

### **Validation of the affordances in the home environment for motor development- infant scale (AHEMD-IS) in Lebanon**

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The home environment is a resource of opportunities that can be conducive to stimulating motor development, especially at an early age. The aim of this study was (1) to validate the use of the AHEMD-IS and investigate its reliability in the context of Lebanon. The English version was translated into Arabic and French language (both official languages in Lebanon), and a sample of 230 families with children between the ages of 3-18 months were selected (150 Arabic and 80 French speaking). Lebanese data was examined using a confirmatory factor analysis; with the AHEMD-SI original structure. Families were asked to complete the AHEMD-IS inventory containing 48 items, which represent 3 factors: physical space (outside and inside), daily activities and play materials. Our findings provided preliminary evidence that the AHEMD-IS is a valid and reliable instrument for measuring the quality and quantity of motor development opportunities provided in the home environment for infants ages 3 to 18 months. In a previous study, the validation of the AHEMD-SR (18-43 months) has been validated in a similar study in the context of Lebanon. Further research is required to assess the implications of such measures to motor development. Answers could be provided by comparing AHMED-IS to AIMS. This constitutes a first step towards building robust instruments with strong motor development implications for researchers and practitioners in Lebanon.

### **Motor abilities following a strength-based intervention program for children with Fetal Alcohol Spectrum Disorder (FASD): 1st and 2nd year data**

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Previously, we reported the preliminary the results of a strength-based intervention program for children with FASD. We now present the results of motor skills assessments obtained over a full two years of the same program. Children who entered the program were initially administered a motor skills assessment using the BOT2 Test of Motor Proficiency (BOT2). From the eight total subtests of the BOT2, we identified each child's top three areas of motor proficiency and then designed an individualized program based on those areas. Eighteen children (age 6-12 years) participated in an 8-week after school motor skills development program that consisted of two 1.5 hour sessions per week. A cross-over design was employed, such that only 9 children participated in the program at any one time, with the other 9 children serving as controls. The current results support our previous findings that

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\*The abstracts are alphabetically arranged by the first author's surname within each of the three sections—Motor Development, Motor Learning and Control, and Sport and Exercise Psychology.

a strength-based intervention can be an effective means of bringing about positive changes in the lives of children with FASD. Interestingly, the data continue to show little indication that the intervention is furthering the development of the specific areas of strength that were worked on within the program itself; however, the trend toward positive improvements in overall general motor ability is persisting. More specifically, in terms of overall group averages, the children in our program increased from the 17th to the 29th percentile over the course of the 8 week program. The current results support the notion that if children with FASD are provided an opportunity to focus on their individual strengths, benefits can be realized beyond the specific motor domains worked on during their time in the program.

### **Object orientation and preferential reaching into hemisphere in children**

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It has been suggested that the best way to measure hand preference is to observe an individual's readiness to use the non-preferred hand in a reaching task (Bishop, et al., 1996). Using such preferential reaching tasks, the consensus is that the preferred hand is used significantly more often for midline and ipsilateral reaches, but right handers are more likely to continue to use their right hand to reach for an object in contralateral hemisphere (Mamolo, et al., 2006). Several factors appear to influence hand selection in reaching tasks, including hand preference, location of an object, and task complexity (Bryden, et al., 2003). The current study examined the influence of object orientation and initial position of the hands in a sample of 44 right-handed children, in three age groups (4-6 years old, 7-9 years old, and 10-12 years old). Participants reached to and picked up a mug oriented in one of three ways (handle to right, left, or neutral position) located in one of three spatial positions (left, right, and midline) from each of two starting hand positions: right hand over left, and vice versa. Participants were asked to either pick up the mug or pick it up and pretend to drink from it. The hand used to perform the task was recorded. As expected, reaching into left or contralateral space resulted in significantly fewer right-hand reaches, as did reaching to a mug with the handle oriented to the left. Interestingly, however, children did not seem as affected by the leftward orientation of the mug as did adults from a previous study (Huszczyński, Bryden, Roy & Lyons, 2009). More specifically, children used their right hand 60% of the time for leftward orientations, while adults only use their right hand 33.9% of the time. Additionally, a pattern emerged where both the location and orientation of the object had significant effects on hand selection. The results will be discussed in light of current theories accounting for hand selection preferences.

### **Development and Application of the Affordances in the Home Environment for Motor Development – Infant Scale (AHMED-IS)**

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The present study reports the development and application of the Affordances in the Home Environment for Motor Development – Infant Scale (AHMED-IS), a parental self-report designed to assess the quantity and quality of affordances in the home environment that are conducive to motor development for infants 3 to 18 months of age. The basic structural components and construct validity were adopted from the original AHMED (designed for ages 18- to 42 months) (Rodrigues et al., 2005). Steps in development included use of

expert feedback, establishment of construct validity, interrater and intrarater reliability, and predictive validity. With all phases of the project, 113 homes were involved. Intraclass correlation coefficients for interrater and intrarater reliability for the total score were 1 and .94, respectively. Application of the instrument involved analysis of the relationship between the AHMED-IS and motor development in infants ( $N = 79$ ) using the Alberta Infant Motor Scale (AIMS). Regression analysis indicated that the total amount of affordances in the home significantly predicted motor development,  $Beta = .42$ ,  $t(78) = 2.43$ ,  $p < .05$ ; therefore supporting preliminary evidence for predictive validity. In addition, the association between AIMS values and AHMED-IS subscale scores (Inside Space, Outside Space, Variety of Stimulation, Gross-Motor Toys and Fine-Motor Toys) demonstrated a positive correlation for the AIMS with Gross-Motor Toys,  $r = .221$ ,  $p = .05$ , and Fine-Motor Toys,  $r = .2497$ ,  $p = .02$ . The association between motor development and home environment found in this study provides significant information about the complex nature of early motor development. Our findings suggest that the AHMED-IS has sufficient reliability and validity as an instrument for assessing affordances in the home environment; both for use in clinical practice and research.

### **Intermanual asymmetry in aiming: A developmental perspective**

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Taking into consideration that strength of manual preference for reaching is increased during childhood, we expected magnitude of intermanual asymmetry of performance to follow this developmental trend with increased advantage of the preferred over the nonpreferred hand as children advance in age. This study aimed at testing that hypothesis by assessing intermanual asymmetry on the Fitts paradigm, comparing 5-6 (young, YC) and 9-10 (old, OC) year-old children, having a group of adults (AD) as control. Comparisons were made across different indices of difficulty (ID), from 3 to 6. The task consisted of reciprocally aiming at targets on a computer's screen by manipulating a computer's mouse on a horizontal flat surface with the left/right hand. Distance between targets was constant (8 cm) across IDs, while target widths were varied: 2, 1, 0.5, 0.25 cm. Results showed significantly increased movement times for the YC as compared with the OC and AD groups. Intermanual asymmetry was similar between groups across IDs. While a trend toward increased intermanual asymmetry as a function of greater IDs was observed for both groups of children, the age  $\times$  hand  $\times$  ID interaction did not reach significance. Temporal organization was different between ages, with longer deceleration times for the AD group as compared with the YC group; no significant difference was detected for the OC group. These results reveal that magnitude of intermanual asymmetry of performance in aiming was relatively stable across ages.

### **Children's use of allocentric cues in peripersonal and extrapersonal reach space**

Cordova, Alberto, UTSA; Carl P. Gabbard, Texas A&M University

Theory suggests that the vision-for-perception and vision-for-action processing streams operate under very different temporal constraints (e.g., Goodale et al., 2008). Under the vision-for-perception idea, perceptual representation of the target and its surroundings are predominately memory-based and derived from allocentric cues; coded as a function of the surrounding visual cues and independent from the participant (egocentric self). Our intent was to examine from a developmental perspective, the ability of children to use allocentric cues to estimate distances of objects (targets) from one another. Children ( $n = 66$ ), ages 5-, 7-, 9-, 11 years and young adults ( $n = 17$ ) were asked to estimate how far a cued target was

from a response target (possible responses ranging from  $-3$  to  $+3$ ) in immediate (visually-guided) and response-delay (1-, 2-, and 4 s) conditions. Participants were systematically positioned in a chair and based on individual's maximum reach, seven target positions were created comprising of four target positions in peripersonal (within reach) space and three in extrapersonal (beyond reach) space. Targets were displayed in random order with three trials at each location. ANOVA results for accuracy indicated differences between Age within Condition and Space ( $p < .01$ ). Overall, adults were more accurate than children. Post hoc analysis revealed that with delays of  $\geq 2$  s, performance was affected with all groups, but most notably with the 5- and 7-year-olds,  $p < .001$ . Overall, children as a group tended to underestimate significantly more than adults in the delay (memory-guided) conditions. In summary, these findings indicate that children, especially younger children, have more difficulty mentally representing memory-guided tasks than adults.

### **The development activities of elite soccer players who progressed to professional status at 16 years of age compared to those who did not**

Ford, Paul R, Liverpool John Moores University; A Mark Williams, Liverpool John Moores University

The developmental activities of expert athletes follow either the early diversification or early specialization pathway. In their Developmental Model of Sport Participation (DMSP), Côté, Baker, and Abernethy (2007) summarized early diversification as engagement between 6 and 12 years of age in various sports and deliberate play activity. In this model, specialization through greater engagement in deliberate practice in the primary sport is delayed until around 13 years of age. Although there is evidence to support this model (e.g., Baker et al., 2003), most tests have involved athletes based in North America and Australia. There is a need to examine the validity of the model using other countries and sports. We examined retrospectively the developmental activities undertaken by 15 year old elite youth soccer players in the UK. Participants began taking part in the sport at 5 years of age and commenced their involvement in an elite training academy from the age of 10 or 11 years. When they reached 16 years of age two groups emerged: those who progressed to professional status (i.e., Professional,  $n = 11$ ) and those who did not achieve this status and continued participation at a lower standard (i.e., Released,  $n = 11$ ). The hours accumulated between 6 and 12 years of age in soccer deliberate play were greater for the Professional ( $M = 1696$  hours) compared to Released group ( $M = 880$  hours). The hours during this period in soccer competition and practice did not differentiate groups. The number of other sports participated in ( $n = 4.5$  other sports) during this period also did not differentiate groups, which contradicts the DMSP. Although there were no group differences between 13 and 15 years of age, players engaged in more soccer deliberate practice compared to play and competition. In soccer, their primary sport, professional players generally followed the predictions of the DMSP and our previous findings (Ford et al., 2009), but our data contradicted the early diversification hypothesis. Findings have implications for participation in youth sports.

### **Development and initial validation of the Furtado-Gallagher Computerized Observational Movement Pattern Assessment System (FG-COMPASS)**

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Mastery in fundamental movement skill (FMS) performance (e.g., kicking) is an important factor in preventing unhealthy weight gain (Okely, Booth & Chey, 2004) as well as increasing participation in organized and habitual physical activity among children and adolescents

(Foley, Harvey, Chun & Kim, 2008; Hume, Okely, Bagley, Telford, Booth, Crawford & Salmon, 2008; Mazzardo, 2008). Since schools are involved in assisting children improve FMSs, assessing FMS development is crucial. Therefore, the purpose of this study was to develop and collect initial validity evidence for a new observational assessment tool (FG-COMPASS) to evaluate FMS development of children 5- to 10 years of age. In Phase I, 110 video clips of children performing 5 locomotor and 6 object-control FMS were developed. In Phase II, rating scales were developed for each FMS. In addition, the efficacy of the rating scales was evaluated by comparing judgments of 30 undergraduate students to a standard. Weighted kappa (Kw) indicated that the agreement was best for hopping (Kw = .85), striking and batting (Kw = .79), skipping (Kw = .77), overhand throwing (Kw = .74), catching and hand dribbling (Kw = .72), and horizontal jumping (Kw = .70). The poorest agreement was for kicking (Kw = .51), side sliding and leaping (Kw = .61). The proportion of specific agreement (Ps) was calculated for each skill to determine the source of disagreement. Six skills had at least one category (e.g., initial, elementary, mature) with Ps values below .70. After review of the problem statements, the rating statements were modified. Next, a follow-up study will be conducted to verify whether the changes will improve accuracy of classifications. In conclusion, this study provided initial validity evidence indicating that five rating scales developed for the FG-COMPASS can be used to classify individuals based on their FMS development. However, a follow-up study is needed to verify whether changes made to six rating scales will improve observer agreement.

### **Is there an advanced aging effect on the ability to mentally represent action?**

Gabbard, Carl P., Texas A&M University; Alberto Cordova, University of Texas A&M - San Antonio; Priscila Caçola, Texas A&M University

Motor programming theory suggests that an integral component in an effective outcome is an adequate action (mental) representation of the movements. Furthermore, there are indications that motor imagery provides a window into the process of action representation (Jeannerod, 2001; Munzert et al., 2009). Although several studies have recently emerged concerning the early development of internal models and the ability to mentally represent action, research with older persons has been sparse. From the available information, there are indications of a decline with advanced age (> 64 years) (e.g., Personnier et al., 2010; Skoura et al., 2008). Here, we examined the possible effects of advancing age during adulthood on motor imagery ability (action representation) in the context of estimation of reachability; i.e., estimating whether an object is within reach or out of grasp. This tactic has been reported to be useful for examining action representation and planning of body-scaling movements. Thirty (30) young adults (mean age  $20.07 \pm 1.46$ ) and 23 older adults (mean age  $77.13 \pm 8.59$ ) were instructed to estimate, using motor imagery, whether randomly presented targets in peripersonal (within actual reach) and extrapersonal (beyond reach) space were within or out of reach of their dominant limb while seated. Seven target distances were scaled to the individual's actual maximum reach and the participant received 5 trials per distance. ANOVA analysis for total accuracy indicated that the younger group was significantly more accurate than the older adults;  $F(1, 51) = 13.16, p < .001, \eta^2 = .205$ . In regard to the distribution and general direction of error, whereas both groups made more errors in extrapersonal space, the values were significantly higher for the older group; that is, they overestimated to a greater extent. In summary, these findings add to the general notion that there is a decline in the ability to mentally represent action with advanced age. These findings provide implications for motor planning in the elderly and possible accident cause.

### **Do changes in motor skills affect infants' sensitivity to object size and depth cues?**

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The emergence of head control, reaching, and crawling have all been shown to impact infants' perception of depth (Bertenthal et al., 1984; Rochat, 1995; Yonas & Granrud, 1985). However, while the emergence of some motor skills tends to enhance depth perception, others seem to temporarily hamper depth perception. In this study, we examined whether 4-, 6- and 8-month-old infants with very different levels of motor abilities, varied in their visual scanning of different-sized objects presented on backgrounds containing different linear perspective depth cues. Sixty infants (20 per age) looked at slides containing different combinations of sizes and linear perspective depth cues: (1) same size, no depth cues: 3 objects of the same size were presented on a background without depth cues, (2) same size, depth cues: 3 objects of the same size were presented on a background with depth cues, (3) different sizes, depth cues: 3 objects of different sizes were scaled gradually with linear perspective depth cues, (4) different sizes, no depth cues: 3 objects of different sizes were presented on a background without depth cues (5) different sizes, reversed depth cues: 3 objects of different sizes were scaled gradually against reversed linear perspective depth cues. Slides were projected on a large screen located 2.29 m in front of infants. Looking time to each object was collected with a remote eye tracker (Tobii x50) while infants were supported in an infant seat. When objects were of different sizes and linear depth cues were present, all infants looked longer at the largest object. This was true whether size was scaled congruently with depth cues or not. The 8-month-olds spent the most time looking at the largest object. When objects were of the same size or depth cues were removed, all infants displayed no differences in looking preference between objects. Thus, it appears that from the age of 4 months, infants are sensitive to the perceptual size effects induced by the presence of depth cues. This result was not altered by levels of motor proficiency.

### **Developmental characteristics of toddlers and adults on a vertical jump motion**

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A research was conducted to investigate the characteristics of the vertical jump of toddlers consisted of one group of 3- to 4-year-old toddlers and another group of 5-year-old toddlers by comparing with the vertical jump of adults. Through 8 Qualisys high speed cameras the kinematics of the vertical jump was captured and recorded at 100 Hz. The following variables were calculated: joint range of motion (ROM), propulsion time, highest and lowest COM positions, and the timing of the maximum angular velocity. Position variables of ankle, knee, hip, and trunk on the both sides of the body were captured for analyzing the range of motion, the timing of the maximum angular velocity. The results indicated that the ROM of the lower extremities of the toddlers was generally small as compared with that of adults. At the result of a propulsion time, toddlers had an increased jump preparation time in comparison with adults. This meant that the toddlers did barely flex and extend their lower limbs and prepared with a slower movement time during the vertical jump motion. As for the range of the center of mass (COM) of the subjects, at the rate of minimum COM for COM of static standing, that of toddler groups was higher than adults, which means the toddler groups barely lower their body for vertical jump. Finally, two toddler groups and adult group on the difference between the maximum angular velocities of the lower limbs had some different patterns. According to the results, age as an internal constraint did effect the timing of the maximum

angular velocity representing the coordinative characteristics of the joints of the subjects. In addition, the results suggest that contrary to what Williams(1983) proposed that 5-year-old toddlers would perform an expert vertical jump motion, we come up with a different conclusion that an expert vertical jump motion would be a possible motion over 5 years old.

### **Development of sitting posture in children with cerebral palsy during intervention with and without stochastic noise**

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Sitting is the most functional posture for play and exploration in the developing child, usually attained by 6-7 months of age. However, children with moderate or severe cerebral palsy (CP) have significant deficits in sitting attainment, and hence are restricted in interaction with the world. Our purpose was to compare two intensive and targeted interventions to promote sitting postural control in children with moderate or severe CP, and to determine differences in behavioral and kinetic measures as a result of intervention. The Gross Motor Function Measure (GMFM), sitting section (modified) was used to code behavioral changes pre and post intervention. COP data were also collected pre and post intervention. Ten children with moderate or severe CP were recruited and randomized into two intervention groups. Both groups received a perceptual motor intervention, with one also receiving stochastic noise via an instrumented mat placed at the support surface. Separate repeated measures  $2 \times 2$  ANOVAs (treatment by time) compared the GMFM and linear and nonlinear measures of the COP;  $p < 0.1$  used due to the small sample size and large variability between children. There was a significant effect of time for the GMFM variable, but no difference between groups. There was a significant interaction effect for RMS (variability of the COP path) in the anterior posterior (AP) direction ( $P = 0.1$ ), and Approximate Entropy in the AP direction ( $P = 0.08$ ). In both cases, the group with the stochastic noise intervention developed in the same direction as expected for typically developing infants in sitting. We concluded that while both interventions produced behavioral changes in the sitting skill, the group with the added stochastic noise during the intervention showed specific improvements in variability and complexity of the COP, which mirrored developmental changes in typical infants' sitting postural control. These results may indicate a potential for greater change in sitting using the stochastic noise intervention, and thus greater function as the child's sitting skill progresses.

### **What about me?: Utilizing random coefficient models to investigate individual behavioral trajectories in school-aged children**

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Sensorimotor performance in school-aged children is typically characterized by increased intra- and inter-individual variability. Statistically characterizing this variability is not only critical for the analysis and interpretation of behavioral data, but may facilitate our understanding of the processes underlying sensorimotor development in typically developing (TD) children and in children with developmental disorders. The statistical analyses traditionally employed in developmental research (i.e., general linear models (GLM)) are often inappropriate as population-level differences are masked by the increased variability and trajectories of change at the individual level are not investigated. Thus, we employed a flexible statistical technique, a random coefficient model (RCM), to parameterize intra- and inter-individual

variability in TD children and children with Developmental Coordination Disorder (DCD) during a sensorimotor adaptation task. The RCM, suited for repeated measures data, characterizes trajectories of behavioral change, a critical component of developmental research. We contrasted the results from the RCM with those from a traditionally employed general linear model (GLM). The RCM not only revealed differences between the two groups of children that the GLM did not detect, but also characterized trajectories of change for each individual. This approach provides researchers an opportunity to probe behavioral deficits at the individual level and also offers insights into sensorimotor development in TD children as well as the idiopathic characteristics of developmental disorders such as DCD.

