne University

Research suggests that general cognitive abilities improve with playing video games (Green & Bavelier, 2012) and that expert video-gamers outperform non-gamers on general cognitive tasks (Boot, Kramer, Simons, Fabiani, & Gratton, 2008). Whereas differences between expert and novice athletes are believed to be attributed to sport-specific knowledge rather than basic cognitive ability (Memmert, Simons, & Grimme, 2009), it is plausible that sports video games may help improve decision making through the development of domain-specific knowledge. Indeed, playing video games may be categorized as a form of deliberate play (e.g. Côté, Baker, & Abernethy, 2007) by promoting the learning of key perceptual-cognitive skills, despite the focus of the activity being for entertainment. This study explored whether playing sport video games enhances decision making. Participants ( $n = 33$ ) were recruited from the 2014 Australian National Inline Hockey Championships across youth (12–16 years), junior (17–21 years), and senior (>22 years) age groups. A short-term gaming intervention and video-based decision making protocol were used. Sport and gaming history were collected, as were peer rankings of general and decision making ability. Preliminary findings show a link between participation in sports video gaming with higher player ranking. For example, a positive relationship was found between average rank of player general ability and years of sports gaming ( $r = 0.39, p = 0.025$ ) and average rank of player decision making and years of sports gaming ( $r = 0.446, p = 0.009$ ). These findings indicate that sport based video game play may go beyond mere entertainment and contribute to the development of perceptual cognitive skills, and thus may be considered a form of deliberate play.

**A temporal examination of achievement goals, motivational climate, and anxiety in collegiate swimmers**

Partridge, Julie A., Southern Illinois University; Massengale, Brittany D., University of Arkansas; Yamada, Masahiro, Porter, Jared M., Southern Illinois University

The purpose of this study was to examine the changes in relationships among achievement goal orientations, perceived motivational climate, and precompetitive anxiety, with attention to possible gender and specialty training group differences among collegiate athletes across a competitive season. A sample of 42 (23 male, 19 female) collegiate swimmers and divers, ages 18–23, completed the Achievement Goal Questionnaire for Sport (AGQ-S), the Perceived Motivational Climate in Sport Questionnaire-2 (PMCSQ-2), as well as the Competitive State Anxiety Questionnaire-2D (CSAI-2D) four times over their competitive season. A three-factor (wave  $\times$  gender  $\times$  training group) repeated-measures MANOVA revealed significant interactions for wave by gender by training group. In addition, results indicated significant main effect differences for wave and speciality training group; however, no main effect was found for gender. Follow-up within-subject one-way ANOVAs showed significant differences in the PMCSQ-2 and CSAI-2D subscales over the four waves of data collection. This suggests that these constructs are dynamic and can change over the course of a competitive season.

**A cross-culture examination of the validity of the Mindfulness Inventory for Sport: The development and validation**

Perng, Yi-Chen, National Taiwan University of Arts; Liu, Chu-Chih, Kainan University

Purpose: The present study aimed to develop and validate the Chinese Version of Mindfulness Inventory for Sport (CMIS). Method: The measurement was validated in two separate studies. Participants in study 1 were 166 male and 32 female collegiate athletes ( $M_{age} = 19.79, SD = 1.56$ ) from a variety of individual or team sports, and 136 male and 68 female collegiate athletes ( $M_{age} = 19.51, SD = 1.61$ ) were recruited in study 2. Exploratory factor analysis (EFA) and item analysis were conducted to examine the factor structure and the item appropriateness of CMIS. Confirmatory factor analysis, correlation test, as well as the multigroup CFA were conducted to examine the construct validity, criterion-related validity, and the measurement invariance of CMIS. Result: Attention control and non-judgment were extracted by EFA. Item analysis supported the appropriateness of each item. A 15-item two-factor version of CMIS demonstrated a good model fit with acceptable evidence of gender and sport type invariance. In addition, the subscales of the CMIS revealed significant correlations with relative criterions in a differential pattern that supported the criterion-related validity and discriminant validity of CMIS. Conclusion: Finally, the 15-item version of CMIS was developed.

### Possible selves and physical activity in retirees: The mediating role of identity

Perras, Mélanie G.M., University of Ottawa; Strachan, Shaelyn M., University of Manitoba; Fortier, Michelle S., University of Ottawa; Meade, Laura, University of Manitoba

Despite the potential for retirement to offer retirees increased leisure time, many retirees remain insufficiently physically active for health benefits. Self-perceptions influence physical activity behavior and may be particularly useful in understanding and increasing physical activity in retirees. Indeed, the transition from work to retirement is viewed as a period for self-exploration and enhancement during which retirees may self-reflect on their health and who they are. Possible selves and identity are two self-perceptions that, when examined relative to physical activity, may help explain physical activity among retirees. Scholars claim that a focus on possible selves may impact identity, which, in the physical activity domain, is a known physical activity correlate. Therefore, identity may serve as a mechanism through which possible selves relate to physical activity. The aim of this study was to examine the relationship between these variables by determining whether exercise identity mediates the relationship between physical activity possible selves and physical activity. We examined the proposed mediation relationship in 531 new retirees. Data on physical activity identity, physical activity possible selves (content and regulatory processes) as well as physical activity behavior (minutes of moderate-to-vigorous physical activity) was collected across three time points (1 month apart from each other) via online questionnaires. Using the PROCESS macro for SPSS, we conducted mediation analyses with bootstrapping resampling methods. Results show that identity mediated the relationship between possible selves (content and processes) and behavior—all related to physical activity, after controlling for past physical activity. The findings contribute to our understanding of the nature of the relationship between identity, possible selves, and physical activity in new retirees. Moreover, these findings provide information about how self-perceptions may be harnessed in intervention efforts to increase physical activity in new retirees.

### The creation and dissemination of a positive athlete stereotype: Exploring the 2014 Sochi Paralympic Games media

Perrier, Marie-Josée, McMaster University; Ventresca, Matt, Queen's University; Martin Ginis, Kathleen A., McMaster University

Purpose: Paralympic athletes are often represented as survivors of tragedy, which can lead to negative stereotypes about disability and Paralympic sport. Yet, little is known about why athletes are represented in this manner and how this representation affects the general public's perceptions of adapted sport and disability. The objective of this project was to explore how journalists developed stories about the 2014 Sochi Paralympic Games and to explore the general public's perceptions of athletes after reading sample news stories. Method: Twenty participants (4 journalists, 10 people without disabilities, 6 people with disabilities) engaged in hour-long interviews; seven news stories about the 2014 Sochi Paralympic Games were used to foster discussion about Paralympic media and Paralympic athletes. Interviews were transcribed verbatim and transcripts were analyzed using a dialogical narrative analysis. Results: Journalists aimed to represent Paralympians as elite athletes by focusing on athletic traits, such as agility and perseverance, rather than perpetuate negative stereotypes by focusing on impairment and the body. After reading the stories that focused on Paralympians' training regimes and event recaps, participants without disabilities perceived Paralympians as successful, elite athletes and had a greater appreciation for the athleticism needed to compete in Paralympic sport. Furthermore, participants had negative reactions to the stories that focused on athletes' disabilities and rather than the competition. Participants with disabilities stressed the importance of presenting the athlete first and avoiding stories that focus on how Paralympic athletes were injured and "overcame" disability to avoid negative stereotypes of Paralympic athletes. Conclusion: Given that journalists were keen to highlight athletes' skills and accomplishments to dispel negative stereotypes of disability and align with readers' preferences for Paralympic media, journalists should continue to focus on stories that introduce Paralympic athletes, their training, and event outcomes.

### An exploration of peer leadership and group dynamics in high school spirit teams

Pierotti, Chelsea P., Babkes Stellino, Megan; University of Northern Colorado

With millions of young athlete leaders in a position to influence their peers through participation in sport, it is valuable to understand the nature, direction, and mechanisms of that influence. The purpose of this study was to examine the relationships among peer leadership, cohesion, collective efficacy, and satisfaction in high school female athletes. Based on Chelladurai's (1978, 1993) multidimensional model of leadership, peer leadership was hypothesized to influence satisfaction directly, as well as through mediating relationships with both cohesion and collective efficacy. High school female dancers and cheerleaders ( $N = 235$ ) ages 12 to 18 years completed measures of perceived peer leadership behaviors, as well as their feelings of cohesion, collective efficacy, and satisfaction with their current team. The relationship of all four constructs was measured using structural equation modeling and canonical correlations. Findings revealed the proposed mediational model indicated moderate fit,  $\chi^2(119) = 207.075, p < .001$ , CFI = .934, RMSEA = .065, SRMR = .051, but a secondary model with only cohesion as a mediating variable had better fit,  $\chi^2(108) = 159.794, p < .001$ , CFI = .941, RMSEA = .054, SRMR = .048. In the new best-fit model, cohesion was a mediating variable between leadership behaviors and collective efficacy. All five of the peer leadership behaviors predicted cohesion, but social support was the strongest predictor. Cohesion, especially task cohesion, best explained higher levels of collective efficacy and satisfaction among the athletes. The results show the importance of educating peer leaders on their ability to make a difference on their team by offering continued social support and including their teammates in the decision-making process. Beyond practical implications, the results also offer further theoretical implications for high school female athletes. The relationship between peer leadership behaviors and athlete satisfaction is not a direct relationship, but reflects more about the cohesion felt among the teammates.



**Who is in control?: A physical activity intervention targeting changes in social control**

Pinkerton, Sean, Wilson, Kathleen S., Rutkowski, Elaine; California State University–Fullerton

Social Control (SC) is a regulatory type of social influence where one individual prompts or persuades another to perform a desired behavior (Lewis & Butterfield, 2005). For physical activity (PA), this regulatory influence has been reported to be used by parents and linked to increased PA in their children (Wilson & Spink, 2011). However, previous research focused on correlational designs, with changes in SC use by parents in response to interventions yet to be examined. This study explored if a pilot PA intervention could change parent and child reports of SC use as well as PA levels. Parent and child dyads ( $n_{\text{dyads}} = 19$ ) were recruited from university employees and their children aged 8–17 years ( $M = 11.5$ ,  $SD = 2.0$ ). Dyads were randomly assigned to an intervention group in which parents promoted activity with their child or control group in which parents received an intervention targeting the parent themselves. The intervention was delivered through weekly emails over a 10-week period, where each email provided an activity targeting a regulatory skill (e.g., goal setting). Parents and children in both groups completed a before and after online survey, which included a PA recall and SC measure (three types of SC assessed: positive, collaborative, and negative). Data were analyzed using a 2 (time)  $\times$  2 (group) ANOVA with an alpha level of 0.10. A significant interaction was identified for parents' report of collaborative SC use ( $p = .03$ ,  $\eta^2 = .24$ ), but no significant differences found for positive and negative SC ( $ps > .15$ ). Child reports showed a trend toward significance for collaborative SC ( $p = .13$ ,  $\eta^2 = .13$ ) but no significant differences for positive and negative SC ( $ps > .15$ ). PA reports showed no significant interactions for parent PA ( $p = .40$ ,  $\eta^2 = .04$ ) and child PA ( $p = .39$ ,  $\eta^2 = .04$ ). These findings suggest that an intervention is able to influence the parent's use of and the child's perception of collaborative SC. More importantly, these results demonstrate a need to further investigate the effects of a PA intervention as an influence on SC and whether this translates into changes in PA.