### **Developing sitting postural control and play in children with cerebral palsy**

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Learning how to maintain upright sitting posture is an important developmental milestone. Self-sitting ability promotes coupling between visual inspection and object manipulation in typically developing infants (Soska et al, 2010). However, children with moderate to severe cerebral palsy (CP) with poor postural control are limited in their abilities in manipulation and play during the developmental process. Play is the occupation of a child to learn about interaction with the world. Our goal was to determine whether improvements in sitting postural control occurred due to a therapy intervention, and whether these improvements in sitting then affected play skills in children with severe CP. Eight children, age 18 months to 6 years, with moderate or severe CP participated in the study. The sitting section of the Gross Motor Function Measure (GMFM) for children with Cerebral Palsy was used to measure behavioral changes in sitting postural control. The GMFM sitting section was modified to include 3 more items in the lower end of the scale, to accommodate the severity of the children. The children came twice weekly for 3 months for perceptual-motor intervention. Sitting (GMFM) and play assessments were done prior to the start of intervention and one week after the end of the intervention. A graduate student in Psychology used a behavioral coding system to evaluate successful manipulations by each child with various toys looking at two conditions: 1) the use of a proper body part to manipulate a toy and, 2) the use of another body part. These numbers were then divided by the total time spent with the toy and this ratio was calculated for both pre and post play assessments. A paired t-test was performed for the play assessment and the scores on the GMFM as well. There were significant improvements in both the play scale ( $p = 0.019$ ) and on the GMFM sitting scale ( $p = 0.000$ ) before and after the intervention. These results demonstrate that exploration of the environment increases when sitting postural control improves in children with moderate to severe CP.

### **Can imprecise internal motor models explain the hand trajectory formation during reaching in young infants?**

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The first reaching movements of human infants lack limb coordination leading to ataxic-like hand trajectories. Kinematically, these early trajectories are characterized by multiple peaks in the hand velocity profile which gradually decrease in frequency during development. It has been proposed that these trajectories can be regarded as a series of concatenated mini



ballistic trajectories that follow the minimum-jerk principle, because the infant is not capable of generating appropriate joint torques to perform a single, large amplitude movement. In this paper we explore an alternative hypothesis that the jerky hand trajectories seen in early infancy are the result of imprecise internal motor models. Specifically, we tested how imprecise estimations of the arm inertia, gravity and Coriolis forces available to an inverse dynamics controller affect hand trajectory kinematics. We designed a 4 df computational model of a human arm (shoulder and elbow) using the Matlab Simulink environment. Results from our simulation suggest that arm control is quite resilient to faulty estimations of mass and gravity. However, imprecise estimations of multi-joint intersegmental torques (i.e., Coriolis forces) by the controller induce multi-peak hand velocity profiles. When the system was also allowed to use delayed position and velocity feedback, the resulting kinematics began to resemble the multi-peak velocity profiles seen in early infancy. This suggests that the output of an imprecise internal model of limb dynamics coupled with delayed feedback may be sufficient to explain the formation of early human hand trajectories requiring no recourse to higher cognitive processes of compensatory motor planning. Our data provide an alternative and parsimonious explanation to previous hypotheses theorizing jerky trajectories are the result of concatenated mini ballistic movements.

### **The transition of infant spontaneous arm movements to goal-directed reaching**

Lee, Mei-Hua, Karl M. Newell, The Pennsylvania State University

The role of the spontaneous arm movements in the emergence of purposeful reaching movements has received limited investigation particularly in considering the individual characteristics of the developmental pathway of change in behavior over time. The objective of the present longitudinal study was to quantitatively describe the qualitative properties of the transition in infants from prehensile spontaneous arm movements to goal-directed reaching movements. Ten full-term infants were observed biweekly from the age of 10 weeks to 28 weeks. Data were collected by means of a four-camera ProReflex system (Qualisys, Inc., Gothenburg, Sweden) and two video recorders (60 Hz). Dimensionless jerk was analyzed for each phase of the spontaneous arm movement to measure the structure of the change in prehensile movement patterns as a function of developmental age (early and before onset of reaching movements). As infant age increased, there was: (1) an increase in movement jerk, which reflects the increasing ability to modulate arm movements to goal-directed reaching movements, and (2) a negative correlation between changes in the movement jerk to the onset of reaching – that is, a change in the movement jerk in spontaneous arm movements predicts the onset of reaching movements. These findings reveal the dynamic characteristics of the spontaneous arm movements that precede the onset of goal-directed reaching movements and their relation to the developmental process of prehension in infancy.

### **The effect of early posture and movement experiences on head control, prereaching movements, and early reaching behaviors**

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Background and Aims: Head control and pre-reaching movements have long been proposed to be important for the development of reaching. There are few studies on the effect of posture and movement experiences in the first weeks of life on head control, pre-reaching arm movements and the emergence of reaching. The purpose of this study was to quantify the effect of daily posture and movement experience starting at 4 weeks old on the emergence

of these three related behaviors. Methods: 22 full-term infants were randomly assigned to Control (CG) or Trained (TG) groups. Infants were observed every other week from 4 to 16 weeks old. A motion capture system recorded head and arm kinematics in supported sitting. The Test of Infant Motor Performance (TIMP) was conducted to track motor development. Accelerometers on wrists monitored activity level. Caregivers performed 20-minutes of daily posture and movement activities (TG) or social interaction without objects (CG) for 4 weeks. Results: TG consistently and significantly differed from CG (all  $p < .05$ ). Head Control: TG had higher TIMP scores on head control items, held their heads in an upright position longer and spent less time using head supports. Pre-reaching Movements: TG showed faster and smoother movements, and moved hands more forward and closer to a midline toy prior to reach onset. TG also differed from CG in shoulder and elbow orientation, and had higher general activity levels. Reaching: TG reached earlier, had more toy contacts and longer contact duration. Conclusion: Infants' early posture and movement experiences play a role in the very early control of their head and arm movements. Moreover, infants show rapid changes in head and arm behaviors as a result of their daily movement-related experiences. Future work will quantify the effect of these experiences on infants born at high risk for lifelong movement impairments such as those born preterm and with brain injuries.

### **Motor milestones may be used as indicators for early diagnose in autism**

Liu, Ting, Michelle Pope, Texas State University-San Marcos

There is a growing recognition that children with autism experience motor delays and impairments. The timing of onset of motor delays is of central importance, given recent assertions that motor differences can aid in the early identification of autism. However, no motor milestone data on children with autism exist to investigate whether movement disturbances can be used for early diagnose in autism. The purpose of this study was to obtain milestone data for autistic children and to determine whether some motor milestones may be useful for predicting autism in early childhood. The parents of children ( $n = 22$ , male = 15, female = 7) who had been diagnosed with autism, answered questions related to their child's early motor milestone development. Most parents (18 out of 22) used their child's baby book or physician's records with an average accuracy rating of 86% of their child's first three years' motor milestones were compared to the norms reported by Bayley (1935). Z-test was used to analyze the differences between the children with autism motor milestones and the norms. The results showed that all children who participated in this study were diagnosed at age three or later. Seven children were diagnosed with Asperger syndrome, one child was PDD-NOS, and the rest had autism. Children with autism were significantly delayed on 15 out of 28 motor milestones when compared to the norms. More importantly, children with autism delayed on 14 motor milestones before the age of two, such as holding their head steady, sitting with support, and reaching and grasping as compared to the norms. It was notable that children with autism were significantly delayed not only for fine motor skills but also for gross motor skills. The authors suggest that motor milestones may be used as indicators for predicting autism in early childhood.

### **The association between the object control subscale of two motor assessments**

Logan, Sam W., Auburn University; Leah E. Robinson, Auburn University; Nancy Getchell, University of Delaware

An accurate evaluation of fundamental motor skills is critical for assessing growth and development in children. Many assessments, such as the Test of Gross Motor Development

-2 (TGMD-2) and the Movement Assessment Battery for Children -2 (MABC-2), are used to assess motor ability, but research has not investigated the reliability of two or more assessments as it relates to motor performance. The purpose of this study was to determine if associations exist between the object control (OC) subscale of the TGMD-2 and the MABC-2. Seventeen children between 4 and 6 years old ( $M = 5.2 \pm .63$  years) were administered the OC subscale of the TGMD-2 and the entire MABC-2 assessment. The TGMD-2 OC subscale qualitatively assesses a child's ability to throw, kick, catch, strike, dribble, and roll a ball and each skill is evaluated on 3 to 5 performance criteria. The MABC-2 is designed to evaluate motor proficiency and movement difficulties and is divided into three subscales: manual dexterity, aiming and catching (AC), and balance. The MABC-2 assesses motor skills in a quantitative nature, emphasizing the number of successful and unsuccessful trials and not the developmental sequencing of movements. Pearson correlations assessed the associations between the TGMD-2 OC percentile and each subscale and the total MABC-2 percentiles. No significant correlation existed between the OC percentile and the percentiles of the following: manual dexterity ( $p = .98$ ), balance ( $p = .82$ ), and total MABC-2 ( $p = .53$ ). A positive, significant correlation existed between the OC percentile and the AC subscale of the MABC-2 ( $r(15) = .65, p = .005$ ). The significant result is encouraging and suggests that the manipulative tasks of the TGMD-2 OC subscale are associated within the AC subscale of the MABC-2. Future research should compare other widely used motor skill assessments to determine if other associations exist.

### **The developmental difference between children and adults with regard to the movement timing correction to an unexpected change in falling velocity**

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The development of motor skill acquisition is related to information on gravity. For example, when catching a falling ball, we use our perception of gravity to supplement sensory information. The purpose of this study is to study the developmental difference between children and adults in estimating the time required to make contact with a falling target. For this purpose, we study the influence of gravity on their ability to estimate this time. We conduct a coincidence timing task with 3 different falling velocities (0.5 g, 1 g, and 2.0 g/s) and 2 velocities with which the targets were projected upward (6 m/s and 8 m/s). The participants comprised 9 first and second graders of an elementary school, 14 third and fourth graders of the elementary school, 6 female aged 22-26 years, and 6 male baseball experts. The participants were tasked to manually press a button concurrently with the arrival of the falling targets, which was raised from start point and fell to same point. The participants were evaluated in terms of accuracy (absolute error), stability (variable error) and movement timing correction. The results show a significant difference in accuracy and stability in the baseball player, the female, the third and fourth graders, and the first and second graders, in that order. Further, the falling velocity of the 1 g target was more accurate than that of the other targets (0.5 g and 2.0 g). We further conducted that the stability is influenced by gravitational pull. The movement timing correction rate for all participants decreased when the falling velocity increased at 8 m/s. However, at 6 m/s. the movement timing correction did not decrease in both groups of adults (baseball experts and female) though it did in both groups of children (elementary school students). This led us to conclude that there are some developmental differences between adults and children in terms of their ability to use sensory information of gravity to estimate the timing of a falling target.

### **The association between mentally representing action and motor ability in children**

Oliver, Brittney D., Student; Carl Gabbard, Texas A&M University; Priscila Cacola, Texas A&M University; Tatiana G. Bobbio, Unicamp

Developmentalists have discovered that use of motor imagery in experiments allows insight to the unfolding nature of mental representations and cognitive processes used in action planning. With this in mind and the understanding that motor imagery provides a window into action representation (Jeannerod, 2001; Munzert et al., 2009), researchers have shown considerable interest in identifying motor imagery ability in children. The intent of the present study was to examine the association between general motor ability and a relatively unreported form of action representation / estimation of reach. That is, judging whether an object is within or out of reach via motor imagery. Twenty-nine (29) children aged 7 to 11 years (mean age 8.5) were assessed for estimates of reach via motor imagery with targets randomly presented in peripersonal (within reach) and extrapersonal space (out of grasp); seven targets were presented with three trials per target. This was followed by an assessment of general motor ability using the Movement ABC-2 (M-ABC; Henderson et al., 2007). Our initial prediction was that there would be a positive relationship between higher levels of general motor ability and estimation accuracy. Motor ability values, based on percentile rank, ranged from 2 to 91, with a mean of 36. ANOVA results indicated no difference between age and total estimation accuracy ( $p > .05$ ); the mean was  $16.38 \pm 2.59$ , ranging from 11 to 20. Correlation analysis using total accuracy score (number of correct answers out of 21 trials) and M-ABC percentiles revealed a moderately positive relationship between the two variables,  $r = .39$ ,  $p = .03$ . When looking specifically at the motor ability subcategories, only Balance was significant in the model, explaining 20% of the variance. Regression analysis showed that motor ability score predicted estimation of reach, accounting for 14% of the variance. In summary, these results suggest that the child's motor ability and the ability to mentally represent action via estimation of reach are positively related.

### **Attenuated cortical activation may underlie movement deficits in children with developmental coordination disorder**

Pangelinan, Melissa M, University of Maryland, College Park; Bradley D Hatfield, University of Maryland, College Park; Jane E Clark, University of Maryland College Park

Children with Developmental Coordination Disorder (DCD) exhibit marked deficits in movement planning and visuomotor behavior. The neurophysiological mechanisms underlying these functional deficits are not well known. We employed EEG to characterize the cortical dynamics underlying motor planning and online control in children with and without DCD. EEG was recorded from children with DCD (mean age 11.1 years) and a typically developing (TD) landscape of children and adults (mean ages 6.7, 11.1 and 22.1 years) during a center-out drawing task. Participants made drawing movements on a tablet between a center position and two peripheral targets. The movements were self-initiated and self-selected. EEG signals were decomposed in the time and frequency domain (movement-related cortical potentials and alpha power, respectively) analyses. Movement kinematics were also assessed and correlated with the EEG measures. Children with DCD exhibited attenuated movement-related cortical potentials for both contralateral and ipsilateral motor areas compared to their age-matched TD peers and adults. However, children with DCD were not significantly different from the young TD group. In addition, the young TD group and the children with DCD exhibited less task-related activation (increased alpha power) than the older TD groups. Although attenuated activation was limited to the parietal region

for the young TD group, the children with DCD exhibited significantly attenuated activation across all areas of cortex. At the behavioral level, the young TD children and children with DCD were slower, jerkier, and exhibited less consistent movement planning than the older TD groups. These data suggest that children with DCD appear delayed compared to the TD landscape and that poor quality motor behavior is associated with a lack of engagement of task-relevant cortical regions. Future studies will determine if these functional deficits are due to delayed structural development of brain areas critical for motor planning and control.

### **Developing the on-line test on perceptual-motor ability**

Park, Seungha, Ewha Womans University; Dong-Wook Han, Chonbuk National University

A study was conducted to develop the on-line test on perceptual-motor ability for children ages 5 to 12 years. The preceding steps for developing this test were an initial test-items selection and the development of on-line program, a pretest, a standardized test, and a specialist-advice on child's performance. Firstly, the initial test items were constructed from modifying the taxonomy of human perceptual motor ability proposed by Fleishman (1952), and the on-line test program for each item were developed with reference existing test such as reaction task, Fitts task, photoelectric rotary pursuits task, and ambient vision task etc. Secondly, the pretest was administrated on a total of 64 children in preschool and elementary school, and the on-line test form confirmed 12 sectors through a pre-test: Control Precision, Rate Control, Reaction Time, Response Orientation, Speed of Hand and Arm Movement, Hand Arm Steadiness, Bimanual Coordination, Manual Dexterity, Timing, Rhythm, Visual Scanning, Ambient Vision. After a pre-test, test duration and index of difficulty on the tasks were rescaled through survey and face validity. Thirdly, a total of 605 children participated in standardized procedures and classified 5 levels on the same age and any age: excellent (over 90%), very good (68-90%), good (32-68%), poor (10-32%), very poor (below 10%). Finally, a specific specialist-advice about children's performance was organized to advance children's perceptual-motor ability. We expect that the on-line on perceptual-motor ability will be useful to parents, teachers, and researchers who interested in engaging children in effective movement activities that integrate perception and movement.

### **Visual-part and music instructions improve timing consistency in bimanual drumming in adults with Down syndrome**

Ringenbach, Shannon D, Arizona State University; Zachary Gibbons, Arizona State University; Chih-Chia Chen, Arizona State University; Genna Mulvey, Arizona State University

The present study examined the influence of visual-part and visual-whole instruction types in comparison to music, verbal, and rhythm instruction types during continuous bimanual drumming. Fifteen persons with Down syndrome (DS), 15 mental age-matched (MA), and 15 chronological age-matched (CA) participants hit two drums with their hands at the same time following music (e.g., pentatonic folk music style in 2/4 meter), rhythm (e.g., sound of drumbeat), verbal (e.g., computer saying "drum"), visual-part (e.g., video of both hands moving up and down and hitting the drums together, from a top-angle view) instructions, and visual-whole (e.g., video of both forearms moving up and down and hitting the drums together, from a side-angle view). Overall persons with DS performed faster and farther from the instruction pacing than CA, and visual-part and music instructions resulted in the more consistent timing than verbal, rhythm and visual-whole instructions. Research supported by the Jerome Lejeune Foundation.

### **Auditory motor adaptation in children with developmental coordination disorder**

Roche, Renuka, University of Maryland, Baltimore; Priya Viswanathan, University of Maryland, Baltimore; Jane E. Clark, University of Maryland, College Park; Jill Whittall, University of Maryland, Baltimore

An increasing number of studies suggest that children with Developmental Coordination Disorder (DCD) have a decreased ability to adapt their motor responses to changing sensory cues (Kagerer et al., 2004, 2006). However, it is not established if this ability to adapt is influenced by the degree of change in the sensory stimulus. We used a bilateral rhythmic finger tapping task with auditory cues to investigate the ability to detect and adapt to cues that were abruptly or gradually moved away from the 180 deg relative phasing of the auditory signals. We enrolled children with DCD between the ages of 5-11 years ( $n = 26$ ) and compared their performance to that of aged-matched typically developing (TD) children. Initially, a psychophysical staircase method was used to determine the phasing difference at which the change in rhythm was perceptible. There were two adaptation conditions that required synchronization of taps to: (1) a perceptible change in rhythm of 45° or 20° depending on the child's perceptual ability; and (2) a gradual change in rhythm until it reached the level of perception. There were twelve 25-s trials. The first and last two trials were baseline where the children performed bilateral 180° finger tapping. The variables of interest were the mean relative phasing between the fingers and the within-trial standard deviation of the relative phasing. We found that most children with DCD were able to adapt to an abrupt change in sensory information [ $F(11, 252) = 21.97, p < 0.0001$ ], but they had greater difficulty in adapting to gradual subliminal changes in sensory information. This finding is similar to younger TD children. Children with DCD were significantly more variable in their motor performance when compared to TD children [ $F(1, 413) = 8.75, p = 0.0033$ ]. However, examination of individual performances showed heterogeneity in motor performance and presented a more complex picture. We interpret our findings from both a developmental and a task-specific perspective.

### **The development of ipsi- and contra-lateral hand foot coordination**

Seaman, Jessica M, Jeffrey M Haddad, Lisa Goffman, Joong Hyun Ryu; Purdue University

The ability of children to produce stable in-phase and anti-phase coordination patterns between hand and foot appears to develop sometime around or after 10-years of age (Cavallari et al. 2001). Interestingly, coordinating the contra-lateral hand and foot appears to be easier than coordinating the ipsi-lateral hand and foot in both children and adults (Volman et al. 2006; Hiraga et al. 2004). Attentional, perceptual and ontogenetic interpretations have been proposed to explain this counterintuitive finding. Examining the developmental time course of hand-foot coordination may help explain why contra-lateral coordination is easier than ipsi-lateral coordination. Seven 7-year olds and twelve 10-year olds sat in a chair with their forearms and feet parallel with the floor. Children produced ipsi-lateral hand and foot movements in-phase and anti-phase. Contra-lateral hand and foot movements were also produced in-phase and anti-phase. Kinematic data from the hands and feet were collected by a Vicon motion capture system. Before each trial, children watched an instructional video demonstrating the target coordination pattern and were directed to perform each trial at their preferred frequency. Average continuous relative phase variability over 10 cycles was calculated to assess the stability of the desired coordination pattern. Similar to the findings of Cavallari et al. (2001), 10-year olds were able to produce more stable ipsi-lateral

coordination patterns than 7-year olds in anti-phase and in-phase. As expected, producing the anti-phase coordination pattern was more difficult for both age groups. While there was a developmental progression in ipsi-lateral coordination, both 7- and 10- year olds showed similar performance when producing contra-lateral coordination patterns. Thus, development is not uniform across all dimensions of bilateral coordination. Overall, the results are consistent with an ontogenetic interpretation of the data.

**Does manual preference in reaching derive from intermanual asymmetry of performance in infants?**

Souza, Rosana M., University Federal of São Carlos; Raymundo M. Azevedo Neto, University of São Paulo; Eloisa Tudella, University Federal of São Carlos; Luis A. Teixeira, University of São Paulo

Manual preference has frequently being assumed to derive from innate performance advantage of one hand over the other. From this viewpoint, such a manual dominance should be manifested early in motor development. To test that assumption, manual preference and intermanual asymmetry of performance was evaluated in 14 five-month-old infants in a task of reaching for static targets positioned at the left, center, or right regarding the infant's mid sagittal plane. Manual preference was evaluated through frequency of reaching movements with the right/left hand toward a toy. Intermanual performance asymmetry was assessed through 3-D kinematic analysis of reaching of the following variables: movement time, movement straightness, number of movement units, peak velocity, and deceleration time. Analysis of manual preference indicated that five infants presented right manual preference, six infants left manual preference, and three infants had inconsistent manual preference. Kinematic analysis showed that for most variables no significant difference was detected between the hands. The single exception was observed in deceleration time, with significantly lower values for the right in comparison with the left hand. Correlation scores between preference and performance asymmetry was nonsignificant for all kinematic variables. These results suggest that at this age performance in reaching is predominantly symmetric, and then early manual preference does not seem to derive from a superior capacity of control over the preferred arm.

**Amplification and diffusion of manual preference from lateralized practice in children**

Teixeira, Luis A, University of São Paulo; Renato P Silva, University of São Paulo; Sylvia L Freitas, University of São Paulo

The effect of lateralized practice on manual preference was investigated in 3-4 year-old right-handed children. Manual preference was evaluated before and after four 15-min. sessions of practice. Probing tasks required reaching and grasping a pencil at distinct eccentricities in the right and left hemifields (simple), and its transportation and insertion into a small hole (complex). During practice the children experienced manipulative tasks different from that used for probing, using the left hand only. Results showed that before practice the children used almost exclusively the right hand in the right hemifield and at the midline position, while the left hand was used more frequently in the left hemifield. Following lateralized practice frequency of use of the left hand increased in most lateral positions, reaching predominance in several individual cases. This effect was observed mainly in the contralateral hemifield and at the midline position. No significant effect related with task complexity was detected, showing that after practice the left hand was used more frequently not only for the simple but also for the complex task. From these findings, implications for lateralization of behavior from

unimanual practice in a developmental timescale are discussed on the basis of the following propositions: (a) amplification of manual preference, with increment in strength of manual preference for a single hand; and (b) diffusion of manual preference, with dissemination of preference acquired in one or a few motor tasks to a number of distinct manual actions.

### **The developmental trajectory of newborn stepping in infants with and without Down syndrome**

Ulrich, Dale A, University of Michigan; Yoo Seok Kang, Yong In University; Emily L. Bayer, Data-Driven Insights and George Washington University

Developmental researchers have demonstrated that newborn stepping is present during the first 8-10 weeks of age in most infants. Several researchers have demonstrated that the slope of newborn steps over age is influenced by rapid weight gain and arousal level in typically developing (TD) infants and the slope can be extended meaningfully by practicing the newborn stepping behavior (Thelen et al, 1984; Zelazo et al, 1972). No data has been published on the trajectory of newborn stepping in the Down syndrome (DS) population known to be significantly delayed in walking onset. Six infants with DS and six TD infants matched on corrected age and gender entered the study as soon as they turned four weeks corrected age. Newborn stepping was elicited via standard procedures and videotaped in their home for two 30 second trials. This continued biweekly until stepping could no longer be elicited. During each session, body length, weight, and head circumference were measured. Arousal level was also scored every 15 seconds during the test trials using standardized procedures by 2 independent raters. The videotaped performances were coded by trained coders. The results indicate that the slope of step frequency is correlated with the slope of weight gain ( $r = .85$ ) and the slope of arousal level (.62), similar to results reported by Thelen et al (1984). The average age when stepping stopped was significantly different in that TD infants stopped at 10 weeks while the infants with DS stopped at 15 weeks on average (Effect size = 1.35). The stepping trajectory of individual infants in the DS and TD groups varied greatly from their group trajectory. The mean steps taken at 4, 6, and 8 weeks were significantly higher in the DS group but no group differences were observed for rate of weight gain and arousal level. Now that a baseline trajectory of newborn stepping has been recorded, the next logical step is to test the hypothesis that newborn stepping practice will extend the stepping trajectory over developmental time and lead to earlier onset of walking in infants with DS.

### **The development of asymmetric stance in early childhood**

Van Zandwijk, Renate, Patricia M Hill, Jody L Jensen; The University of Texas at Austin

The study of balance during stance can tell us many things about the functional state of many of the body's systems, such as the development of the neuromuscular system and the ability to integrate sensory information. Previous studies have shown that symmetric stance does not mature until 7-10 years of age. Since perfect symmetric stance is rarely used in regular life, study of asymmetric stance would be more useful in the investigation of motor development. The purpose of this research was to determine the developmental sequences for standing balance under asymmetric foot conditions. Participants included thirty children between 9 months and 10 years old and six adults. The children were divided into five developmental groups, depending on their scores on motor assessment tests; Independent Standers/Walkers (ISW), Runners/Jumpers (RJ), Hoppers (H), Gallopers (G) and Skippers (S). Where the group S represents those children who demonstrate the highest level of motor



development and ISW group the least. Participants were asked to stand on a force plate with their feet together or with one foot at 1/3, 2/3 or 3/3 of their foot length backwards (for both left and right foot conditions). The balance was compared using three different parameters calculated from COM and COP data; average total distance traveled by the COP, average distance between COM and COP, and average two-dimensional distances between the estimated COM and the location of the theoretical maximum stability point. Group effects were found for both left ( $F(15,77.7) = 10.51, p < 0.05$ ) and right ( $F(15,77.7) = 11.93, p < 0.05$ ) foot-back conditions. We observed that the RJ and the IWS differ from the other developmental groups and the adults, but they did not differ from each other. No differences were found between the S and adults. The results indicate that standing is not mature until children are in the G or H group. Further research on the development between the onset of independent stance and the final maturation of asymmetric balance, could answer many questions about the refinements in motor behavior.

### **The influence of motivational climates on the physical activity in rural, African American school-age children**

Wadsworth, Danielle D., Leah E. Robinson, Mary E. Rudisill, Sam W. Logan, Maria Morera, Colleen Daly; Auburn University

With the growing need for children to be physically active, it is imperative to create physical education programs that promote engagement in physical activity. The aim of this study was to determine the effects of two physical education climates, Mastery Motivational Climate Physical Education Program (MMCPEP; child-centered) and Low Autonomy Physical Education Program (LAPEP; teacher-centered) on physical activity. Participants, African American ( $N = 69$ ) children, were kindergartners, first and second graders from a rural elementary school. Participants were randomly assigned to one of two physical education climates, MMCPEP ( $n = 37$ ) or LAPEP ( $n = 32$ ). Physical activity was measured with Yamax pedometers that were attached to each child's waist. The physical education climates were implemented over 10 school days by two trained experts. Instruction was counterbalanced and fidelity of climates was measured to ensure that the criteria for each climate were met. A condition (MMCPEP or LAPEP)  $\times$  sex ANOVA revealed that participants in the MMCPEP ( $M = 1648 \pm 73$ ) accumulated significantly more steps than LAPEP ( $M = 1409 \pm 68; p = .02$ ) participants. In terms of sex differences, boys ( $M = 1653 \pm 72$ ) achieved significantly higher steps than girls ( $M = 1404 \pm 72; p = .02$ ). No interaction effect was present ( $p = .637$ ). Findings indicate that children participate in more physical activity when exposed to a MMCPEP, when compared to a LAPEP.

### **A multi-methodological and disciplinary examination of expertise development in cricket batting**

Weissensteiner, Juanita R., Australian Sports Commission; Bruce Abernethy, Hong Kong University; Damian Farrow, Australian Institute of Sport

A methodologically pluralistic and multidisciplinary approach was adopted to examine the development of expertise using cricket batting skill as the exemplar task. The two major aims of the investigation were to: develop a conceptual model of expertise for cricket batting skill through retrospective evidence; and validate the conceptual model through the systematic examination of each of the model's key components. The first phase of the investigation, gathered retrospective evidence in the form of semi-structured interviews with elite coaches, administrators, elite and sub-elite batsmen and then applied a Grounded

Theory methodological framework to identify components and factors thought to contribute to exceptional performance. The generated model consisted of perceptual, technical (motor) and cognitive skills, and considered the influence of practice history, socio-developmental background and morphology. In the second phase of the research, the relative contribution of, and the inter-relationships between, key factors in the conceptual model were examined using a cross-sectional research design incorporating participants of two skill levels (skilled and lesser skilled) across three age categories (U15, U20 & adult) and univariate and multivariate analytical procedures. The findings of Phase 2 validated and refined the conceptual model developed in Phase 1 supporting the contemporary notion that expertise is the consequence of a multidimensional and dynamic process. The relative importance and relationship between specific components varied across both age and skill, in particular, adult expertise in cricket batting is reliant on superior perception-action coupling, implicating both visual perceptual and technical skills, refined by extensive task-specific practice, mental toughness and strong intrinsic motivation. It is envisaged that the analytical framework developed in this investigation can serve as a viable template to guide the development of future talent identification programs in a manner based on evidence rather than opinion.

### **Six- to 8-month-old infants' reaching flexibility in response to contextual demands**

Williams, Joshua L, Daniela M Corbetta, Benji D Craddock; The University of Tennessee

With the onset of reaching, infants begin a process of learning to select appropriate action patterns in response to environmental demands. By 8 months of age, infants have become pretty good at modulating their reaching patterns to match the target-object properties. Prior to that age, however, infants may exhibit what appear to be fixed reaching patterns such as consistent bilateral responses, when small objects are presented at midline (Corbetta et al., 2000). Some have argued that neuromotor immaturity may contribute to this apparent motor rigidity (Gesell & Ames, 1947). In this study, we examined to what extent these early, seemingly fixed reaching patterns can be broken if the task-at-hand demands reaching flexibility. Thirty 6-, 7-, and 8-month-old infants were presented with a "board task." During this task infants reached for small, graspable objects presented at midline atop an L-shaped wooden board. To establish a baseline reaching pattern, infants were presented with 5 trials on the board, during which infants could reach and grasp toys with both hands. Next, the board was rotated 90 degrees such that a vertical, opaque panel separated the reaching space into left and right halves. Toys were presented against one side of the vertical panel at infants' midline. In this condition, both arms could still be moved forward, but only one hand could access the toy. Movement kinematics were recorded to assess the displacement of each arm. Results show that all groups were able to modify their preferred reaching patterns in order to use the arm matching the side of toy presentation. Even the 6-month-olds, who exhibited strong bilateral reaching preferences during baseline, were capable of adapting to the contextual demands. These results challenge the notion that young infants lack the neuromotor maturity to modulate their reaching patterns in the face of varied task demands. Rather, from the age of 6 months, infants can identify the appropriate reaching actions and also possess the motor flexibility to select those actions and complete the task at hand.

### **Effect of different treadmill interventions on the development of joint kinematics in infants with Down syndrome**

Wu, Jianhua (Jerry), Georgia State University; Julia Looper, University of Puget Sound; Dale Ulrich, University of Michigan; Rosa Angulo-Barroso, University of Michigan

Infants with Down syndrome (DS) are delayed walkers and produce less coordinated walking patterns. The purpose of this study was to investigate whether two different treadmill interventions would influence the development of joint kinematics differently in infants with DS. Thirty infants with DS were randomly assigned to a lower-intensity, generalized (LG) group or a higher-intensity, individualized (HI) treadmill training group. Both groups started training when they could generate six steps per min while being supported on a treadmill. The training was implemented until participants walked three steps on the floor independently. Then, twenty six subjects (13 in each group) came to our laboratory four times to complete a one-year gait follow-up. Participants walked along a GaitRite mat four times at each gait visit. Reflective markers were placed bilaterally on the participants to measure the kinematic patterns of the ankle, knee, and hip joints in the sagittal plane. Results showed that both the LG and HI groups advanced the development of joint kinematics significantly over the gait follow-up. Furthermore, the HI group produced more advanced joint kinematic patterns than the LG group. Specifically, the HI group placed peak ankle extension at or before toe-off, and spent a higher percentage of time after toe-off to swing the thigh forward. These results imply further benefits in the HI group who may make better use of mechanical energy at the end of the stance phase and reduce the hip muscle forces and moments during walking.

### **Perceptual-motor development in rare target visual searches**

Yan, Jin H, Youlian Hong; The Chinese University of Hong Kong

Many visual searches involve the detection of rare targets and are of life or death importance (baggage screening, medical radiology, and cytology). Obtaining a better understanding of the nature of prevalence effects is of more than merely theoretical importance. Thus, the effect of target prevalence (the frequency of a target's presence) on the ability to find a target among an array of distractors is an active area of research in visual cognition. Adults often miss a disturbingly high percentage of rare targets in visual arrays. The differences in the miss rate resulting from a simple change in target prevalence are accompanied by a reliable pattern of response time (RT). Observers respond faster when target prevalence is low than when it is high. The mechanisms underlying this effect remain hotly debated. This study examines the effects of developing motor control and performance on the speed and accuracy of visual searches. A total of 87 children took part in the two experiments (7 to 8 years, 9 to 10 years, and 11 to 12 years of age). In the experiments, children detected targets that appeared rarely (2%) or frequently (50%). They reported a target's presence or absence by either pressing a key (Experiment One) or marking on recording sheets (Experiment Two). The results replicated past reports of increased errors with reduced target prevalence in adults. A potential developmental trend in performance is linked to a measure of motor function. When the pressure to respond quickly was removed, search accuracy greatly improved for rare targets. A developmental account for the perceptual-motor mechanisms of prevalence effect is discussed. Our data suggest that children as young as 7 or 8 years of age could develop a habitual or learned response in rare target searches. Younger children benefited more from the reduced response speed than older children. To optimize searching performance in young children, slowing responses and offering feedback during practice is a developmentally sound strategy for enhancing rare target search performance.

**Perceiving balance constraint on children visually estimating reachability**

Yeh, Hsiao-Pu, National Taitung University; Hsiu-Hui Chen, National Taitung University

Purpose: the presented study aimed to examine the constraint of balance on the estimation of reachability for children in different age and arm length. Method: 32 children of 9 ( $N = 16$ ,  $140.65 \pm 5.38$  cm or  $127.31 \pm 2.21$  cm height) and 11 ( $N = 16$ ,  $152.65 \pm 2.83$  cm or  $135.85 \pm 3.50$  cm height) years old were divided into 4 groups according to their arm length (long-armed,  $58.5 \pm 2.89$  cm or  $66.43 \pm 2.85$  cm and short-armed,  $54.25 \pm 2.03$  cm or  $58.31 \pm 2.72$  cm). They were required to stand with one foot either on the ground or on the 20 cm high foam cushion. After 3 actual performance, all participants were required to estimate the reachability with 56 trails (7 targets  $\times$  4 times  $\times$  2 balance constraints) without real reach. The response (correct, overestimate, underestimate) were recorded after their estimation. The answers were transformed into pi number and tested via three-way ANOVA repeated measurements. Results: It showed a significant interaction in 7 targets, different balance constraints and two ages,  $F = 4.074(6)$ ,  $p < .05$ ; it also revealed a significant interaction in 7 targets, two types of arm length and different unbalance constraints,  $F = 6.289(6)$ ,  $p < .05$ . The 9-year-old group was found underestimated apparently in the unbalanced condition. Long-armed participants increased their overestimation and short-armed participants became more underestimated in the balanced condition. Conclusion: Participants showed distinct visually estimation on reachability between the balance and unbalance conditions which inconsistent with the observations of Gabbard C., Cordova A. & Lee S. (2009). The perspective of affordance related to body scale ration was proposed for discussion.

### **The perception of deception: The role of kinematic and other information in detecting deceptive intent within movements**

Abernethy, Bruce, University of Hong Kong; Robin C Jackson, Brunel University; Chris Wang, University of Sydney

The purpose of this experiment was to determine whether the ability to anticipate the movement intentions of another person was affected by (i) the domain-specific skill and experience level of the observer, (ii) the deceptive intentions of the actor, and (iii) the nature of the movement pattern information that was available. Of particular interest was to ascertain whether deception is carried within the kinematic signature of the movement or through other, non-kinematic features (cf. Runeson & Frykholm, 1983). World-class ( $n > 13$ ), intermediate ( $n = 18$ ) and novice ( $n = 15$ ) badminton players viewed video clips showing opposing players hitting strokes to either the left or right side of the court under conditions in which the strokes were executed either with or without deceptive intent. Each of the presented video clips was occluded at either 160 ms before, 80 ms before, at, or 80 ms after the point of racket-shuttle contact and the task for the participants was to predict the direction of the stroke (left or right) and report the confidence that their prediction was correct (from 1 'not at all confident' to 5 'extremely confident'). The presented display was in normal format for half of the trials and in point-light format for the remaining trials. Trials containing deceptive intent significantly impaired the prediction accuracy of all participants resulting in fewer better-than-chance predictions and higher prediction error at each level of occlusion. The impact of deception was most pronounced for all the skill groups under the normal video display conditions in which the deceptive pattern co-existed with the immutable kinematic signature of the movement and was least pronounced under the point-light display conditions in which only the kinematic signature of the movement was present. Information present in the video but not the point-light displays enhanced the effectiveness of the actor's deceptive movements.

### **Dynamical analysis of team coordination in real time**

Amazeen, Polemnia G, Arizona State University; Jamie C Gorman, Cognitive Engineering Research Institute; Eric E Hessler, Arizona State University

The quality of teamwork can have dire consequences. Team effectiveness is often measured as an aggregate, a series of numbers that are collapsed across time or individuals after a task has been completed. However, post hoc evaluation precludes intervention and potential prevention of negative consequences. Using the principles of synergetics, we developed an order parameter that captured team coordination both as it occurred and at the level of the team. This order parameter captured critical interactions among team members as reflected in communications data that were captured in a synthetic task environment. The task was for three team members, each with different action capabilities, to remotely control the movements of an unmanned aerial vehicle to take pictures of ground targets.

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\*The abstracts are alphabetically arranged by the first author's surname within each of the three sections—Motor Development, Motor Learning and Control, and Sport and Exercise Psychology.

Participants were novices who were trained on their particular duties for this experiment. They took pictures of up to 89 targets across two experimental sessions that were separated by a multi-week retention interval; perturbations were used to probe team stability. The main manipulation of interest was team membership, which was either preserved (intact) or disrupted (mixed) following the retention interval. Different team dynamics emerged as a function of the interaction of individual team members. Differences between the teams were not evident in an aggregate approach, but attractor reconstruction revealed important differences in coordination dynamics: Mixed teams were more stable than Intact teams and explored the space of solutions without the need for correction. Dynamical stability, as indexed by the largest Lyapunov exponent, was positively correlated with the number of perturbations that were overcome successfully. This finding inspired the creation of a novel training technique in which perturbations were built into the training regime of new teams. Detection of perturbations in real time has important implications for intervention during anomalies in team coordination.

### **Motor preparation of ‘extent’ is reflected in left hemisphere contingent negative variation**

Anson, Greg, University of Auckland; Rebekah L Scott, University of Otago; Brian I Hyland, University of Otago

Cell assemblies provide a powerful heuristic device for understanding potential links between motor programming and brain activity. To explore these links we have fused parameter precuing methodology with electrophysiological measure (electroencephalography (EEG) and electromyography). In particular we have sought to determine whether the preparation of specific response parameters, ‘hand’ and ‘extent’ (distance) are reflected systematically in changes in brain event-related potentials (ERP). Such changes have been well defined when ‘hand’ is precued, revealed as lateralised readiness potentials (LRP). However, an effect of precuing ‘extent’ (when hand is not precued) on preparatory brain activity has not been demonstrated. We investigated the effect of the nature (hand and extent) and amount (0, 2, 4-choice) of precued information on fractionated reaction time and brain ERPs (contingent negative variation (CNV) and LRP). Twelve right-handed, neurologically normal participants each completed 1280 trials in two sessions over two days, one week apart. Five (simple(1), 2-choice(3), 4-choice(1)) hand and/or extent (or neither) precue conditions were pseudo-randomly distributed among 80 trials in each block. EEG was recorded through a 32-channel QuikCap, Neuroscan Synamps system using Scan 4.2 software. LRPs were evident prior to stimulus onset when ‘hand’ was precued. For the conditions in which ‘hand’ was not, but ‘extent’ was precued, CNV amplitudes over the left motor cortex (C3) were significantly greater ( $p < .05$ ) regardless of the hand that moved, indicating a specific effect of knowing ‘extent’ independent of ‘hand’. When neither ‘hand’ nor ‘extent’ were precued (an ambiguous condition) left motor cortex CNV amplitudes were significantly greater than right ( $p < .05$ ) but smaller than when ‘extent’ alone was specified. These results indicate support for a general role of primarily left hemisphere cell assemblies in motor preparation and additionally a specific role for the left hemisphere in preparation of ‘extent’ when hand is not precued.