**“Sweet likes”: Social media interactions about physical activity**

Pinkerton, Sean, Tobin, Jessi L., California State University–Fullerton; Querfurth, Sydney C., University of Münster; Pena, Iowayna M., Wilson, Kathleen S., California State University–Fullerton

The benefits of social relationships on an individual's health and well-being have been well established in the literature (Cohen, 2004). With the popularity of social media sites such as Facebook (Kaplan & Haenlein, 2010), it is not surprising that social media exchanges have been associated with improved social capital and psychological well-being (Ellison, Steinfield, & Lampe, 2007). One might wonder the role that these virtual exchanges play in a specific behavior such as physical activity (PA). The purpose of this study was to explore social interactions over social media with regards to PA. Participants ( $N = 244$ ;  $M_{\text{age}} = 24.5$  years) completed a cross-sectional survey that asked their reasons for posting or not posting about PA. Other questions included a 7-day recall of PA, demographic variables, and how participants respond to others' PA-related posts. Open-ended questions about reasons for posting, for not posting, and responses to others' posts were analyzed using a thematic analysis. The majority of participants used social media (93.3%) with just over half of those posting about PA (54.1%). Participants who posted about PA reported checking social media more frequently ( $p = .008$ ) than those who did not post. Time spent on social media sites did not differ between those who posted about PA and those who did not ( $p = .26$ ). Results indicated that the main reasons for sharing PA included keeping people informed (36.4%), inviting others to join in (12.1%), inspiring others (14.4%), and gaining recognition (12.9%). Common reactions reported by participants to others' posts included encouragement (46.6%) and “liking” the post (39.7%). For those who did not share, reasons reported were privacy concerns (35.5%) and a lack of interest (31.2%). Individuals who did share reported significantly higher total PA ( $p = .006$ ) than those who did not share on social media. These findings suggest some individuals may receive social support for PA over social media. Future research is needed to further investigate the relationship between social media, social support, and PA.

**“Tips” from the pros: Comparison of the highest- and lowest-scoring NHL teams on shot-type usage and effectiveness**

Rathwell, Scott, McKay, Brad, University of Ottawa; Caron, Jeffrey G., McGill University

Publicly available National Hockey League (NHL) performance data allow for empirical analysis of player actions and their effectiveness. Shot-on-goal data from the highest and lowest scoring NHL teams (Chicago Blackhawks and Buffalo Sabers, respectively) were analyzed from the 2013–2014 season. Six separate shot-types and their outcomes (goal or no goal) were tracked: Wrist-shot, snap-shot, slap-shot, backhand, wrap-around, and deflection. While the Chicago Blackhawks outshot (2711 – 2157) and outscored (260 – 152) the Buffalo Sabers, both teams used each shot-type at similar rates. The Blackhawks were 1.4 times more likely to score ( $p = .002$ ) on their shots in general. When each shot type was analyzed, it was revealed that Chicago was 2.7 times more likely to score on a slap-shot ( $p = .004$ ), and 2.2 times more likely to convert a deflection into a goal, ( $p = .008$ ). The effectiveness of other shot-types did not significantly differ between teams. The most common shot-type for both teams was the wrist-shot (51%), followed by the slap-shot (23%), snap-shot (11%), backhand (8%), deflection (5%), and wrap-around (2%). Forwards and defenders differed with regard to their use of each shot-type. Forwards used all shot-types in similar proportions to those described above. Forwards were 1.5 times more likely to score with a wrist-shot than a snap-shot ( $p = .051$ ), and 2.5 times more likely to score with a deflection than a wrist-shot ( $p < .001$ ). Conversely, defenders relied on slap-shots (52%), wrist-shots (36%), and snap-shots (9%) almost exclusively, and the effectiveness of each shot-type did not differ significantly. These results suggest three potential conclusions: 1) the most effective shot-on-goal is a deflection, 2) scoring differences between teams are a function of shot quantity but also shot quality, and 3) the Blackhawks were more effective at converting slap-shots and deflections into goals than the Sabres, perhaps suggesting superior talent at the defense position, a more effective system at generating and executing slap-shots from the point, or both. *SSHRC*

### **An exploration of the psychometric properties of the youth experience survey with Canadian university athletes**

Rathwell, Scott, Young, Bradley W.; University of Ottawa

Although the topic of whether positive development occurs through sport has received much empirical attention in youth/adolescent cohorts, university sport settings are potent yet under-examined venues for personal and social growth (Flett et al., 2010; Rathwell et al., 2014). There have been efforts to validate specific tools for younger sporting cohorts (MacDonald et al., 2012); however, a specific survey measuring university athletes' personal and social development through sport has yet to be developed. This study tested the fit and factor structure of the Youth Experience Survey 2.0 (YES2.0; Hansen & Larson, 2005) in a sample of Canadian university athletes. The YES2.0 was designed to assess youth's (range: 12–21 years) developmental experiences within any structured activity and its application to older sport cohorts is unknown. A total of 605 athletes (237 males, 368 females;  $M_{age}$ : 20, range: 17–25) from 26 different university sports completed the YES2.0. Using AMOS software, a confirmatory factor analysis was conducted to fit the data to Hansen and Larson's (2005) proposed 11-factor model. Results showed problems with model fit, CFI = .734, RMSEA = .053, SRMR = .065. A subsequent exploratory analysis was performed to improve model fit using an iterative specification process guided by modification indices. Results yielded a measurement model with good model fit, CFI = .914, RMSEA = .049, and SRMR = .046. All standardized regression weights were >.6 and Cronbach's alphas for each scale were >.755. The resulting modified 42-item survey measures seven dimensions of university athletes' development, with five positive latent factors (i.e., identity, initiative, interpersonal skills, teamwork and off-campus support) and two negative latent factors (i.e., stress and negative leadership). Discussion focuses on the merits of this refined instrument for measuring developmental outcomes in Canadian university sport settings, limits regarding the breadth of the assessed outcomes in relation to university cohorts, and future steps to further validate the scale in this cohort. *SSHRC*

### **Effects of peppermint scent administration on augmenting swimming performance: Challenges related to orthonasal vs. retronasal scent administration**

Raudenbush, Bryan, Cochran, Nic, Lamp, Melanie; Wheeling Jesuit University

Past research indicates the positive effects of peppermint scent administration on athletic performance in a variety of sports (i.e., soccer, basketball, golf) and exercise (i.e., push-ups, hand-grip, running speed) domains. The present study assessed the effects of peppermint scent administration on augmenting swimming performance. In Study 1, Division II swimmers completed both a 50-m and a 200-m race in both an orthonasal peppermint scent administration condition and a non-scented control condition. In addition, questionnaires related to mood (POMS) and workload (NASA-TLX) were completed. Controlling for sex, BMI and years of competition, there was a trend for the peppermint scented condition to decrease the 50-m time by 3.3% and the 200-m time by 0.7%,  $F(1, 15) = 3.55, p = .08$ . Because this effect is lower than that noted in other sports, it was hypothesized that the sport of swimming presents a unique challenge, since swimmers often breathe through their mouth, thus diminishing the effects of orthonasal scent administration. In Study 2, swimmers completed the same races, but with the administration of an orally inhaled peppermint scented oxygen, with the hypothesis that this retronasal administration may be better suited to swimmers who breathe through their mouth. No significant oxygenated peppermint effect was found,  $F(1,9) = 0.94, p = .36$ . The results of these two studies indicate that some effect can be found through orthonasal scent administration for swimmers; however, the addition of a retronasal scent administration produces no tangible augmentation of swimming performance. With swimming competitions typically being won or lost by mere hundredths of a second, future studies should address additional ways of overcoming this scent administration challenge. *Grant to Bryan Raudenbush from the West Virginia Space Grant Consortium*

### **Effects of cinnamon scent administration on physiology, range of motion, mood, anxiety and perceived workload during a multisession physical therapy program**

Raudenbush, Bryan, Johnson, Kristin, Moore, Sierra, Florian, Jessica, Burke, Allison; Wheeling Jesuit University

Scents have been shown to elicit both emotional and physiological responses. The current study aimed to evaluate the possible effects of cinnamon scent when applied to a physical therapy regimen. Forty-two undergraduate students, 16 male and 26 female, completed a four-trial physical therapy regimen in one of two rooms: a control room or a room infused with a cinnamon scent. The experimenters measured participants' range of motion, mood (POMS), and anxiety (STAI) prior to and following each trial of exercises. At the end of each visit, perceived workload was assessed (NASA-TLX). The data were analyzed using a 4 (visits)  $\times$  2 (groups) mixed-design ANOVA. Significant results were found for ratings of effort on the NASA-TLX,  $F(3, 120) = 2.8, p = .042$ . Participants in the cinnamon scent condition rated their perceived effort exertion as being lower than participants in the control condition. Decreased perceived effort may cause patients undergoing a physical therapy program to feel more comfortable while completing their exercises, thus increasing the likelihood of adherence to the program.

### Who is an athlete? A comparison study of athletic identity in former college athletes, current student-athletes, and non-athlete college students

Reifsteck, Erin J.; University of North Carolina at Greensboro

Athletic identity has garnered much attention in the sport and exercise psychology literature over the years, and, in particular, has been a central construct of interest in research on sport career transitions, including its influence on emotional adjustment and physical activity participation in former athletes (Douglas, 2009; Grove et al., 1997; Reifsteck, 2013). The purpose of the present study was to investigate the meaning and measure of the athletic identity construct to further understand how this identity influences athlete behavior and evolves through sport transitions. First, athletic identity was measured using the Athletic Identity Measurement Scale (AIMS) with former collegiate student-athletes ( $N = 285$ ), current student-athletes ( $N = 284$ ), and non-athlete college students ( $N = 100$ ). Results indicated that current student-athletes ( $M = 39.82$ ) had significantly ( $p < .01$ ) higher AIMS scores than their non-athlete college peers ( $M = 30.29$ ) as well as in comparison to former student-athletes ( $M = 31.98$ ). However, non-athlete college students and former student-athletes reported similar AIMS scores ( $p > .05$ ). Overall, men ( $M = 35.69$ ) scored significantly higher ( $p < .01$ ) on the AIMS than women ( $M = 32.37$ ), but there were no significant gender differences in athletic identity among current student-athletes ( $p > .05$ ). After assessing quantitative differences in athletic identity, responses to the question “what is athletic identity” were coded. Responses of athletes and non-athletes were compared, and revealed both similarities and differences. For instance, both athletes and non-athletes acknowledged that athletic identity was rooted in self-perceptions as well as others’ perceptions, but non-athletes tended to define descriptive characteristics of athletic identity more broadly. Clarifying the meaning of the construct from these varied perspectives provides insight into how athletic identity evolves and influences the psychological and physical dimensions of the transition out of college sports.

### Using short vignettes to disentangle perceived capability from motivation: A test using walking and resistance training behaviors

Rhodes, Ryan E., University of Victoria; Williams, David M., Brown University; Mistry, Chetan D., University of Victoria

Self-efficacy is arguably the largest correlate of physical activity, yet some researchers suggest this is because the construct confounds ability with motivation. Williams and Rhodes (2014) have proposed a more circumscribed construct, called *perceived capability*, meant to measure ability but not motivation and propose that the construct will not be related to simple physical activities that do not require skill but may be linked to more skill-based and complex behaviors. The purpose of this study was to examine whether a perceived capability construct can be stripped of motivational confounds using a disambiguated vignette approach in both walking (simple) and resistance training (more complex) behaviors. Participants were a random sample of 248 university students who were then randomly assigned to either answer resistance training or walking behavior questions. Both groups completed a perceived capability measure and reasons for their answer before and after reading a vignette that disambiguated the phrasing of capability to literal use of the term. Perceived capability was significantly ( $p < .01$ ) higher post-compared to pre-vignette and the differences were greater ( $p < .01$ ) for walking than resistance training. Perceived capability had significantly ( $p < .01$ ) smaller correlations with intention and behavior post-disambiguation, which resulted in a null relationship with walking but a small correlation with resistance training behavior. When perceived capability was combined with intention to predict behavior, however, there was no significant ( $p > .05$ ) difference in the amount of variance explained pre- to post-vignette. Thought listing showed that participants did not report capability barriers to walking and over half of the sample construed capability as motivation/other priorities. The findings support use of a vignette approach for researchers who wish to disentangle the assessment of perceived capability from motivation while creating no overall loss in explained variance of physical activity.

### The effect of stereotype threat on student-athlete math performance

Riciputi, Shaina C., Purdue University; Erdal, Kristi, Colorado College

Student-athletes are susceptible to stereotype threat-related performance decrements on academic tests following exposure to a prime making their athletic identity salient, due to the prevalent notion of the “dumb jock stereotype” in higher education settings (Yopyk & Prentice, 2005). This study expanded on previous research documenting these stereotype threat-induced drops in performance in NCAA Division I (DI) male student-athletes by examining stereotype threat effects on academic performance in DI female student-athletes and Division III (DIII) student-athletes of both genders. Ten female DI and 32 DIII student-athletes (62.5% male) attending a liberal arts college participated in the study. Participants were either primed with their athletic identity or not, then all completed a timed 10-item multiple-choice math test. Math ability was controlled using participants’ standardized math test scores. It was hypothesized that athletically primed student-athletes would perform worse than unprimed athletes. Females were anticipated to perform worse than males when primed, while DI athletes were expected to perform worse following a prime than DIII athletes. A  $2 \times 2$  factorial ANCOVA on math score revealed a main effect of prime condition,  $F(4,36) = 7.49$ ,  $p = .01$ , where participants primed with athletic identity scored lower ( $M = 3.87$ ,  $SE = .35$ ) than unprimed athletes ( $M = 5.27$ ,  $SE = .36$ ). Performance on the test did not vary with gender or NCAA division. The results of this experiment support the primary hypothesis about the overall effects of the athlete prime, providing initial evidence for stereotype threat effects in DI female and DIII student-athletes. These findings add to a growing picture of the potential impact of stereotyping on the academic success of student-athletes across a spectrum of collegiate environments, with important implications for understanding how and why stereotype threat hinders performance in different groups.

### **The effects of soccer ball “heading” frequency and intensity on scent perception: Severity of effects in adolescence during high school competition**

Robinson, Emily, Raudenbush, Bryan; Wheeling Jesuit University

Past research shows that soccer ball heading has detrimental effects on memory, reaction time, and impulse control, as well as scent identification ability and olfactory functioning. The current study examined the effects of heading frequency and intensity on scent identification of high school soccer players. Researchers predicted that the total correct scent identifications would be lower for those players who head the soccer ball with high frequency and intensity. Seventy high school soccer players (30 men and 40 women) completed a brief survey about their soccer-playing history. They were then asked to complete the Brief Smell Identification Test (BSIT). An independent samples *t*-test showed females correctly identified more scents than males. Two groups were formed from the data collected from the survey: a high and low group based on the number of times a ball was headed and a high and low group based on the intensity with which the ball was headed. A two between ANOVA was completed on both the frequency group and the intensity group. Results showed that those who headed the ball more frequently had significantly fewer correct scent identifications. Also, those who headed the ball with greater intensity had significantly fewer correct scent identifications. A two between ANOVA was performed on these two groups and focused on males only, which resulted in males with higher heading intensity and higher heading frequency performing significantly worse in scent identification than females. A positive correlation was also found in males between age and heading the ball more frequently. Soccer players should consider this research in order to educate and prevent future damage to the nasal cavity.

### **Understanding coaches’ reported interpersonal behaviors**

Rocchi, Meredith, Pelletier, Luc; University of Ottawa

Coaches play an important role in athlete motivation. According to self-determination theory (SDT), coaches influence their athletes’ motivation through the extent their interpersonal behaviors support or thwart their athletes’ three basic psychological needs (autonomy, competence, and relatedness). When coaches’ interpersonal behaviors are supportive, an athlete will experience an increase in need satisfaction and a subsequent increase in motivation quality for their sport. The opposite is seen when coaches’ behaviors thwart their athletes’ needs. Despite the importance of interpersonal behaviors, no studies have examined the psychological and motivational predictors of all six types of need-supportive and need-thwarting interpersonal behaviors for coaches. The purpose of the present study is to address this limitation and examine whether coaches’ need satisfaction leads to an increase in their motivation quality, and then an increase in their reported need-supportive interpersonal behaviors and a decrease in reported need-thwarting behaviors. The sample was comprised of 300 Canadian basketball coaches who participated in the study through their provincial basketball association. They reported on their need satisfaction, their motivation, and their interactions with their athletes. The model was tested through structural equation modeling, and the results suggested that the model fit the data well,  $\chi^2(533) = 964.40$ ,  $p < .001$ , SRMR = .047, CFI = .912, TLI = .902. When coaches reported that their needs were satisfied, it led to an increase in motivation quality. High motivation quality was positively associated with reports of need-supporting and negatively associated with need-thwarting interpersonal behaviors. Of the six types of interpersonal behaviors examined, motivation quality had the strongest relationship with relatedness-supportive behaviors ( $\beta = .64$ ) and the weakest with autonomy-thwarting behaviors ( $\beta = -.31$ ). The results support that coaches’ own motivation quality is associated with how they coach and interact with their athletes.

### **Experiences among women with shame and self-compassion in cardio-based exercise classes**

Rogers, Kim, Ebbeck, Vicki; Oregon State University

Shame is a debilitating inner experience elicited by the negative self-appraisal of one’s entire self, and is characterized by a deep-seated sense of being flawed, and therefore unworthy of acceptance and belonging (Brown, 2006). Although significant research has explored self-conscious emotions, including shame, little has been done to examine shame in specific exercise settings that may actually promote the experience of shame. Using Brown’s (2006) *shame resilience theory* as a guiding framework, the purpose of this study was to examine the experiences among women with shame, and the shame-resistant attribute of self-compassion, in exercise, as well as to identify possible strategies for creating a climate in cardio-based exercise classes that emphasizes self-compassion over shame. An interpretative phenomenological analysis epistemology and methodology was used to analyze, understand, and interpret the meaning and lived experiences of shame and self-compassion among 15 women in cardio-based exercise classes. Three superordinate themes emerged for both shame (“I’m just not enough,” “There’s something wrong with me; I don’t belong here,” and “Shame moves in and takes over”) and self-compassion (“The importance of relationships,” “Self-compassion makes me feel whole,” and “Self-compassion is so hard, but it’s worth it”), and four superordinate themes emerged representing the proposed strategies (“Talk about shame in the classroom,” “Create the right climate,” “Establish guidelines for instructors,” and “Learn to help yourself”). The findings of this study suggest that certain elements in an exercise class setting, as well as the type of exercise class, promote shame experiences for women. This study also provides support for the role of self-compassion as a protective and shame resilient mechanism. Further research is needed to expand on the relationships between shame and self-compassion in more diverse samples of exercisers, as well as the application of this study’s proposed strategies in a variety of group, team, and individual exercise setting. *School of Biological and Population Health Sciences*

**Psychological responses and return to play following anterior cruciate ligament reconstruction surgery**

Russell, Hayley, Penn State–Altoona; Wiese-Bjornstal, Diane M., Arendt, Elizabeth A., Agel, Julie, University of Minnesota

Conceptual models of return to play following sports injury prescribe a multidimensional approach (Creighton et al., 2010) to understanding influences on return to play outcomes following anterior cruciate ligament (ACL) surgery and rehabilitation. Theories and empirical evidence about psychological responses to ACL injuries show that cognitions such as self-efficacy and perceived recovery, affects such as fear of re-injury and depression/anxiety, and behaviors such as rehabilitation adherence are among the specific factors predictive of return to play outcomes following ACL injuries (te Weirke et al., 2012; Wiese-Bjornstal et al., 1998). Examining dynamic patterns of specific psychological responses such as these across the latter time course of ACL rehabilitation is necessary in order to understand how they relate to outcomes, specifically return to play. Therefore, the purpose of this study was to determine if psychological responses to ACL injuries during the latter stages of rehabilitation (4-, 6-, and 9-months post-surgery) were different between athletes that returned to play by 9-months post-ACL surgery (returners) and those who did not (non-returners). Participants (21 males, 22 females,  $M_{age} = 28.44$ ,  $SD = 12.77$  years) were physically active individuals who were rehabilitating from surgically repaired ACL tears. Psychological measures repeated at 4, 6, and 9 months included knee self-efficacy, perceived percent recovery, perceived limitations to ability, mental health, and fear of re-injury. The outcome measure of interest was self-reported return to play status at 9 months post-ACL reconstruction surgery. Analyses revealed that returners had less fear of re-injury than non-returners at the 9-month assessment but not at 4 and 6 months post-surgery. Returners also reported higher levels of perceived recovery and lower perceived limitations to ability across 4, 6, and 9 months post-surgery. These results demonstrated that psychological responses are associated, in the hypothesized directions, with return to play status post-ACL surgery.

**Exercise “dating”: Instigating preferred social support for exercise through a match-making website for women cancer survivors**

Sabiston, Catherine, Amireault, Steve, Tamminen, Katherine, Fong, Angela, University of Toronto; Jones, Jennifer, Princess Margaret Cancer Center

Upwards of 90% of cancer survivors are not active at levels that confer health benefits (Lynch et al., 2010; Sabiston et al., 2014). A common reason for not exercising is “no one to exercise with” or “no one to help or support me” (Brunet et al., 2013; Barber, 2013). Women are particularly at risk for low levels of physical activity and use social support as a coping strategy for a number of stressors, including a cancer diagnosis. Interventions focused on enhancing social support for physical activity may be valuable among women cancer survivors. The purpose of this study was to develop an exercise partner matching system. Two focus groups with women cancer survivors ( $N = 9$  total) were held to better understand social barriers to exercise, women’s social needs, and physical activity partner characteristics that would inform the development of a website to match women with other women. The findings of the focus group discussions highlighted age, life circumstance (i.e., developmental phase), distance from home/location, interest in exercise, type of cancer, severity of cancer, exercise history, and personality as integral factors for an exercise partner matching algorithm. Women discussed liking the possibility of having exercise partners selected for them based on the important criteria, and also autonomy in choosing their partners. Some women discussed a desire to have behavioral counseling along with partner matching, while others felt that they would welcome the opportunity to figure out new exercise routines with a partner with no further intervention. Considering these findings, and since social support helps people become and stay physically active, an exercise matching tool has been designed for women to find an “ideal” match to provide social support for exercise. Active Match (see [www.activematch.ca](http://www.activematch.ca)) is developed for partnering women cancer survivors with others for exercise purposes, and will be evaluated for effectiveness of increasing exercise over time.

**Active Living Leaders Training Program for spinal cord injury: A peer training program with key components to influence users’ self-efficacy**

Salci, Lauren E., Ginis, Spero, Martin Ginis, Kathleen A.; McMaster University

Study Design: Quasi-experimental pre- to posttraining design. Objectives: Active Living Leaders Training Program (ALLTP) equips individuals with knowledge and skills to encourage those with spinal cord injury (SCI) to increase their physical activity levels. The purpose of this study was to (a) evaluate participants’ perceptions of the relevance/usefulness of the ALLTP material and its presentation; (b) examine how participants’ self-efficacy changed throughout their completion of the ALLTP; and (c) explore the key components of the program that are associated with participants’ self-efficacy. Setting: Canada Method: Six SCI physical activity trainers and six adults with SCI participated in the study. Participants completed three parts of ALLTP and after each part completed feedback surveys assessing relevance/usefulness of content/resources, presentation of material, self-efficacy to speak about and encourage physical activity among those with SCI, and other feedback items. Means, standard deviations, repeated-measures ANOVAs and Pearson’s correlations were computed. Results: Relevance / usefulness of content / resources and presentation of material were rated favorably. Participants’ self-efficacy significantly decreased from pre- to posttraining. Participants’ self-efficacy to speak about physical activity with individuals with physical disabilities and to encourage individuals with SCI to partake in physical activity were positively correlated with program content and its delivery. Conclusion: ALLTP is perceived positively by users. Decreased self-efficacy to encourage those with SCI after the practical component of the training may be due to participants noticing the complex nature of mentoring through practical sessions. Recommendations to emphasize the key components within ALLTP that positively influence self-efficacy are provided.