### **Practice habits, self-beliefs, self-evaluation and soccer skill level**

Basevitch, Itay, Florida State University, Paul Ward, Michigan Technological University, K. Anders Ericsson, Joyce Ehrlinger, Edson Medeiros Filho; Florida State University

Deliberate practice is a good predictor of skill level (Ericsson & Ward, 2007). Moreover, development history can distinguish between elite and sub-elite players (Ward, Hodges,

Starkes & Williams, 2007). However, once an elite level has been achieved, less is known on what predicts and differentiates player development and skill-level in general. Thus, a longitudinal study was conducted in which accuracy variables were measured for a U-17 elite youth development soccer team on a technical driven-shot task, deemed integral to player development. Participants (i.e.,  $n = 21$ ) performed the driven-shot soccer task three times over a period of 12 months. In addition, information pertaining to players' behaviors, practices and beliefs were collected. Although players did not show significant improvements over the season, after differentiating players based on a within-task criterion (radial error), consistently high performing players significantly differed from consistently low-performing players on a number of practice-related, developmental and behavioral variables. High-performing players significantly differed in their implicit beliefs about their ability to improve their performance, were less satisfied with the level of accuracy attained, were more likely to practice between sessions and began engaging in practice at an earlier age, compared to the low-performing players. These data provide rare longitudinal evidence that show how practice habits, self-beliefs and self-evaluation influence performance accuracy and attained level of task-specific skills. The results of the study can inform the development of an evidence-based training program, using performance and deliberate practice data from the superior performers coupled with tried and tested methods of instruction/training (e.g., Williams, Ward, Knowles, & Smeeton, 2002), that is specifically designed to improve the performance of less successful athletes.

#### **Amount of options affects learners in a self-controlled practice condition**

Bastos, Flavio H., Andrea M. Freudenheim, Go Tani; University of São Paulo

Self-controlling practice implies a decision making process (e.g. Wulf & Toole, 1999), which suggests that the amount of options in a self-controlled practice condition could affect learners. The present study examined if the amount of task components that have no fixed position in a movement sequence affects the way learners self-control their practice. The apparatus consisted of a 200 cm track with 90 LEDs - the first and the last LEDs being the warning and the target light, respectively. The speed of the apparent motion of the light through the track was 1.33 m/s. Participants were required to touch six switches sequentially, the last one coincidentally with the lightening of the target light (timing task). Participants in the group MORE ( $n = 55$ ) were instructed to touch the switches at any order, except for the last one, positioned close to the target light. Participants in the group LESS ( $n = 53$ ) were told which were the first two and the last switch to be touched. Both groups practiced the task until they achieved a less than 30 ms error (timing performance) three times consecutively. Results showed that participants in the group LESS created fewer sequences compared to the group MORE (5 and 22, respectively) and were more likely to keep the same sequence throughout the learning process (LESS: 53% of the participants; MORE: 36%). Nevertheless, the results revealed no differences between groups in the number of trials needed to reach the performance criterion. These results suggest that the amount of options related to a movement sequence affects the way learners self-control their practice, but it has no effect on the amount of practice needed to enhance performance.

#### **The effects of reaching with the dominant and non-dominant hands on lower body musculature while sitting on a stability ball**

Baute, Kelly J, Bill Wyatt, Eric Holten, Allison Berger, John B. Shea, Indiana University

Use of a stability ball as an office chair has been promoted as an aid in improving core musculature and subsequently reducing low back pain. Previous research found no difference

between sitting on a stability ball and a chair without back support. We deduced the lower body musculature provides the stabilizing and coordinating structure while sitting on a ball at a workstation and were interested in examining the lower body musculature involvement while sitting on a stability ball while performing a reaching task with the dominant and non-dominant hands. EMG activity was measured in the quadriceps, hamstrings, anterior tibialis and gastrocnemius on nine college-age right-hand dominant male subjects. A two-way MANOVA of trials by phase of movement was conducted to determine the change in muscle activity for all muscle groups for muscle onset, duration and intensity. Planned comparison analysis was conducted to determine the difference in the intensity of muscle contraction between dominant and non-dominant sides across all four muscle groups. A separate planned comparison analysis was conducted to determine the difference in the intensity of muscle contraction between dominant and non-dominant sides by phase of movement. MANOVA main effect for phase of movement for all muscle groups was significant. The duration of the hamstring contraction and the onset of the anterior tibialis had the highest effect size. Planned comparison of muscle contraction intensity between dominant and non-dominant sides by phase determined the anterior muscles of the dominant side have greater firing intensity than the non-dominant side. Conversely, the posterior muscles of the non-dominant side have greater firing intensity than the dominant side. This finding is suggestive that a learning effect is present. Even the lower body motor firing patterns are more established with use of the dominant hand to stabilize and coordinate movement. Interestingly, when reaching with the non-dominant hand, muscle recruitment appears to be different from reaching with the dominant hand.

### **The relationship among core stability of postural tasks and balancing skills**

Beeger, Hagen, University of Leipzig

The term core is a synonym for the trunk and lumbopelvic region of the body respectively (McGill, 2001). Concerning this matter transversis abdominis is the key muscle to ensure sufficient stability to reduce compressive load on the lumbar spine by increased intra-abdominal pressure. Activation of this muscle cords the abdomen like a belt and is required for postural adjustments (to move the center of gravity back inside the base of support) to maintain balance (i.e. Willardson, 2007). Purpose of this study is to investigate the correlation between different balance tasks and conscious as well as unconscious core stability in 6 to 7 years old children ( $n = 72$ , 33 boys and 39 girls). We collected data of horizontal width of abdomen in sagittal view in habitual stance and with arms raised frontally for indirect measurement of core muscle activation. Unconscious muscle activation was assessed after lifting a weighted ball up to shoulder height. In a second task children were instructed to draw in their abdomen, activate gluteal muscles and keep straight posture (against the internal perturbation of weight of their arms). Dependent variable was the change in length of horizontal width of abdomen from habitual to arm-raise conditions. Balance was measured in one-leg-standing-, walking- and side jumping-tasks. For both conditions, abdominal width was significantly decreased compared to habitual stance. Against our expectation we found no correlations, neither in conscious nor in unconscious condition to (static and dynamic) balance tasks. In contrast to the review of Willardson (2007), the present results did not confirm the assumption that core stability has an important influence on balance in healthy children. Moreover, it seems that core stability is less involved in balance tasks in which the body has to be equilibrated in lateral direction.



**Baseline neurocognitive and neuromotor human performance functioning of female college volleyball athletes with and without mild traumatic brain injury (MTBI)**

Beehler, Pamela, Northern Kentucky University; George Kondraske, University of Texas at Arlington

Over the past ten years, baseline neurocognitive testing techniques such as Immediate Post-concussion Assessment and Cognitive Testing (ImpACT) has been endorsed by the Vienna and Prague meetings of the Concussion Sport Group as a valuable concussion management tool. Objective testing of athletes with suspected concussion (mild traumatic brain injury-MTBI) is important due to unreliable athlete self-report after injury. Recently Beehler, Stovak and Kondraske (2009) have reported that both neurocognitive and neuromotor testing are useful assessment techniques that may be used to detect cognitive and motor differences between athletes who have suffered a MTBI. The purpose of this study was to compare baseline neurocognitive and neuromotor human performance functioning of female college volleyball athletes with and without MTBI. One group of college volleyball athletes ( $N = 5$ , non-MTBI) were tested for (1) neuromotor functioning using an upper extremity central processing motor control module (Model BEP I), and (2) neurocognitive functioning using a computer driven software tool (ImpACT, version 6.1) that formed composite scores representing verbal memory, visual memory, visual motor speed, and reaction time. A second group of college volleyball athletes ( $N = 3$ , MTBI) were tested for neurocognitive functioning only. The MTBI athletes had higher composite scores for verbal memory and visual memory but the non-MTBI athletes had faster composite scores for visual motor speed. There were no differences in their reaction time composite scores. Using the neuromotor functioning tests, the non-MTBI athletes averaged 12.2 items for short term visual memory, and were able to accurately (72%) move their arm while performing a lateral reach coordination movement averaging 110.4 cm/s. They also performed index finger tapping (7.5 taps/s), two-choice and four-choice reaction times (319.8 ms, 335.4 ms), and movement speeds (119.3 cm/s and 108.1 cm/s) respectively, similar to previous findings and will be further discussed as a valuable concussion management tool.

**The effect of walking speed on typing performance using an active workstation**

Berg, William, Rachel Funk, Megan Taylor, Amutha Thirunavukarasu, Ceith Creekmur, Angela Mound; Miami University

To combat sedentariness in desk-bound workers, work-based physical activity programs have been implemented that focus on increasing time spent in physical activity. The introduction of active workstations in the work environment is one of the methods being tested for providing workers with daily low-intensity physical activity. One type of workstation integrates a treadmill with a height-adjustable desk, and allows workers to spend part of their work time simultaneously walking and working. It is unclear, however, whether work performance is affected by this dual-task environment. The purpose of this study was to test the effect of treadmill walking on typing performance when these two tasks are performed concurrently. Twenty-four male and female research participants (mean age = 22.5) performed a 5-minute typing test under each of four conditions, including the control (seated), walking at 0.8 mph, walking at 1.4 mph and walking at 2.0 mph. The order in which the conditions were presented was counterbalanced across participants. Typing performance was quantified as adjusted words per minute, which incorporated measures of both speed and accuracy. We hypothesized that all walking conditions would have a detrimental effect on typing perfor-

mance, but that among the walking conditions, the speed of 1.4 mph would result in better typing performance than speeds of 0.8 and 2.0 mph would. The repeated measures ANOVA was significant ( $p = .0038$ ). However, the only Tukey-adjusted pairwise level comparisons that were significant were between the control condition and typing while walking at 0.8 mph ( $p = .0144$ ), and between the control condition and typing while walking at 2.0 mph ( $p = .0249$ ). That is, typing performance while walking at 1.4 mph was no different than in the control condition, whereas typing performance while walking at both the faster and slower speeds was slightly worse than the control condition. These results support the potential of active workstations to increase physical activity in the workplace without compromising a specific aspect of work performance.

### **The effect of cellular telephone conversation and loud music on braking force and response time**

Berg, William, Dirk Dessecker; Miami University

The dramatic increase in the use cellular phones and other in-vehicle technologies in recent years has raised concern about driver distraction and its effect on safety. Potential distractions don't always occur in isolation, and the presence of multiple decision-making elements has been shown to have a negative impact on driving performance. This experiment tested the effect of cell phone conversation and loud music listening on response time (and sub-components RT and MT) and braking force in a simulated braking task. Thirty-six licensed drivers participated. Participants sat at a simulated driving station with their hands on the steering wheel and their right foot on the accelerator. Participants released the accelerator and depressed the brake pedal as quickly as possible following illumination of a simulated brake lamp. The braking task was performed under six conditions including (a) the control (braking alone), (b) music at 72 dBA, (c) music at 86 dBA, (d) phone conversation, (e) phone conversation and 72 dBA music, and (f) phone conversation and 86 dBA music. Cell phone conversation resulted in slower response time ( $p < .0001$ ) and RT ( $p < .0001$ ), but faster MT ( $p < .0001$ ) and an increase in braking force ( $p < .0001$ ). Loud music resulted in faster response time ( $p = .001$ ) and MT ( $p = .0001$ ), as well as greater braking force ( $p = .0064$ ). RT was unaffected by loud or moderate music, and there were no interactions between music-listening and phone conversation for any of the variables. In summary, participants were distracted by the cell phone conversation; however, the addition of loud music did not exacerbate the deficit. Braking MT was actually faster, and braking force greater when the cell phone conversation was present compared to when it was not. While this might initially appear to be a counter-intuitive finding, it may actually be reasonable to expect someone performing a braking task to move faster and brake more forcefully with a distraction than without one - because it provides a means to compensate for slower RT.

### **How a unimanual goal is achieved via bimanual coordination**

Bernardin, Brandon J, Andrea H Mason; University of Wisconsin-Madison

Unexpected changes in the environment cause functional motor task-switching regularly in sport and occupation. However, most studies using a task-switch paradigm have been cognitive in nature, with motor output limited to simple button presses. The current work extended the task-switching paradigm by requiring a switch in complex motor output to achieve the task goal. Specifically, we investigated the ability of subjects to abort a movement in mid-execution in favor of another movement with the opposite limb that suddenly

took precedence. Given the abundance of evidence showing coupling behaviors when two limbs perform simultaneously, the purpose of the study was to examine the effect of the aborted movement on the goal-directed limb. Subjects prepared for a four-choice unimanual reach-to-grasp. At random, a second reach-to-grasp goal took precedence, requiring subjects to quickly abort the first movement in favor of a second movement performed by the opposite limb. The second movement could be made to targets located at similar (congruent) or different (incongruent) distances to the original target. Results indicated that reaction time was longer ( $325 \pm 10$  ms) for incongruent task-switch conditions, when compared to congruent task-switch ( $315 \pm 9$  ms). Further, movement time was significantly influenced by the congruency of the task-switch. The hand reaching to the first target performed a reversal movement toward the start position once the second target became the new priority. Therefore, the hand reaching to the second target either sped up or slowed down in order to remain coupled with the reversal movement of the opposite hand. Our results provide evidence that a “non goal-directed” movement can significantly influence a simultaneous goal-directed movement. This result is significant when we consider how performance is influenced when an environmental perturbation causes motor task-switching. Performance may not always be determined by the capabilities of the moving limb; rather, performance may be influenced by the opposite limb’s behavior.

### **The impact of progressive fatigue on golf putting performance**

Bertram, Chris P., UFV; Mark A. Guadagnoli, UNLV; Bassam Khaleel, UFV

The current study investigated the effects of exercise-induced fatigue on golf putting characteristics. Several key aspects of putting performance were analyzed, including club head angle at impact, club head speed, swing tempo, and percentage of putts made. Twenty participants of various golf skill levels participated. The experimental group carried a full set of golf clubs while walking on a treadmill for ten-minute sessions at 60%, 70% and 80% of their calculated VO<sub>2</sub>max, respectively. Immediately following each session on the treadmill, each participant performed a series of putts. The control group followed the same procedure except that they rested for the three ten-minute sessions instead of walking on the treadmill. The results showed that putting performance increased with exertion to 70% of VO<sub>2</sub>max, after which performance sharply declined. These data indicate that a certain level of physiological arousal can benefit performance, but once that level is exceeded, performance will suffer.

### **The role of the thumb in mental rotation of hands**

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Mental rotation of human hands has been found to differ essentially from mental rotation of objects. In mental hand rotation tasks, reaction times are influenced by the comfort of the displayed hand position as well as by the current position of the subjects own hands. The role of the thumb for mental hand rotation, however, has not been investigated to a sufficient

degree, despite its special anatomic and functional role in human hand use. In three consecutive experiments, we investigated the effect of thumb position on reaction times in the mental rotation of human hands. In all experiments, the same set of stimuli was used, showing a photograph of a human hand in palmar or dorsal view with the thumb either extended like all other fingers or flexed into the palm of the hand. Hand images were displayed in four orientations ( $0^\circ$ ,  $90^\circ$ ,  $180^\circ$ ,  $270^\circ$ ). In each experiment, 20 subjects were instructed to judge the handedness of the displayed hand by a left or right key press. In Experiments 1 and 2, the key presses were carried out with the index fingers, whereas in Experiment 3, the keys were pressed with the thumbs. In Experiment 2, both thumbs of the participants were taped to the palm of the hand in the same position as displayed in half of the stimulus pictures. The thumbs were fixed in this position one hour before the beginning of the experiment and remained fixed throughout the whole experiment. The results of all three experiments showed effects of rotation angle ( $p < .001$ ), view ( $p < .001$ ) and thumb position (Exp. 1 and 3:  $p < .05$ ; Exp. 2:  $p < .001$ ), and an interaction of angle and view ( $p < .001$ ). Only in Experiment 2, in which the subject's thumb was taped, a threefold interaction of rotation angle, view and thumb position was observed ( $p < .05$ ). We conclude that the position of the thumb plays a crucial role in the mental rotation of hands, with extended thumbs facilitating mental rotation. Fixating the thumb in the same position as in the stimulus pictures even increases this effect, which is in contrast to an expected position effect.

### **Sleep-related off-line motor learning: muscle activation vs. spatial sequence representation effects**

Blischke, Klaus, Universitaet des Saarlandes; Daniel Erlacher, University Heidelberg; Sebastian Brueckner, Universitaet des Saarlandes

After initial learning, sleep enhances performance in spatially defined, repetitive sequential finger tapping skills (e.g., Walker, 2005; Blischke et al., 2008). It is not clear, however, which feature in the motor skill's memory representation is actually enhanced: (a) the allocentric spatial pattern, or (b) rapidly switching on and off flexor and extensor muscles of the respective digits in the appropriate order. The purpose of the following three experiments was to scrutinize between these two effects. 24 subjects participated in each study. Each study required the production of a newly acquired sequential finger skill. One half of the subjects in each study initially learned the skill in the morning, the other half in the evening. Either group then underwent two retention tests (12 h and 24 h after initial learning). In each study, on four adjacent computer keys the same 5-element sequence had to be executed either (a) with four fingers of one hand, or (b) with the two index fingers of both hands, or (c) with only one finger (the index finger) of one hand. All groups learned, and performance in all groups improved significantly between end of practice and the second retention test 24 h later. When sleep was administered during the first 12 h retention interval, distinct and significant sleep-related off-line performance enhancements occurred only in those groups using four or two fingers ( $p < .0005$ ;  $\eta^2 = .64$ ), but not in the one-finger-only group ( $p = .801$ ). This latter group, however, showed some improvement during the second (wake) retention interval ( $p = .074$ ;  $\eta^2 = .26$ ), while the other two groups did not ( $p = .12$ ). When sleep was administered during the second retention interval, all effects were less pronounced, with sleep still enhancing performance only in the groups using four or two fingers ( $p = .026$ ;  $\eta^2 = .20$ ). We therefore conclude, that sleep-related offline enhancement is closely linked to rapidly switching between activation of different fingers, while the spatial component of the sequence representation is in itself of minor importance.

**Is movement automatization by dual-task practice restricted to non-sequential tasks?**

Blischke, Klaus, Universitaet des Saarlandes; Barbara Zehren, Universitaet des Saarlandes; Florian Wagner, Universitaet des Saarlandes; Thorsten Utter, Universitaet des Saarlandes; Sebastian Brueckner, Universitaet des Saarlandes

When executing a voluntary movement (primary task) and a cognitively demanding secondary task simultaneously, performance typically decreases in both primary and secondary task compared to single-task execution. Extensive practice of the primary motor task completely reduces these dual-task costs, indicating that the motor task has achieved a state of automatic control (Blischke, 2001; Maquestiaux et al., 2008). When using a gross motor force production task, this state of automaticity could be reached sooner under dual task than under single task conditions, and was maintained even in a completely new dual-task context (Blischke & Reiter, 2002). The purpose of the present study was to extend this concept to movement sequences. Participants practiced a specific spatio-temporal pattern in a diamond tapping task (800 trials, KR on every second trial) with their non-dominant hand. The experimental group (EG,  $n = 14$ ) did this while simultaneously solving cognitive computation tasks (number subtraction every 3 seconds & verbalizing the result). The control group (CG,  $n = 14$ ) underwent single-task practice. In both groups, after an initial single-task learning session (10 trials, KR provided), performance was assessed under single- and dual-task conditions (no KR) immediately before (pre-test) and 24 h after dual-task practice (post-test). While pre-test results for both groups clearly showed dual-task costs with respect to the temporal pattern ( $p < .002$ ,  $\eta^2 > .52$ ), post test for the task combination practiced revealed complete reduction of dual-task costs in the EG only ( $p = .69$ ), while in the CG these costs were still prevalent ( $p = .006$ ,  $\eta^2 = .46$ ). When, however, at the end of the post-test, a new secondary task was introduced (*N-back*), dual-task costs fully reappeared in the EG ( $p = .005$ ,  $\eta^2 = .47$ ). These results indicate that subjects in the EG did not achieve automatic movement control, but rather learned to effectively switch between both primary and secondary task (Manzey, 1993). This strategy, however, failed, when a new secondary task was introduced.