### Interactive dialogue is important in software-generated workout partners

Samendinger, Stephen, Max, Emery J., Winn, Brian, Kozma, Gregory, Jeffery, William, Kerr, Norbert L., Michigan State University; Forlenza, Samuel T., Shippensburg University; Feltz, Deborah L., Michigan State University

Exergame group dynamics may be an important means to enhance motivation for physical activity. Previous research employing the Koehler effect (a motivational effect seen with conjunctive tasks relying on social comparison and indispensability) has demonstrated a significant increase in persistence with a software-generated partner (SGP) in an isometric abdominal exergame (Feltz, Forlenza, Winn, & Kerr, 2014). The current study seeks to compare the type of introductory interaction (basic verbal versus interactive dialogue) between participants and an SGP to strengthen relational behavior during gameplay. Adults ( $N = 63$ ;  $M_{\text{age}} = 39.6$ ;  $SD = 7.6$ ) completed two blocks of five isometric abdominal exercises for as long as they could using CyBuddy Exercise II, developed for this study. After completing the first block alone, each participant completed the second block alone (Control), with an SGP after a verbal exchange of basic introductory information (Basic SG), or with an SGP after an interactive dialogue tree exchange (Interactive SG). A Koehler conjunctive partner condition (moderately better partner, performance based on weaker team member) is created for the participant by providing visual and verbal feedback on the SGP's performance. Preliminary results indicate mean persistence difference scores are greater for participants in the Interactive SG condition ( $M = 8.06$ ;  $SD = 32.88$ ) compared to the Control condition ( $M = -19.82$ ;  $SD = 31.71$ ),  $p = .033$ . No statistical difference in persistence has been demonstrated between the Basic SG ( $M = -5.64$ ;  $SD = 36.10$ ) and Control conditions or between the Interactive SG and Basic SG conditions. No differences in participant's perceptions of self-efficacy, enjoyment, or exertion were noted across conditions. Preliminary results indicate middle-aged adults may persist longer with an exercise task when there is an interactive introductory dialogue with their software-generated partner. *National Institutes of Health (1R21HL111916-01A1)*

### Effects of a coaching communication workshop on alpine ski coaches' perceptions for engaging in RISE-enhancing interactions with their athletes

Saville, Paul D., Azusa Pacific University; Bray, Steven R., McMaster University

Athletes' motivation to participate and challenge themselves to perform their best in sports can be influenced by perceptions they develop regarding how others (e.g., coaches) view their abilities. These perceptions are referred to as relation-inferred self-efficacy (RISE). Specific coach-athlete interactions have been shown to contribute to positive RISE perceptions (Jackson et al., 2009; Saville et al., 2014), yet there have been no attempts to translate this knowledge to coaches. The purpose of this study was to examine the effects of a coach-athlete communication intervention on coaches' knowledge about RISE and perceptions (self-efficacy and outcome expectations) towards integrating RISE-enhancing behaviors into their coaching practice. Forty-three professional alpine ski coaches (women  $n = 15$ ;  $M_{\text{age}} = 35$  years,  $SD = 14$ ) participated in a 2-hr, two-phase workshop. Coaches' cognitions were measured at three time points: baseline and following each of the two phases of the workshop. Phase 1 was classroom-based, whereas Phase 2 was an experiential session conducted on the ski hill using role-play and mock coaching sessions. Results showed coaches' perceived knowledge ( $F(1, 42) = 27.77$ ,  $p < .01$ ,  $\eta^2 = .40$ ) and outcome expectations ( $F(1, 42) = 26.98$ ,  $p < .01$ ,  $\eta^2 = .39$ ) increased (from baseline) following the Phase 1, whereas self-efficacy ( $F(1, 42) = 17.79$ ,  $p < .01$ ,  $\eta^2 = .30$ ) for providing RISE-relevant information did not show significant changes until after Phase 2. Results indicate that while experienced coaches may have some appreciation for the importance of RISE and RISE-based communication, their knowledge about RISE can be increased. The workshop was successful at enhancing coaches' expectations about the benefits of RISE for boosting athlete's motivation; however, we show that it may be critical to integrate experiential (e.g., role play) activities in order to increase coaches' self-efficacy to implement changes in their RISE-relevant communication with their athletes. *SSHRC, HL Hooker Doctoral Award*

### Examining a multidimensional model of social support and physical activity among first-year university students

Scarapicchia, Tanya M.F., Sabiston, Catherine M., Faulkner, Guy; University of Toronto

The most dramatic declines in physical activity across the lifespan occur during the transition from late adolescence to early adulthood, which is a time when many Canadian youth begin university (Zick et al., 2007). While university students report positive intentions to engage in physical activity, they report several barriers, such as a lack of social support (Kwan & Faulkner, 2011). Moreover, gender differences have been observed with respect to support networks, amount of social support received, and perceptions of support available (Holt & Hoar, 2006). Fostering positive social relationships and support may therefore be an ideal strategy to promote increased physical activity participation among university students. This study examined gender differences in the endorsement of social support dimensions (structural, functional and perceptual) and investigated the association between social support dimensions and moderate-to-vigorous physical activity (MVPA) among first-year university students. Randomly and purposively selected students at the University of Toronto ( $n = 819$ ; female = 63.6%,  $M_{\text{age}} = 18.28 \pm 1.35$  years) completed the Healthy U of T survey in the fall of 2014. The multivariate model was significant for gender differences. In follow-up analyses, the structural social support dimension was significantly different for males and females, and males were significantly more active than females. In the regression models controlling for BMI, ethnicity, living situation, and mother and father's education, the number of friends was significantly associated with MVPA participation for males,  $R^2 = .09$ ,  $F(11, 275) = 2.50$ ,  $p < .05$ . For females, the number of family members was significantly associated with MVPA participation,  $R^2 = .08$ ,  $F(11, 465) = 3.75$ ,  $p < .001$ . In summary, there are gender differences in social support dimension endorsement and the number of individuals in a students' social network may play a crucial role in MVPA participation among first-year undergraduate students. *Supported by a Faculty of Kinesiology and Physical Education Internal Research Grant*

### **Experiencing the athletic and social body: An exploration of identities in collegiate female basketball players**

Scarlett, Louisa J., Bennett, Erica V., Hurd Clarke, Laura, Crocker, Peter R.E.; University of British Columbia

While sport participation has been linked with positive body image, many female athletes feel dissatisfied with their bodies outside of sport due to discrepancies between idealized sporting and female bodies (Petrie & Greenleaf, 2011). The purpose of this study was to qualitatively examine the body-related perceptions and experiences of collegiate female basketball players, and to explore their body perceptions in relation to their athletic and social identities. Semistructured interviews were conducted with six university basketball players and data were analyzed using interpretative phenomenological analysis (Smith, Flowers, & Larkin, 2009). Participants who had strong and exclusive athletic identities experienced more extensive body dissatisfaction than participants with more diversified identities. Some participants perceived their participation in basketball as contradictory to femininity and discussed their athletic and feminine identities as separate parts of their overall self. Others, however, discussed their identification with an athletic femininity that was more compatible with their participation in sport. Regardless of the status of their athletic and feminine identities, participants demonstrated conformity to societal norms and beauty ideals surrounding femininity. At the same time, they expressed a certain amount of body satisfaction associated with the instrumental capabilities of their bodies, but for all participants this satisfaction was coupled with the desire for body change to achieve the lean and toned female body ideal. Findings also demonstrated the utility of the bicultural identity integration framework (Benet-Martínez & Haritatos, 2005) for studying identity integration among female athletes, and contribute to existing research exploring female athlete identity and body image.

### **Biological evidence for interindividual differences in movement imagery abilities**

Seiler, Brian D., Florida Southern College; Newman-Norlund, Roger D., Monsma, Eva, University of South Carolina

Movement imagery (MI) ability is central to theoretical models driving research in the sport sciences, and is assessed predominantly with self-report measures. In addition to psychometric evidence of kinesthetic (KI), internal (IVI) and external (EVI) imagery abilities, recent functional magnetic resonance imaging (fMRI) examinations of real-time MI of movements represented in these questionnaires provide neurological support for intraindividual neural network variability of three modes. To extend this work, the present study compared neural network efficiency of participants screened with the Movement Imagery Questionnaire-3 (MIQ-3) as having “good” ( $n = 18$ ) and “poor” ( $n = 19$ ) imagery abilities in each of the three scales, with the expectation of constrained neural networks among good imagers. In addition to significant moderate interscale correlations between like scales of the MIQ-3, Vividness of Movement Imagery Questionnaire-2 (VMIQ-2), and newly extended MIQ-RS (i.e., daily living movements), significant mean VMIQ-2 and MRQ-RS scale differences favoring good imagers ( $p < 0.01$ ) evidenced convergent validity. Results of a blocked design isolating the neural response during four randomized experimental conditions (KI, IVI, EVI, and REST) (counterbalanced for condition), indicated neural network efficiency in breadth, but not magnitude in some, but not all, instances. Good imagers showed more robust activity than poor imagers (i.e., cingulate gyrus, middle cingulum) when imagery abilities were aggregated. Specifically, although activity was constrained in breadth, good imagers showed greater activity in the left caudate nucleus compared to poor imagers during KI, as well as a more robust activity pattern than poor imagers during EVI (i.e., left precentral gyrus, supplemental motor area, right lingual gyrus and cerebellum). These findings along with temporal cortex activity during EVI are explained in terms of the constrained action hypothesis. Subsequent studies should consider performance effects in conjunction with self-report and biological imagery data.

### **Biological evidence of imagery abilities: Intraindividual differences**

Seiler, Brian D., Florida Southern College; Monsma, Eva, Newman-Norlund, Roger D., University of South Carolina

Movement imagery (MI) remains a prominent topic in the sport sciences informed predominantly by self-report measures. With the proliferation of brain imaging technology (e.g., fMRI), examination of the neural correlates differentiating modes of MI, and cross-validations of self-report and neural measures is timely. In order to inform theory and research designs in the sport, exercise, and rehabilitation sciences, this study examined the construct validity of the Movement Imagery Questionnaire (MIQ-3) using self-report and neural data. First, we examined the relationship between MIQ-3 and Vividness of Movement Imagery Questionnaire-2 (VMIQ-2) scales of 206 right-handed college-age females. Then, based on high MIQ-3 scores on each scale established by cluster analysis, fMRI data was collected on 18 participants during real-time imagery of the MIQ-3 arm rotation task during each condition (kinesthetic [KI], internal visual [IVI], and external visual imagery [EVI]). Interscale correlations between like scales of the MIQ-3 and VMIQ-2 were significant and moderate, supporting construct validity. Neurologically, results of a blocked design isolating the neural response during four experimental imagery conditions (i.e., KI, IVI, EVI, and REST) presented randomly (counterbalanced for condition), indicated both core and imagery-specific patterns of brain activation providing biological validation for imagery abilities delineated in the MIQ-3; KI activated frontal areas, supplemental motor area and subcortical parts of the cerebellum, IVI activated inferior parietal lobule, and EVI activated temporal areas. Our results provide neural support for the existence of the KI, IVI, and EVI abilities measured by the MIQ-3, and to a lesser extent the VMIQ-2. The next step toward validation is to compare neural activity between participants screened as good and poor imagers to determine if good imagers are neurologically more efficient (i.e., a more constrained neural network in respective areas) than poor imagers (i.e., broader network, overlapping areas).

### Gaining momentum: Barriers and facilitators of greater competitive level in parasport

Shaw, Robert B., Perrier, Marie-Josée, McMaster University; Stapleton, Jessie N., Missouri Baptist University; Ma, Jasmin K., Fang, Hanna, McMaster University; Campbell, Duncan, Canadian Wheelchair Sports Association; Tawse, Holly L., McGill University; Martin Ginis, Kathleen A., McMaster University

**Purpose:** Adapted sport organizations and coaches have identified athlete progression to be an ongoing challenge. Indeed, little is known about the factors that facilitate and impede parasport athletes to progress from recreational to higher competitive levels. The objective of this qualitative study was to explore possible modifiable and theory-based factors associated with parasport progression. **Methods:** Participants were 4 men and 4 women with a physical disability who participated in parasport at the recreational, club, provincial, or national levels. They were recruited from a larger quantitative study of social cognitive theory-based influences on parasport participation and consented to participate in a 1-hr semistructured interview. Interviews were transcribed verbatim and subjected to a hierarchical content analysis. Three coders independently coded the transcripts line by line to identify subthemes, which were then categorized into larger themes. **Results:** Nine subthemes emerged from the transcripts that were associated with progression in parasport. Subthemes were subsequently categorized into two broader themes. These were barriers to sport progression and facilitators of sport progression. Athletes discussed several modifiable factors associated with their personal progression in parasport and provided recommendations for how to improve participation for other athletes. Specifically, all athletes mentioned supportive social networks as a facilitator of sport progression while financial restrictions acted as a barrier to sport progression. **Conclusion:** Important themes emerged from the transcripts that illustrate the challenges, facilitators, and benefits that people with a disability experience with regard to progressing through the parasport system. This study enables us to better understand the complexity of sport participation for people living with a disability and provides knowledge that could assist with facilitating athlete progression in parasport.

### Self-Efficacy and performance in volleyball referees

Spencer, Benjamin D., Feltz, Deborah L.; Michigan State University

Sport officials are an under-researched subpopulation in the sport psychology literature. In particular, little is known about psychological factors that may predict officiating performance. Feltz and Guillen (2011) suggested that self-efficacy may influence performance in the refereeing context, as it does in many others. Myers, Feltz, Guillen, and Dithurbide (2012) indicated that referee self-efficacy is composed of four dimensions: game knowledge, decision-making, pressure, and communication. The current study sought to evaluate the relationship of these various dimensions to performance in several aspects of officiating. Volleyball referees ( $N = 76$ ) who were candidates for USA Volleyball (USAV) National or Junior National badges completed a survey which measured experience as an official, experience playing and coaching volleyball, referee self-efficacy, and sources of referee self-efficacy. Following administration of the survey, participants completed the USAV referee evaluation protocol, during which they officiated 6 to 10 matches while being evaluated by a rating team of experienced, high-level referees. Candidates who scored an 88 or above succeeded in the evaluation and earned their badge. Preliminary mean comparisons indicated that referees succeeded in their evaluations reported significantly higher levels of referee self-efficacy than those who were unsuccessful. Specifically, the successful referees scored higher in the Game Knowledge ( $t = 2.268$ ,  $df = 73$ ,  $p = .026$ ), Decision-Making ( $t = 2.405$ ,  $df = 73$ ,  $p = .019$ ), and Pressure ( $t = 2.537$ ,  $df = 71$ ,  $p = .013$ ) dimensions. Additionally, successful candidates were significantly distinguished from unsuccessful candidates in the following aspects of performance: match control ( $t = 5.080$ ,  $df = 74$ ,  $p < .001$ ), communication with the officiating team ( $t = 2.302$ ,  $df = 74$ ,  $p = .010$ ), and communication with match participants ( $t = 2.635$ ,  $df = 74$ ,  $p = .024$ ). These preliminary results suggest that referee self-efficacy may influence an official's ability to command the match via effective communication.

### Relationship between task cohesion, social support, and intention to return to a youth sport team

Spink, Kevin S., Ulvick, Jocelyn D.; University of Saskatchewan

Given the support that has been garnered for youth participating in organized sport (Brustad et al., 2008), it is not surprising that researchers have sought to elucidate the factors associated with sport maintenance. While a number of areas could be examined, one promising area involves focusing on aspects of the team environment. Initial evidence in youth sport suggests that higher perceptions of team cohesiveness are associated with greater involvement with the team (Ulvick & Spink, 2014). One possible explanation for this relationship could be that greater team unity enables more supportive teammate interactions, thus promoting increased participation; however, this speculation has yet to be examined. This study explored the plausibility of social support as a possible mediator in the cohesion-intention to the return relationship. Youth soccer players ( $N = 124$ ) from 10 teams completed measures of early-season task cohesion (YSEQ; Eys et al., 2009), late-season social support (modified SPS; Cutrona & Russell, 1987), and intention to return to the team the following season (Spink, 1995). Given the use of intact teams and the possibility of nesting, an ICC value was calculated for intention to return. A low ICC value (.02) indicated only a small degree of score dependence, so individual-level analyses were conducted using Baron and Kenny's (1986) approach to testing mediation. Regression results revealed significant positive relationships between all variables: cohesion and intention to return ( $b = .29$ ,  $p < .001$ ), cohesion and social support ( $b = .23$ ,  $p < .001$ ), social support and intention to return ( $b = .63$ ,  $p < .001$ ). However, after controlling for social support, the strength of the cohesion-intention to return relationship decreased significantly ( $b = .17$ ,  $p = .006$ ), suggesting partial mediation. The results provide initial evidence for social support as a partial mediator in the cohesion-intention to return relationship. While promising, future experimental research directly testing the relationships demonstrated in the current study is warranted. *Social Science and Humanities Research Council of Canada*



### Sex-differences in theory-based predictors of sport among parasport athletes with mobility impairments

Stapleton, Jessie N., Martin Ginis, Kathleen A., McMaster University

Research indicates that physical disability is more prevalent among women than men, and women with physical disabilities are less active than their male counterparts. Among men and women with spinal cord injury, differences in theory-based predictors of physical activity participation have been identified, but it is unclear whether those findings can be generalized to differences between men and women with other physical disabilities and for more specific types of physical activity, such as parasport. Parasport is a viable physical activity option for men and women with physical disabilities that has been linked with additional physical and psychological benefits to traditional physical activity. As such, the purpose of this study was to examine sex differences in theory-based predictors of sport among parasport athletes with mobility impairments. This study is a secondary analysis of data collected to test of model of social cognitive theory for predicting level of parasport participation. Demographic data were collected and social cognitive theory constructs (social support, task self-efficacy, self-regulatory efficacy, self-regulation, and outcome expectations) were measured among men ( $n = 61$ ) and women ( $n = 22$ ) with physical disabilities that cause mobility impairment ( $M_{\text{age}} \pm SD = 34.36 \pm 12.41$ ). ANOVAs were conducted to identify sex differences within social cognitive theory constructs. ANOVAs revealed task self-efficacy ( $F(1,81) = 6.79, p = .01$ ) was significantly different between male and female parasport athletes. Men reported higher task self-efficacy ( $M = 8.25, SD = 1.57$ ) than women ( $M = 7.04, SD = 2.52$ ). There were no significant differences for social support, self-regulatory efficacy, self-regulation, or outcome expectations between the male and female parasport athletes ( $ps > .05$ ). In order to promote parasport participation among women, community sport organizations may benefit from targeting task-self-efficacy through additional practice opportunities, emphasizing positive feedback from coaches, and incorporating peer athlete mentorship. *Ontario Neurotrauma Foundation and the Rick Hansen Institute Mentor-Trainee Award*

### Philosophies and goals in teaching dance: A qualitative exploration with private studio teachers

Stark, Andrea, Weiss, Maureen R., University of Minnesota; Newland, Aubrey, University of Utah

Dance educators are concerned by a lack of intentional teaching philosophies (Lakes, 2005), given Gray's (1984) model in which teachers' backgrounds and philosophies impact their studio psychosocial climates and student outcomes. This model is untested with teachers and students in private dance studio settings, leaving unanswered questions about the process by which dance teachers achieve desired outcomes in studios. These questions could be resolved by adapting and applying research from sport that examines coaching philosophies and practices, such as Horn's (2008) model of coaching effectiveness; the model describes the influence of coaches' personal characteristics and context on coaching behaviors, with coaching philosophy as mediator. This narrative ethnographic study researched aspects of Horn's model in dance by exploring assumptions about how individuals come to be dance teachers, providing teachers the opportunity to reflect on their teaching philosophies, and inviting teachers to articulate goals for their students and strategies used to reach them. Twenty-one teachers ( $M_{\text{experience}} = 11.67$  years) provided open-ended responses to an online survey and emergent themes were identified using an inductive approach. Teachers described several pathways to becoming a teacher, indicating the journey to teaching is complex and varies by person. Eight themes emerged from their philosophies: facilitating learning, building self-esteem, providing a nurturing environment, having high expectations, encouraging emotional expression, teaching technique, incorporating life lessons, and promoting enjoyment. These themes are comparable to those found in the sport literature. Eight outcome categories, such as appreciating dance as an art form and developing life skills beyond dance, as well as the varied strategies teachers use for achieving them will be discussed. While several themes are unique to dance, findings demonstrate sufficient overlap between teaching dance and coaching sport to support further investigation of sport coaching models in dance studio contexts.

### Using self-reported and objective measures of self-control to predict exercise and academic behaviors among first-year university students

Stork, Matthew J.; Graham, Jeffrey D.; Bray, Steven R.; Martin Ginis, Kathleen A.; McMaster University

Purpose: To examine self-report and objective measures of self-control as predictors of 4-week participation in, and adherence to, exercise and study/schoolwork behavior among first-year university students. Design: Longitudinal. Method: Thirty first-year university students ( $M_{\text{age}} = 18 \pm 0.5$  years) completed self-report (Self-Control Scale) and objective (isometric handgrip squeeze task) measures of self-control, provided their exercise and academic (study/schoolwork) plans for the next month, and then logged these behaviors over the subsequent 4-week period. Results: Trait self-control was a significant predictor ( $p < 0.05$ ) of exercise ( $rs = 0.34$ ) and academic ( $rs = 0.52$ ) behavior, and handgrip squeeze performance was a significant predictor ( $p < 0.05$ ) of academic behavior ( $rs = 0.47$ ) and academic adherence ( $rs = 0.33$ ). Conclusions: This is the first study to demonstrate that an objective measure of self-control can be used to predict real-world behaviors. These findings provide a new understanding of how different self-control measures can be used to predict first-year students' participation in, and adherence to, exercise and academic behaviors concurrently.

### Conceptualizing and measuring the desire for energy expenditure and sedentary behavior: The CRAVE Scale for Movement and Rest

Stults-Kolehmainen, Matthew A., Teachers College, Columbia University; Gilson, Todd A., Northern Illinois University; Brotnow, Line, Yale University Medical School; Bartholomew, John B., University of Texas at Austin; Ciccolo, Joseph, Teachers College, Columbia University; Sinha, Rajita, Yale University Medical School

Transient desires for energy intake (i.e., cravings for highly palatable food) are well studied, but little is known about wants or desires for energy expenditure and sedentary/rest behaviors. Consequently, the purpose of this study was to create an assessment of state want for movement and rest. Two studies were conducted. Subjects were 846 college students from the American Midwest. For both studies, participants completed two versions of the Craving for Rest and Volitional Energy Expenditure (CRAVE). Each consisted of 15 questions related to the “want” or “desire” individuals had to perform sedentary and active behaviors. Seven items related to being physically active (e.g., want/desire to burn some calories; move my body; be physically active, etc.), and eight items were sedentary behaviors (e.g., want/desire to just sit down, be motionless, rest my body, etc.). Each question was rated on an 11-point Likert Scale (0 = *not at all*, 10 = *more than ever*). Participants rated their wants/desires “over the past week” (WEEK) in Version 1 and “at the present moment” (NOW) in Version 2, resulting in 30 total questions. In Study 1 ( $n = 402$ ,  $M_{\text{age}} = 20.9$  years,  $SD = 3.2$ , 62% female, 65% White) an exploratory factor analysis (EFA) with principal axis extraction and oblique rotation concluded that NOW items represented two factors (Rest, Move), but two items did not fit adequately for WEEK. NOW and WEEK items were correlated ( $r = .30$  to  $.61$ ). In Study 2 ( $n = 444$ ,  $M_{\text{age}} = 20.3$  years,  $SD = 2.9$ ; 59% female, 48% White), a confirmatory factor analysis of NOW items revealed a good fit for two-factor data structure ( $\chi^2 = 123.80$ , CFI = .99, NFI = .97, RMSEA = .049) with similar results for WEEK. Based on lower loadings and EFA results, two items were dropped, leaving 13 items. Internal consistency for each subscale was adequate ( $\alpha$ 's > .86). Rest-Move factors were correlated ( $r = -.53$ ,  $-.75$  for WEEK and NOW items, respectively). Items loaded strongly onto the latent factors ( $>.5$ ,  $>.7$  for WEEK and NOW). Consequently, the CRAVE scale has good psychometric properties, but further validation is needed.