**Evolution of movement sequence representation over practice: Consolidation and relearning processes**

Boutin, Arnaud, University of Poitiers; Udo Fries, University of Leipzig; Robin Salesse, University of Poitiers; Stefan Panzer, Muenster University; Arnaud Badets, University of Poitiers; Yannick Blandin, University of Poitiers

Previous research provided evidence that the learning of movement sequences involves both a fast developing, effector-independent component represented in visual-spatial coordinates (e.g., spatial locations of the end effectors and/or sequential target positions), and a slow developing, effector-dependent represented in motor coordinates (e.g., activation pattern of the agonist/antagonist muscle) (see Hikosaka et al., 2002). The present experiment aimed at examining the transition resulting of practice from an effector-independent representation (visual-spatial coordinates) to an effector-dependant representation (motor coordinates). For a first condition, the experiment was composed of 5 sessions. On Day1 was administered the first acquisition phase (18 trials), requiring participants to perform flexion-extension movements of the arm to reproduce a specific pattern of displacement over time. Delayed retention and inter-manual transfer tests were then completed on Day2 before practicing a second acquisition phase made of 135 trials. Finally, delayed retention/transfer tests were

conducted on Day3. Surprisingly, results did not reveal any Day  $\times$  Test interaction but only increased retention and effector-transfer performances across sessions. Therefore, we wanted to assess whether these findings could be modulated by sleep-related effects or by potential retention/transfer tests repetitions? For a second condition, procedure was identical to that previously used, with the exception that no retention/transfer tests were conducted on Day2. Data indicated higher retention performance, providing evidence of effector-dependent representation with extensive practice, but not represented in motor coordinates: the motor code suffered a larger detrimental development of withdrawing retention/transfer tests on Day2 than the visual-spatial code. For this type of task, findings suggested that repeated retention/transfer tests develop a multi-coordinates representation which allows participants to adapt rapidly to any kind of transfer.

### **The ‘learned parameters’ hypothesis as an explanation of the especial skill effect**

Breslin, Gavin, University of Ulster, Jordanstown; Nicola J Hodges, University of British Columbia; Michael Hanlon, University of Ulster; Rodney Kennedy, University of Ulster; A Mark Williams, Liverpool John Moores University

It has been debated that we have a single memory representation for a class of motor skills as opposed to a single representation for each single movement within a class (see Schmidt & Lee, 2005). In recent years renewed interest in this topic has emerged, challenging the concept across all motor skills that a single generalized memory structure represents all actions within a class. In studying the performance of expert basketball players executing the set shot from the foul line (i.e., 15ft from the basket), this well-practised shot was found to be more accurate than at closer distances and hence from the performance scores predicted based on a generalized motor program view of behaviour. We tested the ‘learned parameters’ hypothesis as an explanation of the especial skill effect (Keetch, Schmidt, Lee, and Young, 2005). Outcome attainment and movement kinematics were recorded for 10 expert and 10 novice players performing basketball free-throw shots at five distances (11ft, 13ft, 15ft, 17ft and 19ft) with a regular and heavy weight basketball. Separate regression equations were calculated to estimate the expected performance at the free throw line (15ft). As predicted, experts performed better than expected relative to the regression equation at the 15ft, free-throw line with the regular basketball, supporting the especial skill effect. This effect was not present for the experts when shooting with the heavy ball. Novices did not show an advantage at the free-throw line when performing with either ball. Although the outcome attainment scores support the ‘learned parameters’ hypotheses, kinematic analysis failed to identify differences in the movement pattern for the especial skill, suggesting that these skills (i.e., shooting at different distances) are not governed by separate motor programs.

### **Sensory and dopaminergic contributions to upper limb freezing during bimanual coordination in Parkinson’s disease**

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Freezing is a severe motor symptom in Parkinson’s disease (PD) has traditionally been studied in gait (FOG), but more recently has been identified during continuous upper limb coordination (FO-UL). It is clinically defined as an abrupt cessation in movement in either

limb that lasts at least 1 s, preceded by a reduction in amplitude or irregular cycle frequency. FO-UL has been found to occur more often in anti-phase tasks and with higher speed demand. To date, little research has examined the contributions of sensory feedback and dopamine replacement on FO-UL. The current study examined continuous in-phase and anti-phase wrist-flexion movements in PD ( $n = 15$ ). Individuals with PD were examined both OFF and ON dopaminergic treatment. Speed was manipulated from 0.75 to 2 Hz (by .25 Hz) within each trial. Visual feedback was manipulated in 3 different sensory conditions: no vision, normal vision and augmented visual feedback. FO-UL was recorded during each trial by two separate observers and chi-square analyses were performed based on number of observed freezes. As expected, more freezes were found in anti-phase compared to in-phase ( $\chi^2 = 7.4, p < .01$ ). Interestingly, there was no significant difference between the quantity of freezes OFF and ON dopamine replacement ( $\chi^2 = 0.1, p > .05$ ). Although not significant, more freezes occurred in no vision ( $\chi^2 = 3.2, p = .07$ ) and augmented visual feedback ( $\chi^2 = 3.7, p = .053$ ) compared to normal vision. Surprisingly, results suggest that dopamine treatment does not improve FO-UL. This supports recent research in our lab that has found no response of FOG to dopamine replacement. We conclude that the mechanism for freezing may be outside the basal ganglia system. Alternatively, the possibility that cells are unresponsive to dopamine replacement, or require greater than normal dopamine supplementation should be considered. Additionally, visual manipulations do appear to influence freezing, suggesting that there may be a sensory integration or perceptual component that contributes to FO-UL.

### **Leading joint hypothesis and the learning of bimanual coordination patterns**

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The leading joint hypothesis of intralimb control proposes that single limb multijoint movements are composed of a leading and subordinate joint. The leading joint forms the dynamic foundation of the movement and the subordinate joint fine-tunes the motion of the end-effector during an action. Research has supported the shoulder as a leading joint and the elbow as a subordinate joint within single limb tasks. Recent bimanual research demonstrated that the elbow can act as the leading joint and the shoulder as the subordinate joint. The current experiment was designed to answer the following question: How will the leading joint and subordinate joint roles interact with the learning of a novel bimanual coordination pattern? To examine this issue, participants learned to trace two ellipses, one with the left-arm and one with the right-arm, with a 90 deg relative phase offset between the arms with the right-arm leading. In one condition, the elbow was the leading joint in the left-arm and the shoulder the leading joint in the right-arm, EL-SL. In another condition, the shoulder was the leading joint in both arms, SL-SL. In session one, error was larger in the EL-SL compared to the SL-SL combination, and a faster learning rate occurred in the SL-SL combination. In practice session two, improvement rate was not statistically different between the two combinations, and the error was not different in a 24-hr retention test. The SL-SL combination increased in stability at a faster rate than the EL-SL combination across both days of practice, and maintained this advantage in the 24-hr retention test. The torque impulse and torque sign data, which are used to identify the leading joint, did not change significantly with practice. The current results indicate that prior to learning, the motor system selected leading and subordinate joints based on task constraints. The initial joint roles did not change across practice, however, the same leading joint pattern (SL-SL) across limbs facilitated the stability of coordination during practice and retention.

### Quiet Eye Duration and Gun Motion in Elite Shotgun Shooting

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Quiet eye behavior has not been explored in a task involving a high speed external moving target such as in shotgun shooting. We examined point of gaze and gun barrel kinematics in groups of elite ( $n = 24$ ) and sub-elite ( $n = 24$ ) shooters participating in skeet, trap, and double trap events. Point of gaze was calculated in relation to the scene, while motion of the gun was captured by two stationary external cameras. Quiet eye was operationalized as the final fixation or tracking gaze located on a specific location/object in the visual display for a minimum of 100ms. Quiet eye duration and onset were analyzed, as well as gun barrel profiles in the horizontal and vertical planes. In skeet, trap, and double trap disciplines, elite shooters demonstrated both an earlier onset and longer relative duration of quiet eye than their sub-elite counterparts ( $p < 0.05$ ). In all three disciplines, quiet eye duration was longer and onset earlier during successful compared to unsuccessful trials for both elite and sub-elite shooters ( $p < 0.05$ ). Kinematic analyses showed different spatial and temporal strategies were employed by elite and sub-elite shooters that were evident across all three sub-disciplines of shotgun shooting. The elite shooters modified their shooting strategy to increase the probability of a successful shot outcome based on the specific task constraints of the sub-disciplines, allowing a more efficient and effective movement.

### Novel method for estimating the psychophysical parameters of movement cost for a goal-directed stepping task

Charalambous, Charalambos, Yi-Hsuan Lai, Carolee Winstein; University of Southern California

This project is motivated by the hypothesis that the choice of which limb to use for a stepping behavior is determined by the estimated cost of achieving the goal. Our aim was to develop a feasible method for estimating the psychophysical parameters of movement cost for a goal-directed stepping task. We used a novel clock face-like target array with 36 targets arranged on the floor in 3 concentric circles (radius: 25, 43, 62 cm) around a central "home" start zone. Each circle contained 12 targets spaced 30 deg apart. Each of twelve healthy right-legged adults (5 M, mean 30.2 +/- 4.9 yrs) stood in the home zone and stepped to a verbally specified target under two distinct conditions (Free, Forced). Participants performed 72 trials/condition (36 targets x 2 attempts/condition). In Free, participants stepped as quickly as possible on the specified target using the limb of choice. In Forced, participants were constrained to use the left leg. Targets were cued pseudo-randomly so that no target was repeated. Judged relative cost ( $JRC = 1 - p$  [probability of right leg use]) was determined for Free, and errors (loss of balance, wrong, or missed target) were recorded. Not surprisingly, in Free, 100% used the left leg for the 15 left-sided targets ( $JRC = 1$ ) and likewise, 100% used the right leg for the 15 right-sided targets, ( $JRC = 0$ ). In contrast, for midline targets (3 front, 3 back) group JRC ranged from 0.3-0.5, +/- 0.4. As expected, there were significantly more errors in the Forced (mean 79 +/- 2.6) than Free (mean 40 +/- 1.1) condition ( $t(35) = -2.49, p = 0.018$ ), especially for the furthest contralateral targets. Importantly, in Forced condition, participants were capable of reaching most right-sided targets without error; however, in Free condition, they never used the left leg for these targets. This suggests that for able-bodied individuals, limb choice for stepping may depend more on perceived awkwardness or comfort of the



end position than on perceived capability. Similar to reach-to-grasp actions, movement cost for stepping may depend on the end-state comfort effect.

### **Fight or flight? Movement kinematics analyses of duel in fencing**

Chen, Yin-Hua, Verona University; Yeou-Teh Liu, National Taiwan Normal University

In combat sports such as fencing, the mutual relation between fighters provides the crucial information for instantaneous perception/action. The study investigated the movement kinematics between fencers in different duel conditions, and explored the relation of the kinematic characteristics and performance outcomes. Six national-level male fencers were instructed to space apart in 3 varied distances (90, 100 and 130 cm) playing the roles of attack initiator (Att) and defender (D) in a round robin format. Att self-triggered the forward movement to reach D who was required to retreat by footwork only (the 1st phase); and in case of an unsuccessful attack, D should initiate his rebound attack to Att (the 2nd phase). A 200 fps camera was used to capture the sagittal view of the duel; the anterior part of the neck of both fencers and the index finger of Att were digitized for analyses. The results demonstrated the very different profiles for the two phases of duel because the original space manipulation had been washed out at the end of the initial attack. In the 1st phase, longer space between fencers resulted in lower touching rate, greater amount of spatial error leading to a “draw” in the 2nd phase, D’s longer time lag of movement initiation (MTLag), and larger amount of difference in maximum movement velocity between fencers (RelMaxV). Moreover, in touché outcomes, MTLag and RelMaxV were larger, whereas in the 2nd phase, negative MTLag and smaller RelMaxV were found. In conclusion, when the fencers were spaced apart more than 90 cm, “to fight” aggressively with high maximum approaching velocity was the useful strategy for a successful attack. But as in the 2nd phase that the space was much shorter because it was the error or strategically-left distance from the initial attack, quick initiation of rebound attack became the key element to win the duel. These results provided the further evidence of perception/action coupling (Gibson, 1961), giving the basic understandings of kinematics analyses in fencing duel and could be applied to training or competition.

### **Changing the effect of speed on accuracy and movement coordination**

Chen, Hsiu-Hui, Ya-Ting Ku, Yu-Fang Hsiu, Hsiao-Pu Yeh; Taitung University

The effect of speed on accuracy has been challenged in training participants (Carlton, et al. (2006). Variability in motor output and Olympic performance. In: Davis, et al. (Eds.), Movement System Variability). How the relationship of trade-off between speed and accuracy changed over practice and how the learners organize their movement to satisfy the requirement of task were investigated in the presented study. Method: four 10 and 11-year-old children participated. They practiced table tennis three times a weeks each forty minutes over six months. The test of forehand stroke emphasized on either speed or accuracy was implemented before and after each practice session. The location of ball landing and the kinematics data of joints of whole body (head, shoulders, elbows, wrists, fingers, hips, knees, ankles, toes) and racket were recorded in test for analyzed. Results: the rate for successful strokes was increased for each participant over learning. While averaged velocity did not changed significantly under the requirement of speed, it increased apparently in accuracy emphasis. For two participants, the amplitude of strokes increased in speed requirement. The results of principle component analysis on coordinates of whole body joints and racket

in representative trials (the first success stroke in each practice session) showed that three to four components could explain more than 90 percentage of variance. However, the variance each component explained did not change significantly over learning. The difference in movement pattern under different task constraint was only found in the structure of coefficients of eigenvectors for minor components. The values of eigenvectors in second and third components revealed different between speed and accuracy requirement. Interestingly, the difference disappeared for three of the participant over learning.

### **Task-specificity of enslaving effect associated with increment and decrement of finger force production**

Chiang, Huai-Hsiao H., Hsien-Shuo Huang; Chung-Yuan Christian University

When a subset of fingers is required to produce force, the unintended force is produced by other fingers of a hand. This phenomenon referred to as enslaving or the interdependency of fingers has come under recent study in the motor control literature. Given that the previous enslaving literature has focused on maximal and sub-maximal isometric force production, the present research was designed to study the role of transition during force production in the enslaving phenomenon. To this end, we examined behaviorally two levels of force production (20% and 60% of MVC) with two different rates of force development (RFD) followed by a static phase, transition of force, and another static phase. Subjects kept all four fingers on separate load cells while using the specified finger to produce the required force, which allowed us to measure the enslaving effect on the other fingers. The behavioral results have shown that the index finger revealed the least whereas the ring finger revealed the most force error and force enslaving. The AVOVA indicated that there were significant effects during force decrement phase for both the force error and enslaving than those of force increment phase for all fingers. Not surprisingly, larger enslaving effect was found on the finger directly adjacent to the master finger for both force increment and decrement phases. On the other hand, both the force error and the enslaving effect in force decrement phase were pronounced than those of in force increment phase in each finger. Moreover, the result also indicated the index finger with less force error, less dependent, and reversing for the ring finger in both force increment and force decrement. Providing the results, the control characteristic for both force increment and force decrement demonstrated the task-specific mechanisms among four fingers. During multi-finger isometric force production tasks reflect a combination of factors including the primary end-effector performing the task, the interaction of task, and the amount of nominal force.

### **The effects of short-term observational practice on acquisition and retention of movement**

Chin, Mu-Cheng, Wu-Chou Chen, Yu-Kai Chang; National Taiwan Sport University

Concerning the visual perception perspective of observational learning, the observation of spatial and temporal information of movements is recognized as an important contributor for assessing motion information. The purpose of this study is to advance the understanding of the role of observational learning by assessing related-real-time video (RRTV), related-slow-motion video (RSMV), and unrelated-motion video (UMV) demonstrations on the acquisition and retention of movements. Thirty participants, aged 24.6 years, were randomly assigned to either RRTV, RSMV, or UMV conditions, and were instructed to perform a 24 trials motor task without KR (modified from Black, Wright, Magnuson, and

Brueckner, 2005). This task was performed at three different time setups: 1st) prior to; 2nd) 3 minutes immediately after (acquisition); and 3rd) 24 hour delay after (retention) specific video observational intervention. A two-way mixed ANOVA (3 conditions  $\times$  3 setups) was computed for relative timing errors (RTE, representing movement characteristics), absolute timing errors (ATE, representing overall time), and mean absolute difference (AD, representing subjective error detection). A significant interaction was found between conditions and setups on RTE. Following a Tukey post-hoc analysis for RTE, RRTV and RSMV conditions have revealed significant improvements in acquisition and retention compared to UMV condition. In conclusion, both related video demonstrations might contribute specifically to the acquisition and retention of movement characteristics; however, this practice has limited contribution regarding overall performance time and subjective error detection.

### **An external focus of attention enhances balance learning in older adults**

Chiviawosky, Suzete, Universidade Federal de Pelotas; Raquel Wally, Universidade Federal de Pelotas; Nels Rydberg, University of Nevada, Las Vegas; Gabriele Wulf, University of Nevada, Las Vegas

Studies with young adults have shown that an external focus of attention (i.e., on the movement effect) results in more effective motor learning and greater automaticity than an internal focus (i.e., on one's body movements). The present study examined whether instructions inducing either an external versus internal focus would differentially affect the learning of a balance task in older adults (mean age: 69.4 years). The task required participants to stand on a balance platform tilting to the left and right, and to try to keep the platform as close to horizontal as possible during each trial. The external focus group was instructed to focus on keeping markers on the platform horizontal, while the internal focus group was instructed to focus on keeping their feet horizontal. The dependent variable was time in balance (i.e., platform movements within  $\pm$  5 degrees). Participants performed 10 30-s practice trials on Day 1, with focus reminders given before each trial. Learning was assessed on a retention test consisting of 5 trials without instructions performed one day later. The external focus group demonstrated more effective learning than the internal focus group. The results suggest that the benefits of an external attentional focus are generalizable to older learners.

### **Reduced frequency of knowledge of results enhances learning in subjects with Parkinson disease**

Chiviawosky, Suzete, Tiago Campos; Federal University of Pelotas

Parkinson disease (PD) can be described as a progressive neurological disorder, known to cause a large number of motor and non-motor limitations, which have an impact on functions of varied degrees. The study of procedures and factors that affect motor control and learning on bearers of PD are, nevertheless, still very limited. The objective of this study was to compare the effect of different frequencies (100% vs. 66%) of knowledge of results (KR) in the learning of motor skills with spatial control demand on subjects with PD. Twenty parkinsonians were randomly divided into two groups. The 100% group received KR after each trial whilst the 66% group received KR in two thirds of the trials, more specifically, two KR's at each three trials. The task used involved dislocating an implement, made up of a ruler attached to a cursor, which was manipulated by the subjects with the objective of reaching a determined distance from the initial point.

The participants carried out the task with the dominant member, without visualizing the implement. In the acquisition and retention phases, the objective was to position the cursor at a distance of 60cm from the initial point. The objective of the transfer phase was to position the cursor at a distance of 50 cm from the initial point. The tested hypothesis is that subjects with PD, who practice with reduced KR frequency, will present a better learning than those who practiced with 100% KR frequency, according to previous results with adults without neurological commitment. The data analysis carried out through the ANOVA, presented differences between the groups at the retention phase, showing that reduced KR frequencies are more efficient than high frequencies, in the learning of a linear positioning motor task in adults with PD.

### **The dorsal stream anticipates future actions**

Claxton, Laura J, Purdue University; Jessi Witt, Purdue University; Jeffrey M Haddad, Purdue University; Joong Huyn Ryu, Purdue University; Katelyn Ponto, Purdue University

Research on the theory of two visual pathways (Milner & Goodale, 1995) has examined the processes at the time of action and after a short delay, but not for anticipated, future actions. The dorsal pathway, which provides information for visually-guided actions, has a short-to-nonexistent memory store (Hu & Goodale, 2000). However, if the dorsal pathway can anticipate future actions, then its purpose might extend beyond guiding moment-to-moment actions and instead be involved in planning future actions. In our experiment, participants grasped a disc and placed it in a hole. Marteniuk et al. (1987) found that when adults reach for a disk to fit it into a hole (a precision action), the initial reach duration was longer than when they intended to throw the disk to the ground (a less precise action). To manipulate the anticipated precision of the task, we surrounded the openings with smaller or larger circles, creating an Ebbinghaus illusion. Thirty right-handed college students reached for a disk and alternated fitting it into one of two holes. In the illusion condition, the holes were identical in size, but one hole appeared 8% smaller. In the no illusion condition, one hole was 8% smaller. Kinematic data was collected using a motion capture system (VICON), with reflective markers placed on the wrist, thumb, and index finger. As expected, participants reached differently when planning to fit the disk into a hole that was physically smaller: peak velocity of the reach to the disk was slower ( $t(29) = 1.68, p < .05$ ; always one-tailed) and reach duration was longer ( $t(29) = 1.66, p < .05$ ). However, when participants reached for the disk to fit it into a hole that appeared smaller, there was no difference in peak velocity of the reach to the disk ( $t(29) = 1.07, p > .15$ ) and no difference in reach duration ( $t(29) = 0.39, p > .35$ ). Even though the illusion caused two identical holes to appear different in size, the kinematics of the reach to the disk remained the same, suggesting that the dorsal pathway anticipates future actions.

### **Attentional influences on the performance of secondary physical tasks during posture control**

Cluff, Tyler, Taher Gharib, Ramesh Balasubramaniam; McMaster University

While maintaining balance we often engage in conjoint secondary tasks. These tasks, superordinate to posture, are referred to as suprapostural tasks and can be physical or cognitive. In this experiment, we examined the role of cognitive load, focus of attention and suprapostural performance on the statistical stability of COP trajectories. We considered the following six conditions: upright stance, upright stance with cognitive load,

suprapostural (pole balancing), suprapostural externalized focus, internalized focus, and suprapostural with cognitive load. Statistical stability was indexed via root-mean-squared COP and finger displacements. The mean power frequency of COP displacements was computed by Welch periodogram. Short- and long-range Hurst exponents and critical times for switching postural regimes were determined by stabilogram-diffusion analysis. Last, the decay exponent alpha for the probability of change in fingertip speed  $P(\Delta s, \Delta t)$  was determined by detrended fluctuation analysis. COP variability increased during suprapostural performance, but was not affected by cognitive task performance. Dynamical analyses of postural fluctuations by correlation/diffusion methods revealed the existence of a drift and correct mechanism. The correlational structure in the COP signal, across two time-scales, changed as a function of the suprapostural task. However, focus of attention manipulations did not affect the variability of sway or pole position. Similarly, the MPF of COP and fingertip displacements were not dependent on focus of attention. When participants performed an additional cognitive task while pole-balancing and standing, there was a significant decrease in the overall variability of postural sway and pole displacement. This finding was further supported by increased stringency in the probability for changes in fingertip speed, amounting to a less variable distribution of fingertip increments. These results are discussed in the context of dual-time scale models of posture control and the adaptive resource model of attention allocation.

### **Information processing demands while texting on a simulated driving task**

Cobb, Jennifer M, Zachary Fluster, Gregory Leder, Ashley Seaver, Joy L. Hendrick, James F. Hokanson; SUNY Cortland

Research has revealed the negative impact that cellular conversation while driving has on one's ability to operate a vehicle (Beede & Kass, 2005; Hendrick & Switzer, 2007). The proliferation of text messaging devices has raised the question of the effect that texting has on driving performance. It was the purpose of this study to examine the effects of sending and receiving text messages on reaction time (RT) while performing a simulated driving task compared to the effects of other common distractions behind the wheel. RT, movement time (MT) and total response time (TRT) under four conditions were compared: Control (C) (driving only), eating/drinking (ED) (eating popcorn and drinking water), talking (T) (hand-held cell phone conversation) and texting (TX) (sending/receiving text messages). Participants ( $N = 27$ ) were tested on two days with the order of conditions randomly varied. They were seated at a driving simulator, with their right foot on a pedal. While simulating driving, participants reacted to a visual stimulus by moving their foot from one pedal to another. This protocol served as the control and one distraction task (ED, T, TX) was added for each of the experimental conditions. On day 1, participants completed two sets of 20 control trials and five practice trials each the other conditions. On day two, participants completed 20 trials of each condition. RT of each condition was significantly slower than the control: C ( $M = 0.42$   $SD = .06$  s), ED ( $M = 0.47$   $SD = .06$  s), T ( $M = 0.58$   $SD = .12$  s), TX ( $M = 0.86$   $SD = 0.42$  s). MT of each condition was significantly slower than the control: C ( $M = 0.66$   $SD = 0.10$  s), ED ( $M = 0.75$   $SD = 0.11$  s), T ( $M = 0.83$   $SD = 0.14$  s), TX ( $M = 1.14$   $SD = 0.40$  s). The same effect was found with TRT: C ( $M = 1.08$   $SD = 0.17$  s), ED ( $M = 1.22$   $SD = 0.18$  s), T ( $M = 1.41$   $SD = 0.25$  s), TX ( $M = 2.00$   $SD = 0.77$  s). Mixed ANOVA revealed that the TX means reported significant differences ( $p < 0.05$ ) from each of the other three means. Results provide evidence of the dangers associated with distractions behind the wheel, with texting providing the most serious risk.

### **Inferior members and erector spinae muscular action potential in different angle positions of the knee during horseback riding: Therapeutic implications**

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**Objective:** The main purpose of this study was to compare the muscle activity in different angle positions during horseback riding as well as to compare the muscle activation during horseback riding with a sitting position in a chair. **Methodology:** Nine healthy volunteers from 19 to 23 years old were evaluated. Remote surface electromyography (EMG) was used to measure muscle activity of the trunk (erector spinae) and inferior members (tibialis, rectus femoris, vastus lateralis, gastrocnemius lateralis, and soleus) during horseback riding on the same horse, using three different internal angle positions of the knee (120°, 90° and 60°) which were compared with the sitting position in a chair without back support. EMG values were calculated for data obtained for eight seconds, collected in three trials from each subject in all position using the Root Means Square (RMS) data analyzed by AqDados-Lynx software. **Results:** The normal distribution was not observed by Kolmogoroff-Smirnoff test. Friedman's test showed that during the horseback riding, no significant differences of the muscular activation were observed according to different internal knee angle alterations. Significant changes were observed between sitting position when compared with all knee angles during horseback riding. **Conclusion:** In a horseback riding situation, there is a major demand of muscular activation for the individuals to search the adjustments necessary to be maintained in the activity. Since no significant differences between the angles of the knee during horseback riding were observed, changes in the angle variation due to the elevation or shortening of the stirrups are likely not to be significant under therapeutic perspective (hippotherapy), regarding the demand of muscle activation. Further studies are necessary to consider the type of behavior of the pattern muscle activation.

### **Regulation of interceptive actions: Effects of expectancy about upcoming target velocity and practice**

De Azevedo Neto, Raymundo Machado, Augusto Teixeira; University of Sao Paulo

This study aimed at verifying whether control of interceptive actions is affected by expectancy about upcoming target velocity and practice under different regimes of target velocity change. The task consisted of hitting a tennis ball at the end of an electronic trackway with a racquet simultaneously with the arrival of a luminous moving target. Participants were divided into two groups: unchanged velocity (UV) group practiced the task with the target moving at 3 m/s throughout the trackway; velocity decrease group (VD) had target moving initially at 3 m/s and then decreased to 2 m/s 300 ms before its arrival. Following practice, performance was evaluated either under certainty or 50% uncertainty about target velocity decrease. Analysis of temporal errors showed the following: (a) groups were not significantly different across experimental conditions, (b) more accurate movements were observed under velocity decrease than under unchanged velocity in the condition of uncertainty, and (c) no significant difference was detected between target velocities in the condition of certainty about upcoming target velocity. Kinematic analysis of magnitude of online movement correction for velocity decrease showed that the UV group presented higher values as compared with the VD group. These results suggest that expectancy about future target velocity modulates the use of online visual afference in the regulation of interception. Additionally, practice under target velocity decrease seems to favor movement corrections of lower magnitude.

These findings are consistent with the conceptualization of an internal model mediating vision and control of interceptive actions.

### **The role of force regulation in continuous and synchronization finger tapping**

Du, Yue, University of Maryland, College Park; Jane E. Clark, University of Maryland, College Park; Jill Whitall, University of Maryland, Baltimore

Movements, such as writing and speaking, require control of both force and timing. Studies of timing control have examined paced finger tapping following the removal of the auditory cue (continuous paradigm) (Wing & Kristofferson, 1973) and paced finger tapping with a concurrent cue (synchronization paradigm) (Vorberg & Wing, 1996). Two major findings from these studies are the two-level process model of timing regulation and negative mean timing asynchrony. Timing of force production, however, has been ignored in these studies and little attention has been given to the relationship between timing and force regulation during paced finger tapping. To probe this relationship in young adults, we examined finger tapping in a continuous and synchronization paradigm while varying the inter-onset interval (500msec, 1000msec, 1500msec) and/or the target force (preferred force and double preferred force). There were two main results. (1) In the synchronization task, the time of peak force was always closer to the external cue than the time of tap contact. Furthermore, when the force was doubled, the contact time but not the time of peak force was farther from the external cue. (2) Force curves differed between continuous and synchronization tapping. In the synchronization tapping task, force increased faster so as to better synchronize the time of peak force with the external cue. This produced an asymmetrical force impulse compared to the symmetrical force impulse in continuous tapping. Taken together these results suggest that force regulation may play a more important role in synchronization than continuous tapping. We discuss our result in light of previous studies that address the interdependence of force and timing in rhythmic unimanual tapping (e.g., Sternad et al., 2000).

### **Height judgments and obstacle crossing in individuals with Parkinson's disease**

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Parkinson's disease (PD) is a neurodegenerative disorder that affects one's mobility leading to higher instances of falls. While perceptual and proprioceptive deficits have been identified in PD, there is debate as to how these deficits might contribute to overall mobility impairments. However, there has never been direct evaluation of perceptual judgments to determine if there is a measureable deficit. The objective of this study was to evaluate how individuals with PD estimate obstacle height, and whether this estimation affects obstacle crossing behaviours. Participants ( $N = 8$ ) with PD were asked to view one of three obstacles (1.5, 10, 20cm) placed 6m away and elevate their foot to the perceived height of the object. During the height estimation the participants were instructed to either look at only the obstacle (proprioceptive feedback) or look at their foot and obstacle (vision proprioception). Following the height judgments the participants were instructed to approach and step over the obstacle to determine if self motion affected height judgments. The results showed that height judgments were significantly more accurate ( $p < 0.05$ ) when the participants were allowed to look at their foot. The judgments using only proprioception were inaccurate and significantly higher than the obstacle height. Providing self-motion was not found to signifi-

cantly improve perceptual judgments for either condition. In addition, these differences in height judgments did not carry over to obstacle crossing behaviours. The participants used a safety margin of approximately 10cm scaled to the obstacle height, to ensure a successful clearance of the obstacle. These findings suggest that perceptually, individuals with PD were able to integrate information from two sources of sensory feedback to improve height judgment accuracy over proprioception alone. During action, individuals with PD compensate for mobility impairments by applying a larger safety margin when stepping over obstacles.

### **Duration for cognitive and motor activities in lucid dreams**

Erlacher, Daniel, University of Heidelberg, Institute for Sport and Sport Science

Nocturnal dreams can be considered as a kind of simulation of the real world on a higher cognitive level (Erlacher & Schredl, 2008). Within lucid dreams, the dreamer is aware of the dream state and thus able to control the ongoing dream content. Previous studies could demonstrate that it is possible to practice motor tasks during lucid dreams and doing so improved performance while awake (Tholey, 1982). Even though lucid dream practice might be a promising kind of cognitive rehearsal in sports, little is known about the characteristics of actions in lucid dreams. The purpose of the present study was to explore the relationship between time in dreams and wakefulness to gain insight into the temporal structure of simple cognitive and motor tasks. We conducted two sleep laboratory experiments with a total of 15 lucid dreamers. In Experiment 1 participants had to count to 10, 20, and 30 and in Experiment 2 to walk 10, 20, and 30 steps during their lucid dreams. Lucid dreamers were instructed to mark the following events by left-right-left-right eye movements (LRLR): the onset of lucidity, the beginning of each sequence and the end of the lucid dream task. The LRLR are clearly visible in the recording of eye movements (EOG) and the interval between two LRLR can be measured. Sleep was recorded by means of standard procedures (Rechtschaffen & Kales, 1968). Results showed that absolute duration of counting or walking in the lucid dream takes more time than for the same tasks during wakefulness ( $M = 30\%$  for Counting;  $M = 50\%$  for Walking). For both conditions, however, relative timing revealed similar percentages for both conditions (highest typical error is 1.4 for Counting and 2.5 for Walking). Our results for lucid dreaming indicate a tendency for simple cognitive and motor tasks to require more time, whereas these differences are not visible for the relative timing of the tasks. Thus they support the notion that a temporal structure for actions in lucid dreams is present and therefore mirror a functional equivalence between dreamed and waking activities.

### **The effect of self-regulated modeling on a ballet passe releve**

Fagundes, Julie, California State University Fullerton; David D. Chen, California State University Fullerton; Patti Laguna, California State University Fullerton; Darlene O'Cadiz, California State University Fullerton

The purpose of this study was to determine the effect of the amount of self-regulated modeling on learning and retention of a ballet passé releve. Fifty-two undergraduate students (mean age = 22.31) participated in the study that consisted of an acquisition phase (15 trials), an immediate retention test (5 trials), and a delayed (two days later) retention test (5 trials). Half of the subjects chose the number of viewings of the model demonstration (two or six viewings) and the other half were yoked to the self-regulated subjects. Three types of dependent variables (reproduction accuracy based on experts' rankings, balance time, and



cognitive representation scores) were submitted to separate ANOVAs. Results indicated that the self-regulated modeling group displayed a greater cognitive representation than their externally controlled counterparts during acquisition, immediate retention, and delayed retention tests. In addition, a higher frequency of exposure to video demonstrations led to greater cognitive representation scores. Analyses of performance reproduction accuracy and balance time data during acquisition revealed a learning effect and identified no significant findings for immediate and delayed retention tests. Results will be discussed with respect to theoretical underpinnings of self-regulated learning and modeling research.

### **The effects of self-controlled feedback and error estimation on motor skill learning**

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Despite the evidence that self-controlled (SC) feedback (FB) facilitates motor learning for a range of skills (Chen, Hendrick, & Lidor, 2002; Chiviacowsky & Wulf, 2002; Janelle et al., 1995, 1997), the causal mechanism of these effects is still unknown. Research showing that participants in SC FB conditions strategically ask for FB following successful trials (i.e., those perceived to be accurate), indicates that learners can effectively self-evaluate their performance (Chiviacowsky & Wulf, 2002). This suggests that error estimation (EE) may be a critical component involved in producing SC FB effects. EE has previously been shown to enhance motor learning (Liu & Wrisberg, 1994), but it has never been directly compared to SC FB. If EE is a primary contributor to SC FB effects, it would be expected that a SC condition and an EE condition would yield equivalent learning benefits compared to a yoked control condition. The purpose of this study was, therefore, to compare a SC FB group to yoked FB groups that either did or did not estimate their errors prior to receiving FB (EE and YK, respectively). Participants learned a blindfolded beanbag toss according to procedures similar to those reported by Chiviacowsky & Wulf (2007). Results indicated that the SC and EE groups were more accurate during retention and transfer than the YK group. On average, participants in the SC group requested FB on just over half of the 60 acquisition trials, which is higher than the rate seen in previous research. The EE group consistently overestimated their accuracy by about 10 cm ( $p < .05$ ). The results suggested that error estimation may be just as effective as self-controlled FB in facilitating motor learning and consistent with the idea that the benefit from SC FB is derived at least in part from the act of self-evaluation in order to make decisions about whether or not to request FB. This functional equivalence also points to error estimation as a viable instructional strategy for situations in which self-control of feedback is not an option.

### **Examine the process of learning multiple-segmental movement as the example of learning to bike on roller trainer**

Fan, Yung-Yi, Hsiu-Hui Chen; National Taitung University

Few studies have been found on examining how human learned a complex motor skill. Purpose: the presented study aimed to quantify the process of learning a multiple-segmental skill based on both outcome performance and whole body movement coordination. Method: 12 male college-students were recruited to learn to ride a bicycle on the roller trainer. The participants practiced ten minutes per day for five days. The successful riding time (SRT) of each trial was recorded. The three-dimensional coordinates of whole body joints and markers attached on bike was collected for 20s in each practical trial. Results: The learning curves

plotted on SRT revealed discrete which corresponding to the transition of system dynamics. Moreover, the curves of SRT could be separated as before, during and after transition according to the variability of standard deviation. The autocorrelation on the trajectories of bicycles movement in lateral axis was found a higher ( $> .4$ ) coefficient of correlation at about 50 frames lag (0.25 sec) for the trials before transition implicating a coordination for controlling. The movement pattern for controlling showed a trend of decaying in the values of components vectors over learning. Conclusion: Learning to ride the bicycle on roller trainer revealed a discrete progressing process. The PCA could be used as the tool to quantify the changing movement pattern.

### **Expert perception of situational probability information in a time stressed interceptive task**

Farrow, Damian, Australian Institute of Sport; Darren McMurtrie, Tennis Australia; Tara Handke, Australian institute of Sport; Machar Reid, Tennis Australia

An extensive body of literature exists across a variety of sports demonstrating that experts are able pick-up useful anticipatory information from the kinematics of an opponent's movement pattern to which novices are not attuned. However, the contribution of situational probability information, such as sequential dependencies in an opponent's pattern of play, to expert anticipation is less established. The purpose of this study was to determine the contribution of such probability information to the anticipatory responses of skilled tennis player's representative of two different stages of development. Participants were required to predict the location of tennis serves presented to them on a plasma touchscreen from the perspective of the receiver. Serves were sequenced into a series of games and sets with a score presented before each point, typical of a game of tennis. The game score (e.g., 15-0, 30-15) was manipulated to provide advance probability information. Specifically, the location of the serve for the first point of each game was always directed to the same location. A total of 12 service games consisting of 96 points were presented with our interest in whether players would detect the relationship between the game score and resultant serve location as measured by response speed and accuracy. A  $2 \times 12$  (skill level  $\times$  service game) ANOVA with repeated measures on the second factor revealed a significant skill by service game interaction for response time ( $F_{11,297} = 2.31, p < 0.05$ ). The older and more skilful players picked up the occurrence of the first point service pattern after the ninth service game whereas the younger, players did not. There were no significant differences between the groups in relation to response accuracy ( $F_{11,297} = 0.75, p > 0.05$ ). The findings highlight the important role of situational probability information, in addition to movement kinematics, for successful anticipatory performance and suggest that the pick-up of such information is not utilised by younger, skilled players.

### **Emotional influences on postural sway prior to gait initiation**

Fawver, Bradley J, Kelly M Gamble, Christopher J Hass, Christopher M Janelle; University of Florida

Postural adjustments prepare the body for movement. Previous work has demonstrated that emotional state impacts postural adjustments during quiet standing, but how emotion alters postural sway when preparing whole body movement remains unknown. We sought to determine the effects of emotional stimuli on postural sway for individuals preparing to initiate forward gait. Participants ( $N = 24$ ) stood on a force plate in front of a projection screen in preparation to initiate gait, and then walked several steps. Following baseline

assessment, a picture representing six discrete categories (attack, erotic, happy people, sad people, neutral faces, and blank) replaced the fixation-cross and remained on the screen for several seconds. Participants were instructed to initiate gait following picture offset. Postural sway in the anterior-posterior direction was measured during the baseline period and for the first two seconds of picture presentation. No differences between gender and across picture categories existed during baseline. Greater posterior movements were occasioned during the first second compared to the second ( $p = .001$ ) when collapsed across valence categories, and greater posterior sway occurred during exposure to attack pictures compared to erotic and happy people pictures ( $p = .041$ ). Posterior sway was attenuated during exposure to happy people and erotic pictures relative to the blank pictures. The main effect of valence was substantiated through an analysis of postural change over the total time of picture onset ( $p = .047$ ). Collectively, results indicated that the presence of emotional stimuli modulates postural adjustments when individuals are preparing to initiate gait. Posterior movements were elicited in response to all emotional stimuli, with attack pictures resulting in the greatest posterior sway. Theoretical and practical implications are offered with a particular focus on how emotion affects approach and avoidance actions.

### **End-state comfort, spatial bimanual coupling, and ecological relevance**

Fischman, Mark G., Michael A. Urbin, Leah E. Robinson; Auburn University

Two well-known motor control phenomena are the end-state comfort effect, and spatial bimanual coupling. Last year we presented two experiments that compared the strength of these effects against each other. Participants simultaneously picked up either two standard drinking glasses (high ecological relevance, Exp 1) or two plastic PVC cylinders (marginal ecological relevance, Exp 2) from a shelf and placed them upright on a counter below. The starting position of the glasses or cylinders appeared in four orientations: (1) both objects upright, (2) both objects overturned, (3) left object upright – right object overturned, and (4) left object overturned – right object upright. We monitored the position of the participant's thumbs, thumb-up or thumb-down, when initially grasping each object. In orientations (1) and (2), the objects could be grasped with a thumb position that ensured a comfortable end-state and also satisfied bimanual coupling constraints. The interesting orientations were (3) and (4), where using opposite grips would ensure end-state comfort, but violate bimanual coupling. We found overwhelming support for the end-state comfort effect in Exp 1, but significant departures from it in Exp 2, where bimanual coupling was much more likely. We interpreted these results as suggesting that an object's ecological relevance can exert powerful effects on anticipatory planning behavior. However, a possible limitation of these experiments was that in addition to differences in the ecological relevance of the objects, there were also differences in their shapes. The grasping surface of the glasses was beveled and tapered from top to bottom. The PVC cylinders, however, were smooth and perfectly straight along their entire length. In the current experiment we used smooth, straight-sided drinking glasses, identical in length and diameter to the PVC cylinders. Forty participants performed the 4 conditions described above. The end-state comfort effect was present in 90.3% of the cases, thus supporting the ecological relevance argument in human-object interaction.