### Absolute and relative coach-athlete interactions: How you think your coach treats you compared to the rest of your team

Stuntz, Cheryl P., St. Lawrence University; Boreyko, Caitlin L., Ithaca College

Most research examining coaching behaviors has focused on how coaches treat the team as a whole for behaviors such as training and instruction, negative rapport, and cross-domain relationships (i.e., knowing and caring about aspects of athletes' lives outside sport; Stuntz & Spearance, 2010). However, qualitative research suggests athletes also pay attention to how the coach treats them compared to how the coach treats other athletes on the team (e.g., Norman & French, 2013). Believing that you receive more coach attention relative to other individuals on your team may enhance your perceptions of your sport experience. Based on past research, we hypothesized that (a) perceiving your coach provided your team with more frequent technical skills instruction, more cross-domain relationships, and fewer negative rapport behaviors as well as (b) perceiving your coach provided you with more frequent technical skill instruction, cross-domain relationships, and negative rapport behaviors relative to others on the team would predict greater satisfaction of the basic psychological needs, athlete satisfaction, and perceived coach competence. Collegiate athletes ( $N = 251$ ) completed a questionnaire. Path analysis,  $\chi^2(8) = 9.52$ ,  $p = .30$ ; CFI = 1.00; TLI = .99, RMSEA = .03, showed that coaches providing more technical skills instruction, fewer negative rapport behaviors, and stronger cross-domain relationships to the team as a whole predicted greater fulfillment of the basic psychological needs, which in turn predicted greater athlete satisfaction and lower perceived coach competence. In addition, as hypothesized, believing you received more negative rapport and more cross-domain relationship behaviors relative to your teammates predicted greater satisfaction of the basic psychological needs. Essentially, both the absolute frequency of coaching behaviors given to a team as well as the relative amount of coaching behaviors given to each athlete on the team should be considered in future research.

### The relationship between perceived coaching antidoping efficacy and athletes' performance enhancement attitudes

Sullivan, Philip, Razavi, Parmida; Brock University

Within sport, coaches' beliefs, and athletes' perceptions of these beliefs, are known to affect athlete perception and behavior (Horn, 2008). The current study investigated this process with respect to doping and performance enhancement. Doping is a serious issue within sports at many levels that requires more research, particularly with respect to coaching. Recently, Sullivan and colleagues designed and validated an instrument that assesses coaches' efficacy in their abilities to successfully intervene when they suspect their athletes of doping—the Doping Confrontation Efficacy Scale (DCES; Sullivan et al., 2014). The current study examined if athletes' perception of their coaches' confrontation efficacy was related to their own attitudes with respect to performance enhancement. A sample of 84 university athletes, primarily in the sports of football ( $n = 45$ ) and rugby ( $n = 27$ ), completed a modified version of the DCES, which assessed player's perception of their coaches' efficacy with respect to five factors of a successful confrontation (e.g., Resources, Initiation, Intimacy, Legitimacy, and Outcomes). They also completed the Performance Enhancement Attitude Scale (PEAS; Petroczi & Aidman, 2009), which comprises a unifactorial measure of doping attitudes. Results showed that four of the five perceived efficacy factors (all but Resources) were significantly related to antidoping attitudes. A multiple linear regression model significantly predicted athletes' PEAS scores ( $F(1, 80) = 8.322$ ,  $p < .01$ ). Intimacy ( $\beta = -.31$ ) was the sole significant predictor. This suggests that the more athletes felt their coaches were efficacious about the intimacy of their relationships with respect to a confrontation, the more strongly the athletes disagreed with doping. These results support the link between athletes' perception of coaching behavior and their own attitudes, specifically with respect to the issue of performance enhancement. As well, they offer further validation for the construct of doping confrontation efficacy.

**The effect of sporting context on PYD outcomes in youth sport**

Sullivan, Philip, Marini, Matthew, Brock University

Positive youth development (PYD) is a theoretical framework that examines youth development as an asset towards fostering positive outcomes, and reducing negative maladaptation (MacDonald et al., 2012). Organized sport in particular has been found as an ideal environment to foster PYD (Fraser-Thomas, Côté, & Deakin, 2005). Youth who are involved in a structured sport environment are found to be more engaged and more intrinsically motivated as compared to youth who participate in unstructured programs in sport, leisure activities, or school (Wilkes, & Côté, 2010). One factor that could uniquely impact PYD within sport is the level of competition (Jones et al., 2011). Youth sport comprises different competitive contexts, two popular ones of which are recreation (i.e., house league) and competitive (i.e., travel). The current study investigated a potential difference in PYD outcomes derived by competitive and recreational youth sport athletes. A sample of 65 youth sport participants ( $M_{\text{age}} = 14.9$ ) who identified themselves as either primarily competitive ( $n = 35$ ) or recreational ( $n = 30$ ) sport athletes completed the short version of the Youth Experiences Survey for Sports (YES-S; Sullivan et al., 2013). The YES-S measures five interrelated outcomes of youth sport, four positive (Personal and Social Skills; Cognitive Skills, Goal Setting and Initiative) and one negative (Negative Experiences). Analysis of Variance revealed that there was a significant difference between the groups on two subscales—Cognitive Skills,  $t(61) = -2.68, p < .05$ , and Goal Setting,  $t(62) = -2.75, p < .05$ . In both cases, competitive athletes reported significantly higher outcomes than recreational athletes. These results suggest that although previous research has indicated that sport can contribute to PYD, different sporting contexts may contribute differently to these outcomes.

**Longitudinal relationships between perceived variety, autonomous motivation, and exercise behavior**

Sylvester, Benjamin D., Beauchamp, Mark R.; University of British Columbia

Recent research suggests that perceptions of variety are related to exercise behavior in the short-term. Specifically, Sylvester et al. (2014) found that perceived variety in the context of exercise was able to explain unique variance in exercise behavior (in addition to that explained by the satisfaction of the basic psychological needs for competence, relatedness, and autonomy) and that this relationship was mediated through perceptions of autonomous motivation over a 6-week period. The purpose of this study was to examine whether this prospective relationship holds longitudinally over a more sustained period of time (i.e., 6 months). Participants ( $N = 260$ ) were a convenience sample of community adults who completed online questionnaires to measure perceived variety in exercise, along with satisfaction of the needs for competence, relatedness, and autonomy at baseline, and measures of autonomous motivation and exercise behavior, 6 months later. The results of structural equation modelling revealed that perceived variety ( $\beta = .063, p < .05$ ) and satisfaction of the need for relatedness ( $\beta = .064, p < .05$ ) were unique indirect positive predictors of exercise behavior (through autonomous motivation) 6 months later. In addition, satisfaction of the needs for competence ( $\beta = .342, p < .01$ ) and autonomy ( $\beta = .132, p < .05$ ) were found to positively predict autonomous motivation, but not exercise behavior. In conclusion, the results of this study provide insight into the sustained predictive effects of perceived variety in exercise over time in relation to autonomous motivation and exercise behavior. Furthermore, the results support Sheldon's (2011) contention that satisfaction of the needs for competence, relatedness, and autonomy, may be an incomplete subset of the types of positive experiences that are involved in supporting autonomous motivation, and behavior, over time. *Supported by a graduate scholarship to Ben Sylvester by the Social Sciences and Humanities Research Council of Canada, and a career investigator award from the Michael Smith Foundation for Health Research to Mark Beauchamp*

**Hockey parents' perceptions of their own and other spectators' behaviors differ by gender and competitive level**

Tamminen, Katherine A., University of Toronto; McEwen, Carolyn E., University of British Columbia; Kerr, Gretchen, Donnelly, Peter, University of Toronto

Poor spectator behaviors can be detrimental to youth athletes' sport experiences, and efforts to improve spectator behaviors could benefit from targeted interventions for specific groups of parents. The purpose of this study was to examine differences in parents' perceptions of their own and other spectators' behaviors based on a) parent gender and b) their child's level of minor hockey. Minor hockey parents ( $N_{\text{mothers}} = 322, N_{\text{fathers}} = 214$ ) completed online demographic questions and a questionnaire assessing perceptions of their own and other spectators' behaviors (Omli & LaVoi, 2009). Parents perceived that other spectators' behaviors ( $M = 2.14, SD = .63$ ) were worse than their own behaviors ( $M = 1.35, SD = .23$ ),  $t(536) = -30.16, p < .05, r = .79$ . Two factorial ANOVAs were conducted to examine differences in parents' reports of their own and other minor hockey spectators' behaviors based on the parent's gender and their child's competitive level. For parents' own behaviors, there was a significant main effect of gender ( $F(1, 484) = .23, p < .05, \eta^2_p = .01$ ) and competitive level ( $F(5, 451) = .49, p < .05, \eta^2_p = .03$ ). Fathers reported engaging in poorer spectator behaviors compared to mothers (Cohen's  $d = .22$ ). Parents of recreational athletes reported observing significantly better spectator behavior compared to parents of children participating at the A-level (Cohen's  $d = .45$ ) and compared to parents of children participating in multiple levels of hockey (Cohen's  $d = .48$ ). Regarding other spectators' behaviors, there was a significant main effect of competitive level ( $F(5, 484) = 17.28, p < .01, \eta^2_p = .13$ ), but the main effect for gender was not significant. Reports of other spectators' behaviors among parents at the lower competitive levels (recreational and C-level) were significantly better compared to parents at higher competitive levels (A-level, B-level, and developmental/elite level; Cohen's  $d = -1.33$  to  $-.81$ ). There were no significant interactions between gender and level for parents' reports of their own or other spectators' behaviors.

### Social and individual reference norm and physical self-concept

Tietjens, Maike, Dreiskämper, Dennis; University of Münster

When analyzing the correlations between motor abilities and physical self-concept of children, most studies concentrate on direct interrelations between performance and self-evaluation. Only a few studies deal with the reference norm orientation in terms of internal and external frame of reference (social and individual comparison), although there is evidence that in sport the external frame of reference might moderate the interrelationship (Tietjens & Niewerth, 2005). The aim of the study is to analyze the correlation pattern of motor performance, perceived physical self-concept, global self-evaluation, and reference norm orientation. This study of 128 (female 44.5%;  $M_{\text{age}} = 11.57$ ;  $SD = .622$ ) fifth- and sixth-graders examines the differences in physical self-concept (PSC-C; Dreiskämper et al., 2015), preferred reference norm orientation (RNO), and motor performance (DMT 6-18; Bös et al., 2008) in respect to age, gender, and sports club membership, as well as the relationship between these constructs. Comparisons between gender and age are made and structural equation modeling is performed to analyze pathways between the factors. With regard to physical self-concept, significant gender differences ( $F(8, 103) = 3.32, p < .001, \eta^2 = .205$ ) are confirmed in MANOVAs in favor of boys on strength and endurance as well as significant differences concerning club membership ( $F(8, 104) = 3.32, p = .006, \eta^2 = .181$ ) in almost all scales (except strength, coordination, and global self-worth). Structural equation modeling shows that internal reference norms ( $\beta = .40$ ) and external reference norms ( $\beta = .30$ ) moderate the interrelation between motor abilities and physical self-concept. Physical self-concept and global self-evaluation correlate significantly with each other ( $r = .64$ ). The results indicate that children in this age group use both internal and external frames of reference to evaluate their performance independently from type and extent of their sport activity.

### Self-compassion, psychological flexibility, and body-related emotions

Ullrich-French, Sarah C.; Cox, Anne E.; Cole, Amy N.; Dizon, Eleanor; Kim, Eunsam; Preciado, Laura; Washington State University

There are mixed findings regarding how body-related emotions associate with exercise and physical activity experiences. It is therefore important to examine resilience factors that could lead to a greater understanding of how we manage body-related emotions. Self-compassion, for example, reflects an adaptive way of reacting to and interacting with thoughts, emotions, and experiences. Self-compassion is assessed by the degree to which one uses self-kindness versus self-judgment, applies a sense of common humanity versus isolating oneself, and is mindful versus over-identifying. As a complementary construct grounded in acceptance and commitment therapy, psychological flexibility represents the nonjudgmental and adaptive interactions one has with their own thoughts and emotions. Little is known about how these psychological factors interface with body-related emotions. Therefore, the purpose of this study was to examine how self-compassion and psychological flexibility associate with body-related emotions. A sample of college students completed assessments of self-compassion, psychological flexibility, negative body emotions (i.e., shame, guilt, anxiety) and body pride, a positive body emotion ( $N = 432$ ; 64% female). Lower psychological flexibility related with higher guilt ( $r = .40$ ), shame ( $r = .40$ ), anxiety ( $r = .36$ ) and lower pride ( $r = -.41$ ). Higher self-kindness and mindfulness related respectively with lower guilt ( $r = -.23, -.17$ ), shame ( $r = -.27, -.23$ ), anxiety ( $r = -.24, -.22$ ), and higher pride ( $r = .43, .34$ ). Having a higher sense of common humanity only related with less shame ( $r = -.15$ ) and more pride ( $r = .23$ ). Higher self-judgment, isolation, and over-identification related, respectively, with higher guilt ( $r = .42, .35, .27$ ), shame ( $r = .39, .34, .21$ ), anxiety ( $r = .43, .39, .26$ ), and lower pride ( $r = -.42, -.35, -.27$ ). Implications for the adaptive role of psychological flexibility and self-compassion in mitigating negative emotions are discussed. *Berry Family Fellowship*

### Reimagining fitness testing in schools: Enjoyment, need satisfaction, and intention

Vazou, Spyridoula, Mischo, Amanda, Ekkekakis, Panteleimon; Iowa State University

Mandatory physical fitness testing in physical education (PE) is one of the most widely implemented physical activity promotion policies in the US. However, the method of implementation of both fitness testing and practice does not appear to be informed by psychological theory and its impact on motivation remains unknown. Thus, this study compared the effects of a PE lesson consisting of practicing running (PACER), push-ups, and curl-ups following the standard Fitnessgram instructions (“traditional”) and an alternative (“novel”) lesson on enjoyment, need satisfaction, and desire to repeat the lesson. The novel lesson emphasized positive peer interactions, incorporated teamwork (games with a partner), added music and video, and used a variety of aerobic movements while the fitness activities remained the same with the traditional lesson (running, push-up and curl-ups). Thirty-five 4th- and 5th-graders from one school completed both 30-min PE lessons, 1 week apart. Enjoyment (short Physical Activity Enjoyment Scale), situational need satisfaction (Activity Feeling States scale), and intention to repeat the lesson were assessed upon completion of the lesson. Physical activity during the lessons was measured by accelerometers. The intensity of the two lessons was similar, averaging approximately 7 METs. However, compared to the traditional lesson, the novel lesson was perceived as more enjoyable and led to higher satisfaction of the basic psychological needs of competence, autonomy, and relatedness. Moreover, students expressed a stronger intention to repeat it in the future. These results highlight the need to reconsider how physical fitness testing is presently implemented in schools. Incorporating elements from psychological theory could enhance the motivational impact of this policy in a practical manner and without altering the essential nature of the activities.

**An ethnographic study of positive youth development in recreational sport**

Vierimaa, Matthew, Queen's University; Bruner, Mark W., Nipissing University; Côté, Jean, Queen's University

Organized sport is recognized as a fertile context for the facilitation of positive developmental outcomes for young athletes (Holt & Neely, 2011). However, the mechanisms through which athletes acquire life skills and developmental experiences and apply them to other contexts (e.g., school) are not well understood (Turnnidge, Hancock, & Côté, 2014). In addition, recreational sport represents a unique yet understudied sport context to facilitate positive youth development (Holt & Jones, 2008) due to its increased emphasis on fun and enjoyment in comparison to competition and winning. Thus, the present study employed an ethnographic approach to explore the social and contextual factors of a recreational youth basketball league and investigated how and whether positive youth development occurred over the course of a season. The lead researcher volunteered as an assistant coach with one of the teams and engaged in fieldwork throughout the 6-month playing season. Data were collected via a combination of participant observation, field notes, and informal and semistructured interviews with players, coaches, and league organizers. Data analysis was informed by Wolcott's (1994) description-analysis-interpretation approach. Key themes identified from the data suggest an implicit approach to the transfer of positive developmental outcomes and highlight the importance of diverse interpersonal relationships, positive early sport experiences, and the role of competition in the development of character. The present findings draw attention to the unique developmental benefits of participation in recreational sport and provide practical implications for youth sport administrators, coaches, and athletes.

**Acute aerobic exercise facilitates multiple aspects of cognition: An ERP and serum BDNF study**

Wang, Chun-Chih; Liu, Jen-Hao; Chi, Lin; Chang, Yu-Kai; National Taiwan Sport University

Emerging studies have proved the beneficial effects of acute aerobic exercise on multiple aspects of cognitive function. However, whether acute exercise affects different conditions of cognitive functions equally, as well as the neuroelectric and biochemical mechanisms underlying the positive effects of acute exercise on cognitive functions, remains underexplored. The present study attempts to further the current knowledge base by determining the general or specific improved cognitive functions induced by acute exercise, as well as extending the previous research by investigating potential neuroelectric and neurobiological mechanisms simultaneously through examinations of N1 and P3 components of stimulus-locked event-related potential (ERP) and serum brain-derived neurotrophic factor (BDNF) levels, respectively. Twenty college students participated in exercise and reading treatments on two separate days in a counterbalanced order, whereby they were required to implement 30 min of cycling with moderate intensity under the exercise condition and reading a magazine that was related to exercise was the only factor used in assessing the group engaged in the reading condition. Following each treatment, a Stroop Test was administered and an ERP was recorded. Blood was collected immediately from both groups following their respective treatments. The results indicated that acute exercise facilitated response times on both the Stroop-congruent and -incongruent conditions, but had a larger magnitude of increase on the Stroop-incongruent condition. Acute exercise induced a larger P3, but did not influence the N1 and serum BDNF levels. These findings suggest that acute exercise improves cognition both generally and selectively. This facilitation of cognition may be related to acute exercise-induced attentional resource allocation and conflict detection processes, as indicated by late and endogenous factors, but not sensory processes revealed by early and exogenous ERP components, as well as alteration of serum BDNF levels.

**Replenishing the self-regulation reserve: Can exercising actually increase our limited resource?**

Weatherson, Katie; Bailey, Kaitlyn; Bourne, Jessica E.; Jung, Mary E.; University of British Columbia

Self-regulation describes the human capacity to override an automatic response in an attempt to change one's behavior (Muraven, Tice, & Baumeister, 1998). Self-regulation is hypothesized to be a limited resource, akin to a muscle, that becomes depleted with each attempt to regulate behavior (Muraven & Baumeister, 2000). Many studies have examined depletion of this self-regulatory store; however, very few studies have examined whether self-regulatory control can be replenished. The purpose of this study was to assess the degree to which self-regulatory reserve could be impacted by engaging in relaxing leisure activities, namely, yoga or watching a nature documentary. Healthy university students ( $M_{\text{age}} = 21.33 \pm 1.68$ , 54% female) were randomly assigned to either a 50-min group yoga class ( $n = 31$ ) or 50-min group nature film on campus ( $n = 21$ ). Prior to participating in the leisure activity, all participants completed an initial Stroop test designed to deplete initial self-regulation (Martin Ginis & Bray, 2010). After engaging in their assigned activity, participants completed a handgrip test to assess concluding self-regulation strength (Muraven et al., 1999). Finally, participants completed measures on the Exercise Feeling Inventory (EFI). There were no significant differences between conditions for age, sex, past exercise history, or Stroop test results ( $ps > .05$ ). However, there was a significant difference in hand grip test performance between conditions, such that the individuals who participated in the yoga class held the hand grip for significantly longer than individuals who watched the nature film,  $t(50) = 3.86$ ,  $p < .001$ ,  $d = 1.11$ . Additionally, EFI results revealed that participants reported feeling significantly calmer, relaxed, and revived following the yoga as compared to the film ( $ps < .05$ ). This exploratory research examined the ability of leisure activities to increase self-regulation reserves and suggests that relaxing exercise may in fact replenish these stores, thus allowing the individual to maintain a greater reserve for future behaviors.

### **Girls on the run: Impact of a positive youth development program on life skills, physical activity, and sedentary behavior**

Weiss, Maureen R.; Phillips, Alison C.; Stark, Andrea; University of Minnesota; Riley, Allison; Girls on the Run International

Girls on the Run ([www.girlsontherun.org](http://www.girlsontherun.org)) is a positive youth development program that uses running and other physical activities as a vehicle for teaching life skills and promoting healthy outcomes in elementary- and middle-school-age girls. Social-contextual elements include an intentional curriculum, instructor training to ensure fidelity, and skill-building opportunities presented within a supportive climate. The 5Cs + 1 framework (Lerner & Lerner, 2006) is used, with lesson plans over the 12-week season targeting competence, confidence, connection, character, caring, and contribution. We conducted a season-long assessment of impact with 5,124 girls (ages 7–13 years) participating on 270 teams across 28 councils. Girls completed self-report measures of confidence, connection, character, and caring (Fry & Gano-Overway, 2010; Harter, 1985); showed competence by whether they completed the culminating 5k run; demonstrated contribution by a community impact project; and reported physical activity (PA) and sedentary behavior (SED) using the YRBS. Analyses addressed the following: (1) Did scores change from pre- to postseason for the entire sample? (2) Did scores change for girls who began the season with scores below the sample mean? (3) What percentage of girls improved from pre- to postseason on constructs? Results indicated (1) relatively high scores at preseason for confidence, connection, character, and caring remained high at postseason; 90% of girls completed the 5k; 112 teams reported community impact projects; and PA significantly increased and SED decreased; (2) girls with lower preseason scores significantly improved on all constructs ( $ES = .42$ – $1.46$ ); and (3) for the total sample, percentage improvement across constructs was 31–50.5%, whereas 55.4–74.1% of girls improved who began with lower preseason scores. Findings provide preliminary evidence that Girls on the Run is having a positive impact on youth development. Future research with comparison groups and a longitudinal design will provide a stronger assessment of impact.

### **Item validation of the Curling Strategy Assessment Tool (CSAT)**

Westlund, Nicole, Hall, Craig; Western University

Despite repeated calls by researchers, few imagery interventions have examined the effects of cognitive general (CG) imagery on athletic performance (Martin et al., 1999). The only two controlled imagery interventions conducted to date have yielded mixed results regarding the ability of CG imagery to improve performance (Guillot et al., 2009; Munroe-Chandler et al., 2005). A potential reason for this lack of research might be the absence of a validated tool to measure strategy performance (Westlund, Pope, & Tobin, 2012). Recently, Westlund and Hall (2012) developed the Curling Strategy Assessment Tool (CSAT) in order to assess strategy performance in the sport of curling. Participants are given curling scenarios and for each scenario there are four shot options to choose from; participants select which shot they would play for each scenario. Although it was previously validated (Westlund & Hall, 2012), the CSAT has since been modified to reflect a more accurate depiction of the types of strategic situations encountered in the sport of curling. Therefore, the purpose of this study was to further validate the modified items on the CSAT. Three NCCP Level 3 curling coaches with an average of 16.67 ( $SD = 4.73$ ) years of coaching experience at the provincial, national, and international levels took part in a focus group to determine the correct answer for the 93 scenarios developed for the CSAT. Each of the scenarios were discussed at length and only kept in the item pool if 100% agreement for a correct answer was determined. If necessary, response options or the scenario itself were modified based on the coaches' recommendations. The goal of this study was to have a pool of items that have been validated to test an athlete's knowledge of the correct tactic to employ in a given strategic situation. The CSAT will continue to be used in future imagery interventions to test athletes' strategy performance. It is our hope that the development of a validated strategy measure can help show support for the link between CG imagery use and improved strategy performance.

### **“No flag on the play”: Using behavioral modification to reduce injuries in American football**

White, Andrew C., Wiese-Bjornstal, Diane; University of Minnesota

Game injury rates for American football are higher than for any other sport (Radelet et al., 2010; Rechel et al., 2008). Additionally, research suggests that many injuries may be the result of illegal, aggressive play (Fields et al., 2010). Despite these findings, no published studies have used behavioral modification strategies to reduce injury and penalty rates in youth football. This pilot study establishes Fair Play rules for American football; similar rules in youth ice hockey have reduced injury and penalty rates, as well as improved registration rates (Roberts et al., 1996). Fair Play rules were implemented in one division of a 7th grade ( $M_{age} = 12.29$  years) football league. Throughout the regular season, 104 Fair Play games and 58 standard rules games were observed. Trained research assistants also tracked team penalties and injuries. At the end of the season, players were asked to complete brief questionnaires on aggression, sportsmanship, enjoyment, as well as self-report their injuries for the season. Similar to youth hockey, the majority of teams earned their Fair Play points. Eighteen of the twenty-eight (64.3%) participants who completed the postseason questionnaire reported having at least one injury (50% were head/neck injuries), and eight (28.6%) reported sustaining two or more injuries. Observational data show a trend toward fewer 15-yard penalties and unsportsmanlike conduct penalties, as well as fewer injuries that prevented players from returning to the game for Fair Play teams; however, these trends were nonsignificant. As in youth hockey, it may take a year for players and coaches to adapt to the Fair Play rules (Smith et al., 2009); therefore, differences between Fair Play and standard rules teams may not be present immediately. Given these trends, increasing concern about concussions, and the declining registration rates for youth football throughout the United States, further exploration into the effectiveness of Fair Play in youth football is warranted.