### **End-state comfort effects in the overturned glass task: Influence of shelf height**

Fischman, Mark G., Casey M. Breslin, Maria Morera, Simone Resende, Leah E. Robinson, Mary E. Rudisill; Auburn University

The end-state comfort effect reflects a tendency to minimize awkward hand and arm postures at the end of simple object manipulation tasks, rather than at the beginning. We tested this effect in an everyday task of picking up an overturned drinking glass from a shelf, turning it right side up, and filling it with water. Previous research has shown that the majority of adult humans perform this task by grasping the glass with an awkward, thumb-down grip, followed by supination of the hand (outward rotation) to finish with a comfortable thumb-up posture. However, in a real-world setting, such as a kitchen, people often have to reach for glasses in cabinets where shelf heights vary from low to high. The purpose of this study was to determine whether the starting height of the shelf on which a glass was placed would influence the end-state comfort effect. Forty-seven participants (16 men, 31 women) used their preferred hand to pick up an overturned drinking glass from a shelf, turn the glass upright, place it on a counter below the shelf, and then fill the glass with water from a measuring cup. Three shelf heights were used (96-, 146-, and 169-cm above the floor), comparable to shelf heights in a standard kitchen cabinet. Participants performed one trial at each height in a counter-balanced order. Our hypothesis was that as shelf height increased, sensitivity to end-state comfort would decrease, and particularly for the highest shelf. This hypothesis was not supported, as an overwhelming majority of participants (44 of 47) used a thumb-down grip in all three conditions. A chi-square analysis revealed the difference between the number of thumb-down grips and all others was statistically significant [ $\chi^2 = 264.3, p < .001$ ]. A possible explanation for these findings is that our top shelf was simply not high enough. We reject this possibility, however, as 13 participants were no taller than 160 cm. Taken together, the data suggest that end-state comfort is a viable constraint on anticipatory planning behavior, even at the extremes of one's reach envelope.

### **Dual tasking indicates elderly inability to delegate locomotion to lower levels of control**

Fosnaugh, Erin, Leslie Decker, Sara Myers, Nick Stergiou; University of Nebraska at Omaha

Dual tasking is a useful paradigm to investigate information processing resources in the brain and its interpretation follows the view that these resources are limited. In the present study, a dual-task paradigm has been used to understand whether the control of locomotion, that basically involves both higher and lower levels of control, is delegated to the lower levels while a secondary task that increases the cognitive load during displacement is performed. Ten young adults and 10 elderly adults participated in the experiment that involved conditions of normal walking at self-selected pace (control condition), and while performing a secondary cognitive-linguistic task (phonemic fluency). The gait performance was evaluated during 3 minutes for each condition using the right and left minimum toe clearance (MTC) that is a critical event in the gait cycle. The Coefficient of Variation (CoV) of each MTC time series was then calculated to get information about the gait control strategy. For both conditions, the CoV values on the right and left sides were significantly smaller in the young than in the elderly. For the young, both left and right CoV values were significantly smaller under the dual-task condition as compared to the control condition. No differences were observed between the conditions in the CoV values for the elderly for both sides. The decreased CoV values in the young group while performing the secondary task indicate a more automatic control of the gait. An explanation is that to maintain a safe gait, despite an increased cognitive load, delegation of control to lower levels (spinal) occurs, generating a stronger closed loop or limit cycle behavior of the legs. Inversely, in the elderly this ability may have diminished. Lastly, the similar tendency observed for both sides, while the linguistic task performed is known to be left hemisphere dominance, is consistent with the bilateral motor control of gait.

### **The mirror neuron system: A neural substrate for methods in stroke rehabilitation**

Garrison, Kathleen A., Carolee J. Winstein, Lisa S. Aziz-Zadeh; University of Southern California

The putative human mirror neuron system (MNS) is defined as motor brain regions that respond both when we perform an action and when we observe similar actions being performed by others. Thus the motor system may be engaged without overt movement. Rehabilitation of motor function after stroke is often challenging due to severity of impairments and poor to absent voluntary motor ability. Methods in stroke rehabilitation that engage the MNS, e.g. action observation, rebuild functional movements despite impairments by using covert practice as an alternative or complement to voluntary practice during physical therapy. This study first maps the MNS in participants with chronic MCA stroke and moderate-to-severe upper limb hemiparesis ( $n = 15$ ), and in age-matched non-disabled volunteers ( $n = 15$ ), by localizing overlap in brain activity during action observation and execution in fMRI using single-subject unsmoothed data. Post-hoc lesion analysis evaluates the specific effect of lesion characteristics on MNS maps with regard to anatomy and shared voxel counts. We further compare the whole brain response to observation of actions that can and cannot be performed by participants with stroke. In the healthy brain, action observation engages primarily the MNS. After stroke, some observed actions are no longer physically possible for the observer to perform due to motor impairments, and thus engage a more deliberative processing supported by other multimodal cognitive areas commonly referred to as the "mentalizing system." Observed actions were adapted from the Wolf Motor Function Test related to task difficulty and are considered possible if performed with the non-paretic limb, and no longer possible if performed with the paretic limb. Results (ROI analyses,  $p < 0.05$  corrected) show that: (1) upon observation of possible actions, participants with stroke engage the MNS (IPL, PMv, IFG) comparably to non-disabled volunteers; whereas (2) upon observation of no longer physically possible actions, participants with stroke engage the MNS and the mentalizing system (TPJ, mPFC, ACC, PC).

### **How one breaks Fitts's law and gets away with it**

Glazebrook, Cheryl M., Luc Tremblay, Timothy N. Welsh; University of Toronto

Pratt et al. (2007) have reported what they have termed a 'violation' of Fitts's Law. Specifically, they have found that participants required less time than would be predicted by Fitts's Law to reach the furthest target location when all possible target locations (i.e., placeholders) are presented prior to movement initiation. Subsequent studies have manipulated the amount of contextual information present during planning and execution stages and have indicated that the locus of this 'violation' effect may lie in movement planning processes (Bradi et al., 2009; Radulescu et al., 2009). To date, however, kinematic analyses have not been utilized to examine this proposal. The purpose of the present study was to assess contributions of planning and control processes to the 'violation' effect by conducting detailed trajectory analyses. Participants performed aiming movements to either the near, middle, or far target in 3 different placeholder arrays. Consistent with previous findings, movement time (MT) increased significantly from the near to the middle target, but did not differ significantly between the middle and the far target. Of greater theoretical relevance, the kinematic analysis revealed that: (1) participants reached higher peak velocities (PV) as the relative position of the target increased from the near-middle-far location; (2) there was no significant difference in the time to reach PV ( $F < 1.2$ ); and, (3) participants spent more

proportional time after PV when aiming to far versus near targets. Thus, the present results suggest that both movement planning and control are influenced by the relative position of the target. That is, while individuals reached higher PV when aiming to further targets, greater absolute and proportional time was required to control the movement. Future work will examine how movement planning and control are affected by varying the visual contexts that lead to this phenomenon.

### **The beneficial effect of a probe task on motor learning depends on the type and the temporal locus of the probe task**

Goh, Hui-Ting, University of Southern California; Katherine J. Sullivan, University of Southern California; Gabriele Wulf, University of Nevada, Las Vegas; James Gordon, University of Southern California; Carolee Winstein, University of Southern California

Dual-task probe paradigms are used to assess attentional demands during skill acquisition. In doing so, it is assumed that the probe task is neutral in its effect on the learning of the primary task, particularly if probe frequency is relatively low. To test this assumption, we investigated whether the effect of probe task on motor learning depends on the type (choice vs. simple) or temporal locus (preparation vs. execution) of the probe, using a 17% probe frequency. There were 5 groups of participants ( $N = 49$ ), 1 no probe Control (Con) group and 4 probe groups: Choice-Preparation (CP), Simple-Preparation (SP), Choice-Execution (CE), and Simple-Execution (SE). The experiment took place over 3 consecutive days. On Day 1 and 2, all participants practiced a rapid discrete arm movement that was required to match a template with specific spatiotemporal parameters (total of 288 trials). Performance accuracy was quantified by root mean squared error (RMSE). An audio-vocal response time (RT) task was used to probe the attentional demands of the primary arm task across practice (delivered every 6 +/- 1 trials) for the 4 probe groups. The audio probe cue was presented 500ms before the 'Go' cue for the Preparation groups and 300ms after movement started for the Execution groups. The probe task was either a simple or a 2 choice RT task based on the group assignment. Delayed retention tests were conducted on Day 2 (DR1) and Day 3 (DR2) to infer learning of the primary task. There was a significant Type  $\times$  Temporal Locus interaction for performance accuracy on both DR1 ( $p = 0.02$ ) and DR2 ( $p = 0.01$ ). Further analysis revealed that the CP group performed better (lower RMSE) than the SP group on DR1 ( $p = 0.01$ ). In contrast, the SE group performed better (lower RMSE) than the CE group ( $p = 0.03$ ) and the Con group ( $p = 0.04$ ) on DR2. The beneficial effects of the probe task on motor learning suggest that: (1) the probe is not neutral for primary motor task learning and (2) the probe task may provide a process-specific interference that boosts encoding processes for the primary task.

### **Social affordances could alleviate social interactions in individuals with autism spectrum disorder**

Gonzalez, David A, Jim L Lyons, McMaster University

Social interactions have often been shown to be problematic for individuals with Autism Spectrum Disorder (ASD), with several cognitive-behavioural theories proposed to explain the mechanisms underlying these difficulties (e.g., Theory of Mind: Baron-Cohen, 2004; Weak Central Coherence; Frith, 1989, etc). The highly cognitive nature of these theoretical research approaches may, however, underestimate the degree to which the direct perception of environmental factors influence the observed difficulties experienced by individuals with

ASD in social interaction. The aim of this study was to apply the precepts of Social Affordance Theory (Schmitt, 2007) to determine whether individuals with ASD could use this direct information to successfully determine the intentions of another. Nine participants with autism spectrum disorder (ASD; 1 female) and nine age and handed matched participants without ASD (1 female) participated. Action phrases were used to portray the intentions of others, and participants responded to pictorial images to determine which of several objects would serve to best fulfill those intentions. Results suggest that individuals with ASD demonstrate comparably accurate, but slower, responses when compared to the typically developing participants. We hypothesize that individuals with ASD are utilizing social affordance cues to infer the motor intentions of others when these intentions are based upon specific action demands. This would suggest that the ability to perceive such affordances may, unlike certain information-processing abilities, be spared in ASD.

### **Can learning under an external focus of attention counteract the negative effects of choking under pressure?**

Gottwald, Victoria M, Gavin P Lawrence, Michael A Khan; Bangor University

Previous research suggests that implicit strategies adopted during learning can help alleviate performance decrements typically associated with the presence of pressure. Specifically, Masters (1992) proposed that if explicit learning can be minimised then a breakdown of automatic processes under pressure is less likely to occur in future pressure situations as the performer has no access to explicit knowledge. Similarly the Constrained Action Hypothesis (Wulf et al., 2001), suggests another strategy to reduce the breakdown of automatic processes is adopting an external focus of attention. Thus, the purpose of the current experiment was to investigate how learning with an external focus of attention affects performance under subsequent pressure situations. Since previous studies have generally used outcome measures of performance, the current study also measured movement production using variability methodology (Khan et al., 2006). Novice participants ( $N = 30$ ) performed a 2.5m golf putt. Following a pre-test, participants were randomly assigned to one of three focus groups (internal, external or control). Participants completed 400 acquisition trials over two consecutive days before being subjected to both a low-anxiety and high-anxiety transfer test (no focus of attention instructions were provided here). Dependant variables included number of successful putts, mean radial error and variability analysis using data from 3D Vicon motion analysis. Results revealed that all groups increased performance following acquisition. However, only the control group demonstrated a decrement in performance in the high-anxiety transfer test. These findings suggest that adopting an appropriate focus of attention during learning can prevent choking; with an external focus of attention stopping the breakdown of automatic processes and an internal focus of attention acting as a self-focus learning strategy and thus may desensitize individuals to the effects of anxiety (see Beilock & Carr, 2001).

### **Do vision and audition influence bimanual timing coordination for in-phase and anti-phase patterns in a linear slide task?**

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The purpose of the present study was to investigate the role of vision and audition in the coordination of in-phase and anti-phase movement patterns at increasing frequency of oscil-

lation in a bimanual linear slide task. The dependent variables were mean error of relative phase and standard deviation of relative phase. Results indicated that vision and audition did not influence the accuracy and the variability in performance of the two relative phase patterns, whereas increasing frequency influenced the performance of the anti-phase pattern, but not the in-phase pattern. As a potential explanation of the current findings, it is hypothesized that the bimanual linear coordination task did not rely on vision and audition because the task was perhaps governed by proprioception. With consideration for specific motor tasks, investigating the role of vision, audition, and proprioception on the performance of coordinative movements remains an important question for continued research.

### **Global vs. local perception when making anticipating judgments: An investigation using the moving window paradigm**

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Anticipation is a crucial component of superior performance in tennis. Huys and colleagues (2009) reported that the key visual information underpinning effective anticipation is picked up globally from different areas of an opponent's posture rather than locally from a single source. If perceptually skilled players use a global pick-up strategy, it is reasonable to predict performance decrements when access to peripheral visual information is perturbed. In this study, we applied the moving window technique to restrict information pick-up via the visual periphery by manipulating the (circular) window size around the point of fixation (McConkie & Rayner, 1975). In a video-based perceptual test, 21 tennis players had to predict the direction of 96 tennis serves presented on a computer screen. All sequences were occluded at the moment of racket-ball contact. The window sizes, which varied between 2 and 8 degrees of the visual field, were systematically manipulated using the EyeLink II-System (SR Research). Using a within task criterion (i.e., based on performance on a control condition involving no manipulation), players were split into Perceptually Skilled ( $n = 11$ ) and Perceptually Less Skilled ( $n = 10$ ) groups. A repeated measures ANOVA on the accuracy scores revealed a significant main effect for the size of the moving window,  $F(5, 95) = 23.33$ ,  $p < .01$ ,  $\eta^2 = .55$  (i.e., better scores with increasing window size). The interaction between size of the window and perceptual skill was significant,  $F(5, 95) = 2.31$ ,  $p = .05$ ,  $\eta^2 = .11$ . In contrast to the Less Skilled participants, anticipation performance in the Perceptually Skilled players decreased when the window size was reduced to 8 degrees. In this latter condition only the visual periphery is removed (e.g., if a participant focused on the apex of the ball toss vision towards the lower body was perturbed). Findings suggest that the Perceptually Skilled players use a more global rather than local perceptual strategy when perceiving the intentions of others.

### **Measuring reaction time: A methodological question**

Hart, Melanie, Karen S Meaney, Texas Tech University

Reaction time (RT) is an ability that is important in many sports and activities of daily living (e.g., driving). There are a number of manufacturers that promote activities and technologies that claim to improve individuals' RTs. Research has been conducted to examine the effectiveness of some of these activities with mixed results (Hart et.al, 2005; Uderman et al., 2004). One possible explanation for the differing results is the method used to measure RTs. The purpose of this study was to examine the equivalency of computerized RT and the Nelson



RT tasks. Children ( $N = 47$ ) involved in a summer physical activity program completed two different simple RT tasks. For both tasks, participants completed 20 trials using the right hand. In one method participants sat in a chair in front of a computer, which was placed on a normal height table. The stimulus pattern on the computer screen contained a warning followed by the stimulus to which the subjects responded as quickly as possible. The response was a discrete finger press (index finger) on a response key. The second method required the subject to sit in a chair with the right arm resting on a table with index and thumbs extended and approximately one inch apart. The Nelson timer was placed between and parallel with the index finger and the thumb. The timer was held so that the zero line was level with the top of the thumb. The researcher gave a warning of “ready” and released the timer. When the timer was released, the subjects were instructed to grasp the timer with the fingers and thumb as quickly as possible without moving the arm from the table. RT was recorded as the number at the top of the thumb. The mean RTs were calculated with two methods: all trials and with the 5 longest and 5 shortest RTs removed. Mean RTs were analyzed using a Task  $\times$  Trim ( $2 \times 2$ ) repeated measures ANOVA. The results indicated significant ( $p < .05$ ) Task effect and interaction. The results suggest that RTs obtained from the two methods cannot be compared, and that the method of calculating the mean RTs results in differing outcomes.

### **Learning how to balance: Effects of self-selected use of a balance bar and its subsequent motivational influence**

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A self-controlled learning environment benefits the learning of motor skills. This study investigated the effects of a perceived physical-assistance device (balance bar) and the potential motivational value it may generate on the acquisition of a dynamic balance task. Fifty-nine undergraduate students volunteered to participate in the study and were assigned randomly into one of the four groups: decision, control-bar, control no-bar or yoked group. The study consisted of three phases: acquisition (15 trials), immediate retention test after 5 minutes (5 trials), and seven-day delayed retention test (5 trials). For each trial participants were instructed to stay balanced on the platform for the duration of 30 seconds. Time in balance was measured to the nearest millisecond and was defined as being in balance if the platform was within 3 degrees of horizontal. A 4 (Group)  $\times$  2 (Sex)  $\times$  3 (Trial Block) ANOVA with repeated measures on the last factor was performed on acquisition balance data. Follow-up analyses of a significant Group  $\times$  Sex  $\times$  Trial Block interaction revealed that female participants in the decision group had significantly higher balance scores than the control-bar group while no differences were identified among male participants. Females were found to be better than males in both retention tests, but the hypothesis that self-selected use of a balance bar would have an advantage over other groups was not supported for retention data. In addition, motivation was not identified as a significant factor. The results indicated that self-controlled environment did not benefit learners equally, and a need exists to examine other variables such as the factors of sex and the type of balance bars used.

### **The role of biological motion and nonbiological motion during action-observation**

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for Sport and Exercise Sciences, Liverpool John Moores University, Liverpool; Simon J Bennett, Institute for Sport and Exercise Sciences, Liverpool John Moores University, Liverpool

The human mirror neuron system codes the goal of an action and how that goal is achieved. Although these effects occur due to processing biological motion, the goal of an action is also resonated by observing non-biological motion (Gazzola et al., 2007). It was suggested that observers can ignore the deviations in kinematics (i.e., nonbiological motion) and code the task goal if the action is familiar. However, when the task is unfamiliar a reduction in mirror neuron activity is likely to occur. Whilst these effects are present in neurophysiological paradigms and behavioural motor interference tasks, it is unclear whether learning is inhibited when observing nonbiological motion. The present experiment compared motor learning in a novel 5-segment movement sequence task, which was constrained by a specific absolute and relative timing profile. Participants ( $n = 32$ ) observed a biological or nonbiological moving dot stimuli; a control group (CTL) viewed a blank screen. The dot stimuli followed either a biologically plausible (BIO) or implausible (constant) velocity profile (NonBIO). A third dot stimuli did not contain a velocity profile because motion information was removed – instead the stimuli appeared as series of 5 flashes that were congruent to the absolute and relative timing profiles (NoMOTION). Compared to the CTL and NoMOTION groups, the BIO and NonBIO groups learned relative timing by reducing movement time, and increasing peak velocity, in segments 2 and 5. This suggests that relative timing information was learned from dot stimuli that has an origin that was human (biological) or computer generated (nonbiological). However, when the dot stimuli were presented as a series of flashes, and trajectory information was removed, observers were unable to code the action goal. We suggest that speed and direction information (Tremoulet & Feldman, 2000) contained in the nonbiological motion dot stimuli trajectory gave the impression that the task was more plausible (i.e., familiar), which allowed observers to code the action goal.

### **Relative phase dynamics in motor-respiratory coordination**

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During exercises like running and manual wheelchair propulsion, the frequencies of movement and breathing are most often different and thus exhibit multifrequency relationships. The order parameter, or quantitative measure of the state of a system, typically used to describe motor-respiratory coordination is, therefore, the frequency ratio—the number of movement cycles produced per breath. It is possible, however, that even if multifrequency coordination is a function of constant coupling between oscillators, it may manifest itself at specific locations. In that way, multifrequency coordination is reflected in the relative phase regime. We instructed participants to perform larger-integer, complex ratios (e.g., 5:3) with the assistance of displays. Their performance was attracted to corollaries of the inphase and antiphase patterns observed in bimanual coordination. Difficulties in multifrequency ratio performance in motor-respiratory coordination can, therefore, be partly attributed to over-attraction to particular relative phase patterns. Thus, it is necessary to further understand relative phase dynamics to gain insight into even more complex motor-respiratory behavior. We used the phase transition paradigm to examine the stability of relative phase performance in motor-respiratory coordination. Performance was most stable when forward leg movements coincided with exhalations as opposed to inhalations. With increases in the frequency of oscillation, phase wrapping was observed, but transitions between relative phase patterns were not. This is a departure from the results observed typically in bimanual

coordination and may be a function of the inherently large frequency detuning between movement and breathing.