**Stable or dynamic: Exploring the dynamics of groupness during an activity class**

Wilson, Kathleen S.; McLeland, Kathryn; Hamamoto, Sarah; California State University–Fullerton

Examined in the organizational area, groupness is a fairly new construct in the exercise area that describes the extent one views a collection of individuals to be a group (Spink et al., 2010). This relatively basic construct has previously been linked to adherence in structured activity classes (Spink et al., 2010) and intention to return (Viglietta et al., 2012). However, little is known about how this construct changes over time. This study examined the dynamics of the perception of groupness over the course of a 16-week activity class. A second purpose was to explore the relationship between groupness and attendance in these classes. University students ( $N = 66$ ;  $M_{\text{age}} = 21.9$  years) enrolled in four group exercise classes for credit participated in this study by completing a survey three times over the course of the semester. Groupness was assessed by five questions used previously (Spink et al., 2010). A three-level multilevel model was performed using HLM with time at level 1, student at level 2 and class at level 3. Most of the variance was at the student level (55.9%) followed by variance over time (28.9%) and finally class level (15.2%). Neither time ( $b = -.48$ ,  $p = .34$ ) nor a quadratic time term ( $b = 0.10$ ,  $p = .44$ ) were significant predictors of groupness. These findings suggest the relative stability of the construct of groupness with most of the variability occurring at the individual and class levels. Instructors also recorded the attendance for students and reported the percent attendance for 55 of the students. Attendance did not appear to be related to perceptions of groupness. Attendance was not related to baseline groupness ( $p = .66$ ) or the rate of change over time ( $p = .25$ ). However, these classes may be unique because students register for credit, and attendance is a part of their grade in the course, which may partially explain the lack of relationship between groupness and attendance.

**Everything is cool when you're part of a team? Interdependence influences cognitions, emotions, but not performance under pressure**

Wolf, Svenja A., University of British Columbia; Geukes, Katharina, University of Münster; Heldmann, Felix, Schulz, Oliver, German Sport University Cologne

Pressure is an innate characteristic of competitive sports and can change how athletes think, feel, and perform (e.g., choking under pressure; Mesagno & Hill, 2013). Most research on performance under pressure has focused on individual, independent tasks. However, competitive sports often involve interdependent team-tasks and it is yet unsolved whether athletes on such teams perceive the same pressure, respond with the same emotions, and suffer the same performance consequences as their independent counterparts. In the present study, we aimed to provide first answers to these questions by assigning 72 team handball players (24 years of age, 51% male) to either an individual (i.e., performance scored individually) or an interdependent (i.e., performance scored additively) dyad. As part of these dyads, each athlete completed a throwing accuracy task (i.e. penalty shot) under low pressure and high pressure (e.g., monetary incentives, presence of an audience) conditions. Directly prior to completing these tasks, athletes reported their perceptions of pressure (single item) and anxiety (Sport Emotion Questionnaire; Jones, Lane, Bray, Uphill, & Catlin, 2005). Whereas all athletes perceived more pressure ( $f = .69$ ) and anxiety ( $f = .65$ ) under high-pressure conditions, athletes in the interdependent dyads indicated less of an increase than athletes in the independent dyads ( $f = .24$  and  $.28$ ). Interdependent athletes also generally responded with less anxiety ( $f = .28$ ). Yet, despite these effects, dyads did not differ, nor did they show any pressure-induced changes with regard to performance. Thus, it remains unknown which consequences the observed cognitive and emotional differences entail. Similarly, it needs to be investigated whether they are a function of shared responsibility (Brawley, Carron, & Widmeyer, 1987), diffusion of evaluation (Carron, Estabrooks, Horton, Prapavessis, & Hausenblas, 1999), or other mechanisms. Nonetheless, these differences indicate that being part of a team alters athletes' perceptions of and responses to competitive pressure.

**Exercise modality associated with special working memory tasks in late-middle-aged adults**

Wu, Chih-Han, Chen, Feng-Tzu, National Taiwan Sport University; Ho, Yu-Ming, Hsiuping University of Science and Technology; Chang, Yu-Kai, National Taiwan Sport University

Although older adults generally experience less efficient cognitive functions with aging, the degree of cognitive decline is moderated by several lifestyle factors, such as engaging in regular exercise. Several meta-analytic and narrative reviews have indicated that regularly participating in exercise is positively associated with improved cognitive functions in older adults. However, previous studies have primarily emphasized only aerobic types of exercise, and cognitive inhibitions, among older adults. The current study aims to extend the knowledge base of this field of inquiry by examining exercise modality, in relation to special working memory, among late-middle-aged adults. Forty-five participants, aged between 50 and 65 years, were assigned into one of three groups, including an open-skills group (e.g., tennis, table tennis), a closed-skills group (jogging, cycling), and a no-exercise control group, based upon their previous exercise habits within the past 6 months. A spatial working memory task was administered to assess the effects on specific cognitive functions among participants in each group. Results revealed that both the open-skills and closed-skills groups demonstrated greater correct rates of spatial working memory on tasks, relative to those of the control group, but no differences obtained between these two exercise groups. These findings suggest that participation in exercise is associated with superior special working memory in individuals during the late-middle-age period of life. Additionally, the positive relationships between exercise and specific cognitive functions may be enhanced regardless of the specific exercise modality involved.

### **Rating of perceived exertion and affect during a 30-minute moderate exercise bout in young cancer survivors: A pilot study**

Wurz, Amanda J., Wing, Erin K., Brunet, Jennifer; University of Ottawa

Physical deconditioning is a common side effect of cancer treatment and prolonged periods of physical inactivity among young cancer survivors. This may precipitate greater perceived exertion during exercise, in turn contributing to negative in-task affect. While the associations between ratings of perceived exertion (RPE) and affect during exercise have been investigated in other populations, little research has been done with young cancer survivors. As part of an on-going study, the aims of this pilot investigation were to describe young cancer survivors' RPE, and explore the associations between RPE and affective responses during exercise. Participants were seven youth ( $M_{\text{age}} = 13.7$  years;  $SD = 2.5$ ) who completed treatment for cancer <12 months. Halfway through a 30-min bout of supervised walking (performed at 65–74% of their maximum heart rate); participants' RPE and affect were obtained from the Borg RPE scale and the Physical Activity Affect Scale (PAAS). The RPE ranged from light (11) to hard (16), with an average rating of moderate (12.7;  $SD = 1.6$ ). The RPEs were not statistically significantly associated with any PAAS subscales: positive affect ( $r_s = .45$ ), negative affect ( $r_s = .32$ ), fatigue ( $r_s = -.30$ ), tranquility ( $r_s = .11$ ). While there was generally good agreement between actual exercise intensity and participants' subjective ratings of intensity, there was some variability. The possibility that young cancer survivors perceive greater intensity, as a result of physical deconditioning should be considered, as it could have implications for compliance. The lack of association between RPE and affective responses may be a result of the small sample size. These associations should be reexamined with larger samples before concluding that young cancer survivors' RPE are not related to their affective responses during exercise. Continued examination of young cancer survivors' exercise perceptions and experiences may provide insight into factors that influence participation and maintenance, ultimately informing future interventions and enhancing overall physical activity.

### **Aerobic and coordination exercises are differently associated with cognitive functions and neuroelectrical activation in older adults**

Yang, Kao-Teng; Chang, Yen-Shan; Chu, Chien-Heng; Wang, Chun-Chih; Chang, Yu-Kai; National Taiwan Sport University

Studies associated with exercise and cognitive functions have predominately emphasized aerobic exercise or cardiovascular fitness. The purpose of our study was therefore to further understanding about this relationship by exploring exercise modality, the nature of cognitive functions, and the types of fitness index, through applying behavioral and neuroelectrical approaches. Thirty older adults were assigned into either an aerobic exercise, a coordination exercise, or a control group, as determined by their previous exercise experience. After completing congruent and incongruent trials of a modified Stroop Test while recording event-related potentials, each group conducted multiple physical tests that assessed health- and skill-related fitness. The results revealed that both the aerobic and coordination exercise groups exhibited superior Stroop Test performances in terms of both congruency trials, relative to the control group participants. Fitness variables are therefore shown to be positively correlated with higher cognitive performances, regardless of the type of fitness indices. Regarding neuroelectrical measures, while both exercise modality groups exhibited larger P3 amplitude, the aerobic exercise group showed an additionally more attenuated N2 amplitude. These findings suggest that both aerobic and coordination exercises, as well as health- and skill-related fitness indices, are positively associated with diverse cognitive functions in general for an older population. However, the underlying mechanism of the relationships may be differentially related to specific neuroelectrical processes involved in neurocognitive control.

### **The relationship between moderate-to-vigorous intensity physical activity and resting EEG in children with attention deficit hyperactivity disorder**

Yu, Chien-Lin, Tsai, Yu-Jung, National Taiwan Normal University; Huang, Ching-Ju, University of Taipei; Hung, Tsung-Min, National Taiwan Normal University

Elevated electroencephalographic (EEG) theta power and reduced alpha, beta power have been indicated as the main neural abnormalities in children with attention-deficit/hyperactivity disorder (ADHD). Physical activity (PA) has been found to be beneficial to cognitive performance in a wide range of the population, including children with ADHD. Therefore, the study aims to examine the relationship between PA and resting-state EEG power in children with ADHD. Methods: EEG was recorded during the eyes-open resting state for 20 boys ( $9.8 \pm 1.44$  years) with ADHD. Moderate-to-vigorous intensity physical activity (MVPA) was measured by RT3 Triaxial for a week. Several multiple regression analyses on MVPA and theta, alpha, and beta of the frontal, central, and parietal regions of the brain were performed. Results: The results indicated that higher MVPA was associated with higher beta power at the frontal region. Lower alpha and beta power has been implicative of an abnormal hypoarousal state in children with ADHD. Conclusion: The nature of a cross-sectional design in the present study precludes a causal inference between MVPA and cortical arousal. However, future studies employing an interventional design to examine the causal role of MVPA on reducing cortical abnormality in children with ADHD are suggested.



**The effect of self-control strength depletion on respiratory gas exchange and exercise performance during a maximum effort cycling task**

Zering, Jennifer C.; Graham, Jeffrey D.; Bray, Steven R.; McMaster University

Strenuous exercise and challenging mental tasks require substantial self-control over effort and attention. The strength model (Baumeister, 2007) proposes that expenditure of self-control on one task leads to a negative carryover effect on subsequent tasks. Research by Marcora et al. (2009) showed reductions in endurance performance following 90 min of demanding cognitive tasks that may have depleted self-control. However, self-control depletion can be induced within minutes using tasks with high self-control demands. The purpose of the present study was to investigate the carryover effects of a demanding cognitive self-control task on performance of a graded exercise test (GXT). Using a randomized crossover design, we tested the hypothesis that time to exhaustion on the GXT would be reduced after completing a high-demand self-control task (stop-signal task [SST]) compared to a control task (watching a documentary film). We also assessed whether potential changes in exercise performance brought on by self-control depletion were associated with alterations in respiratory gas exchange. Participants ( $N = 15$ , age =  $19.47 \pm 1.69$ ) performed two GXTs on a cycle ergometer separated by 1 week. Each GXT was preceded by either the SST or control task. Participants reached voluntary exhaustion sooner after completing the SST ( $380.07 \pm 106.73$  s) compared to the control task ( $392.07 \pm 105.19$  s) ( $p < .01$ ). There were no significant differences between conditions on measures of perceived exertion (RPE), heart rate, or respiratory gas exchange (ventilatory threshold and respiratory compensation point) ( $ps > .05$ ). Results support research showing mental fatigue and self-control depletion lead to reductions in exercise performance, suggesting there are common brain-based mechanisms that are taxed by cognitively- and physically-demanding tasks. However, results of the respiratory analyses suggest self-control depletion does not affect ventilation prior to the later stages of exhaustion. Implications for athletes' training and precompetition strategies are discussed.