### **Effects of contextual interference and the axis of target location changes on quiet eye duration in a dart throwing task**

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The location-suppression hypothesis (Vickers, 1996) proposes that the final fixation before the onset of a movement in an aiming task, known as quiet eye (QE), is used to scale the parameters of the movement. In this experiment, we examined this hypothesis by comparing QE durations in dart throwing under practice conditions of high, (random practice; RP) and low contextual interference (blocked practice; BP). We predicted that RP would result in longer QE durations than BP because the movement parameters would need to be re-scaled more frequently. Participants also performed the task with target location changes in the horizontal (HA) and vertical (VA) axes. Here, we predicted that performing the throw with VA changes would result in longer QE durations than performing the throw with HA changes, as greater parameter adjustments (e.g., force, release velocity) would be required in the vertical plane. Two groups of 12 participants (7 male, 5 female) were matched based on pretest accuracy and assigned to the RP and BP groups. Participants threw darts to a regulation size dartboard that was projected onto a wall. There were 3 equidistant targets on the dartboard within each axis. Participants threw 30 times to the VA and HA targets in separate sessions with a short rest in-between. The BP participants threw to each of the 3 targets in blocks of 10 trials. The RP participants threw to each target 10 times, but in a random order. Eye movements were recorded to video at 30 fps with an ASL 5000 system. A second camera recorded the initiation of the arm movement and a mixer combined the videos in order to identify the QE period. ANOVA revealed main effects for practice type and axis (both  $p < .05$ ). Supporting our predictions, RP resulted in longer QE than BP and target changes in the VA resulted in longer QE than target changes in the HA. The results support Vickers' (1996) hypothesis, suggesting that QE is used to parameterize a movement pattern. The results also suggest that the cognitive load associated with contextual interference may be processed in the QE period.

### **The effectiveness of table tennis training on motor performance and visual perceptual ability in children with DCD**

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In recent years, research and clinical literatures have made efforts to establish effective treatments for both physical therapy and education in children with developmental coordination disorder (DCD). The aim of this study was to examine the effectiveness of a task-specific intervention, table tennis training, for children with DCD. From a potential sample pool of 142 children in 4 grades in Taiwan, 32 children with DCD were recruited by Movement Assessment Battery for Children (Movement ABC) and were randomly assigned into two

groups: table tennis training and control group. Each child was further individually given two tests, i.e. Test of Visual-Perceptual Skills-Revised (TVPS-R) and Developmental Test of Visual-Motor Integration (VMI). After 10 weeks of training program, children were again administered all three tests. Analysis of covariance (ANCOVA) with group as the between subjects factors and pre-test performance as covariance was conducted. Results showed that children in training group performed better in motor test than control group did after intervention. Besides, 9 children in training group had their Movement ABC performance improved beyond the clinical cutoff line. Finally, though training group did not perform differently from control group in TVPS-R and VMI tests after controlling pre-test scores, their total score of TVPS-R increased from 87.4 to 97.2, whereas VMI score increased from 106.0 to 111.8. Given that motor deficiency is one of the most influential problems in children with DCD, the results of the present study provided some support for the benefit of task-specific intervention approach. Furthermore, compared with traditional intervention strategies that focused on repeated movement, task-specific programs such as table tennis training are more interesting for children and will be a feasible approach for parents and physical educators to help children with DCD. More work is emerged to provide clearer and more intense evidence for the effectiveness of task-specific intervention programs in the case of children with DCD.

### **Exploring the relationship between passers and receivers in basketball lead passes**

Hsu, Yu, Yeou-Teh Liu, National Taiwan Normal University

The fast break is the best method to create easy scoring opportunities in basketball games. However, to have a successful lead pass, not only the passers require deception, timing, quickness and accuracy but the receivers have to cooperate with their teammates. If the teamwork cannot be successfully executed, the opportunities to get the critical points will be lost. The purpose of this study was to investigate the relationship between the passers and the receivers of the successful lead passes. There were 2 experiments performed in this study. Two high-speed cameras (200Hz) were used to capture the performances of the passes. The head of the receiver was digitized using Kwon3D system. Experiment 1 examined the consistency of the fast break lay-ups without a ball from players of 2 different skill levels. The RMS error from the mean instantaneous speed of each trial was used to compare the performance consistency. The result showed that the RMS error of the varsity players were significantly lower than the recreational group,  $p < .05$ . The finding provided the basis of affordance for the experienced players to perform a successful lead pass. In Experiment 2, 2 passers performed 5 lead passes to each of the varsity players and the RMS error between the ball/no ball conditions and between the 2 passers were examined. The results showed the significant difference between the ball/no ball conditions but there was no difference between passers. Further analyses identified the “good passes” as those receiver’s speed profiles with balls that were not different from the no-ball condition in terms of the RMS error. We also found the critical running speed of the receivers at the ball release and the stable linear relation between the ball and the receiver after the ball release played the crucial roles in a good lead pass. The results are discussed in the context of ecological psychology and the movement variability.

### **Interlimb coupling during cooperative bimanual actions when objects are physically connected**

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We have previously reported that end-state comfort is a predominant constraint in bimanual grasping and placing tasks, regardless of whether the manipulated objects are separate or connected (Hughes et al., 2009). Kinematic analysis of the data revealed that physically coupling the limbs results in greater interlimb independence during the deceleration portion of the movement compared to when the limbs maintained their physical independence. We present a follow-up study designed to examine this finding under more specific experimental conditions. Thirty right handed college-aged participants were randomly assigned to either the no-spring first. In the no-spring first group participants performed the task when the blocks were separate first (no-spring), and then when the blocks were connected by a spring (spring). Participants in the spring first group performed these two tasks in the opposite order. Participants grasped and then placed the objects on the target board in one of two target locations; same target location (90 deg external rotation of the blocks by both hands), and different target location (the left hand was required to rotate the left block 90 deg internally, while the right hand is required to rotate the right block 180 deg). Measures of interlimb coupling based on movement velocity were calculated in the sagittal plane (x- and z- axes), and included root mean square (RMS) of the velocity difference and between-hands correlation coefficients during the acceleration and deceleration portion of the velocity profile. Lower RMS velocity difference values indicate greater coupling between the hands, whereas higher correlation values indicate greater interlimb synchronization. There was a decrease in interlimb coupling during the deceleration portion of the movement in the bimanual spring group compared to the bimanual no-spring group. We suggest that participants viewed the objects connected by a spring as an integrated entity, and this allowed for more independent control of the two hands.

### **Visual search under task constraints while anticipating the results of basketball free throws**

Ishibashi, Yukimasa, Takaaki Kato, Tomohisa Nagano, Yuji Ohgi, Mitsuo Sasaki; Keio University

Our aim was to compare the visual search behavior of twelve expert basketball players with that of twelve novices as they anticipated the results of a free throw in basketball by using an eye-movement registration system. The accurate judgment of the result of a free throw at an early stage is one of the most important skills in basketball and it depends on the acquisition of visual information that has both temporal and spatial components. The subject's experimental task was to predict the success of a free throw by responding verbally with 'In', 'Out' or 'Uncertain', while viewing a randomized successful/unsuccessful video-based model of a free throw. The video of the shooter was captured from a position to the side of the shooter's shooting arm and perpendicular to the plane of the intended motion of the ball. The video was temporally occluded before the ball reached the goal (133 ms). Spatial factors were extracted from the shooter's free-throw motion and the trajectory of the ball by annotating kinematic information. The results showed that experts were able to anticipate a successful free throw more accurately than could novices. The experts and novices also displayed different visual search behaviors. Experts performed more fixations and fixation locations during the pre-shot routine phase than did novices, but performed fewer of these behaviors during the ball-release phase and the ball-in-flight phase. Also, the duration of fixation of the experts was shorter than that of the novices during the pre-shot routine, whereas it was longer in both the ball-release and the ball-in-flight phases. Based on the protocol data, experts utilized advanced cues, such as the related angle, position, and

coordinated movements of the shooter. The visual search behavior of experts was coordinated ahead of the shooter's movement and the ball's trajectory to pick up important advanced cues. An effective visual search behavior is therefore an important factor in improving accurate judgments in this task.

### **Learner-regulated feedback enhances ball putting learning**

Ishikura, Tadao, Doshisha University

The purpose of this study was aimed to examine the effects of learner-regulated feedback on learning of ball putting and to analyze the changes of putting movements. Thirty-six participants putted the golf ball using the hammer made from rubber, and performed the task which stops a ball on the line 3m away from the starting position. After a pretest, participants were assigned to one of three groups (100% KR, 100% KB, LRF) and practiced 50 trials. Those in the 100% KR group performed the task in its natural context, while those assigned to the 100% KB group heard the location at which the ball stopped after every putting. Those of the LRF group were provided with knowledge of results (KR) only when a participant demanded the distance information at which the ball stopped. Participants of 100% KB and LRF were not able to see a ball after hitting the ball. All participants then performed the immediate test after practice trials, and performed the retention test on the next day. The result of analysis showed that, in each group, a total variability (TV) and a variable error (VE) at immediate test were less than those at pretest. Also, in the immediate test and the retention test, the TV and the VE of the LRF was less than that of the 100% KR. Third, in each group, there was more distance which the head moved during putting at immediate test than that at pretest. In the relative location between participants' head and head of hammer during putting, the tendency for the immediate test to synchronize rather than the pretest was shown. These results suggest that the learner-regulated feedback is effective in learning of the ball putting but does not influence on the differences in putting movement compared with the natural practice condition.

### **Examination of performance changes on a continuous task when adding a secondary electronic task**

Jeansonne, Jennifer J, Kiran B Sehgal, Southeastern Louisiana University

The use of electronic gadgets has gained popularity especially with the combination of our high-paced lifestyles; however we use these devices without regard to the effects on motor performance, reaction time and mistakes. The need to educate individuals on the negative effects of multi-tasking on motor performance is critical (Hosking, Young & Regan, 2009; Wang, et al., 2009). The purpose of this study was to compare performance on a balance system (Biodex) and simple calculations (same for all) on a calculator, when performed separately and concurrently (dual task). Significant changes in time and performance were observed. Participants ( $n = 23$ ) performed 2 days of testing with 2 sessions each. Day 1 participants performed 1 practice trial of 20 simple math problems. Problems were read to participant and they entered into the calculator and called out answer. The same procedure was used for the 2nd trial; however, time taken to perform the 2nd set of math problems and the number of wrong answers was recorded. Subjects then learned how to use the balance system and performed limits of stability test after practicing. Time and performance scores were recorded. A week later participants returned and performed the balance test and math calculations concurrently. Time, errors and performance were recorded for each. Time to perform math calculations increased on average 84 (+/- 10.6) seconds with an increase

on average of 2 (+/- 0.5) errors. The performance on the balance test decreased by 13.5 (+/- 2.5) points, and time increased on average by 32 (+/- 2.7) seconds. Dependent t-test compared single to dual performance scores. Results showed significant differences ( $p < .05$ ) for all measures comparing single to dual task performances. The continuous motor skill of balancing and the button pressing on the calculator are simulations of driving and texting, emailing or calling. These significant results indicate the negative effects on motor performance and the danger of these activities when performed while driving.

### **Tactile attention in ball catching**

Juravle, Georgiana, Charles Spence, Oxford University

Three experiments are reported in which we investigated the distribution of tactile attention during ball catching. Thirty participants took part in Experiment 1, split according to their basketball experience: none, intermediate (5-12 years of leisure play), or advanced (20 years or plus, 1st division players). In every trial, participants had to catch a bouncing basketball thrown at them by the experimenter. The hand movement triggered a short tactile pulse in a tactor attached to their wrist to which they made a speeded response by saying 'BALL'. The pulse was presented at one of four different hand positions: at the initiation of the movement, at an angle of 25° of the moving hand with respect to the body, at an angle of 45°, or when the hand reached forward and formed a straight angle with the body. The results showed faster RTs when the vibration was delivered to the moving hand, as compared to the hand at rest or catching the ball. Moreover, expert basketball players were significantly faster to respond to the tactile stimulus as compared to the novices. In a second experiment, we investigated whether this effect was specific to the tactile modality or whether instead it extended to other modalities, such as audition. We therefore ran the same experiment with a group of 9 novice participants. Participants were now required to respond to an auditory signal delivered over headphones. The results showed the same pattern as in Experiment 1, with faster RTs in response to an auditory signal delivered when the hand was moving, as compared to the other hand locations. In a third experiment, 9 participants gave a speeded vocal response to a vibratory stimulus delivered at their resting hand at four ITIs corresponding to the average timings of stimulation in the previous experiments. The results showed comparable performance for the four tested ITIs. These results highlighting similar processes involved in tactile and auditory response times during ball catching movements are discussed with regard to the current theories on attention and sensory suppression.

### **Neural substrates for motor memory consolidation depend on practice conditions: A double dissociation of primary motor cortex and dorsolateral prefrontal cortex**

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Different practice conditions invoke different levels of cognitive processing during motor practice and lead to different retention performance (learning). However, little is known about how differences in practice condition affect the post-practice consolidation processes that are critical for retention of skills. The purpose of this study was to investigate how constant (CP) and variable (VP) practice conditions modulate the role of two neural substrates: primary motor cortex (M1) and dorsolateral prefrontal cortex (DPC) during the early motor memory consolidation phase. We used repetitive transcranial magnetic stimulation (rTMS) to

specifically perturb M1 and DLP immediately after task practice under constant and variable conditions, and observed the effect of that perturbation on the 24-hr retention test (learning). Fifty nine young adults were randomized to 6 experimental groups (2 practice conditions  $\times$  3 rTMS conditions): no rTMS (CP, VP), M1-rTMS (CP-M1rTMS, VP-M1rTMS), and DPC-rTMS (CP-DPCrTMS, VP-DPCrTMS). The constant practice groups practiced a discrete ballistic arm movement task under single amplitude parameter condition, while the variable practice group practiced the task under different amplitude parameters. In the rTMS groups, we applied 1Hz rTMS at 110% motor threshold intensity for 10 minutes over one of the two neural substrates (M1 and DPC) immediately following practice. We compared learning of the M1- and DPC-rTMS groups with the no-rTMS control groups. The 24-hr retention test indicated that variable practice was more beneficial to motor learning than constant practice. More importantly, rTMS applied post-practice over M1 disrupted motor learning in the constant but not variable practice condition. On the contrary, rTMS applied post-practice over DPC disrupted motor learning in the variable practice but not constant practice condition. Our findings indicate that variable and constant practice, each previously known to engage different degrees of cognitive processing, also depend on different neural substrates for motor memory consolidation.

### **The role of lower-limb proprioception in the multi-segmental postural coordination of professional ballet dancers**

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Ballet dancers are known to exhibit heightened proprioceptive awareness and enhanced levels of postural control. However, it is not known if these enhanced perceptual and motor skills are related, nor has intersegmental postural coordination been measured in ballet dancers. In the present study we measured proprioception and postural coordination in professional ballet dancers and non-dancers, and determined the relation between performances of the two tasks. A joint-position matching task was used to assess proprioceptive awareness for the ankle, knee, and hip joints of both legs. To assess postural coordination we used a visual tracking task in which participants tracked the fore-aft motion of a virtual target by standing on one leg and swaying so as to maintain an equal perceived distance between their head and the target at all times, at frequencies of 0.20 and 0.60 Hz. *SD* of relative phase between the ankle and hip joints was used to index coordination stability during task performance. For joint-matching, a significant joint  $\times$  group interaction was observed,  $F(1,54) = 44.44, p < .001$ . Post-hoc tests indicated that non-dancers were less accurate than dancers in matching ankle [ $t(54) = 15.66, p < .001; M = 4.64 \pm 1.87^\circ$ ], knee [ $t(54) = 7.91, p < .001; M = 4.69 \pm 1.58^\circ$ ], and hip [ $t(54) = 6.08, p < .001; M = 5.50 \pm 1.68^\circ$ ] joint positions; the interaction occurred because this difference was magnified at the ankle. For *SD*, a significant main effect was present for group,  $F(1,54) = 4.38, p = .041$ , indicating that overall, dancers exhibited lower mean *SD* ( $M = 30.86^\circ \pm 17.79^\circ$ ) than non-dancers ( $M = 40.15^\circ \pm 18.43^\circ$ ). Joint position matching and postural coordination variability were correlated for ankle ( $r = 0.304$ ) and knee ( $r = 0.311$ ; all  $p < .05$ ), although that relation was driven primarily by the group differences. These results demonstrate that dancers are more sensitive to proprioceptive information in their lower limbs, and this may be a mechanism driving their increased coordination stability.



**A quantitative and qualitative movement analysis of coordination in expressive movements**

Kim, Seonjin, Seoul National University; Sooyeon Kim, Seoul National University; Jong-seong An, Seoul National University; Hwansoo Kim, Seoul National University

The purpose of this study was to examine the relationship between human expressive movement and motor coordination by analyzing coordinated inter-limb movement. Expert and novice dancers were selected to participate in this study. 6 different conditions were applied; strong and light weight expression, and in-phase and anti-phase inter-limb movement depending on the type of breathing movement. For the experimental task, the subject performed an upward and downward right arm movement while bending and extending the lower limbs. To analyze the weight expression factors, quantitative and qualitative variables were examined. For the quantitative analysis, kinematic and kinetic variables, jerk cost and maximum force were analyzed. For the qualitative analysis, qualitative movement changes, movement shape and changes of flow were analyzed by professional movement analyst, and subjects' perception of weight expression were examined by an interviewing. The results of this study were as follows; For light weight expression, all the subjects showed lighter and smoother performance in anti-phase than in in-phase condition. All the subjects showed the lowest jerk cost in anti-phase coordination with breathing. For strong weight expression, the experts showed stronger and firmer performance in anti-phase than in in-phase condition. However, the novices showed better performance in in-phase than in anti-phase condition. The experts' perceived weight expression rating corresponded with the result of the kinematic analysis. However, the novices' perceived weight expression rating was different from the result of the kinematic analysis.

**The effects of bilateral movement training on upper limb function and neural activity of cerebral motor cortex in chronic stroke patients**

Kim, Seonjin, Seoul National University; Jehkwang Ryu, Seoul National University; Min Joo Kim, Seoul National University; Sang Bum Kim, Chung-Ang University

This study compared the neurophysiological and behavioral changes associated with two rehabilitation protocols: unilateral and bilateral movement training. 19 chronic stroke patients were randomly assigned to two training protocols with 12 weeks training sessions. Each session consisted of 5 sub-tasks: T-bar sliding, Wrist curl, Arm curl, Forearm twist, and Finger ladder. The tasks were performed with both impaired and unimpaired arm moving synchronously (bilateral training) or with only the impaired arm moving (unilateral training). To compare the changes associated with rehabilitation protocols, we performed behavioral and neurophysiological assessments before and after the interventions. The behavioral states of the patients were measured by Fugl-Meyer Assessment, Box and Block Test, and 3D Motion Analysis. The neurophysiological states were assessed by fMRI. FMA and BBT were used for the assessment of functional abilities of the affected upper limb. Kinematic measurements of the upper limb movements were measured by QUALISYS 3D motion analysis system. Neurophysiological measurement was performed with a 1.5T fMRI scanner. The tasks were forearm supination-pronation, wrist extension, and finger opposition. One-experiment-run contained sequences of right hand movement-rest-left hand movement-rest-bimanual movement. A total of 3 runs was performed. The results of this study are as following. First, FMA and BBT scores were significantly improved with movement training protocol, and bilateral group showed higher scores than unilateral group. Second, kinematic

measurement showed that the movement trajectory of affected arm became smoother for the bilateral movement training group. Third, patients in bilateral group showed increased contralateral and ipsilateral hemispheric activation during paretic arm movement. In conclusion, there are neurophysiologically and kinematically positive changes after rehabilitative training in both groups, but more significant improvement is shown in the bilateral group.

### **Practice schedules and time scales of motor learning**

King, Adam, Karl M. Newell, Pennsylvania State University

The conclusion about practice schedule distributions from Lee and Genovese's meta-analysis (1989) indicates that the effect of practice trial distribution is largely as a performance variable with little influence on learning. In spite of the distinction between performance and learning, little work has investigated these two variables separately to determine how they are influenced by practice distribution. Using a weighted space and time performance score (PS) function as feedback to channel the subjects to a specific space-time task demand relating to an equal emphasis of speed and accuracy, participants learned to trace a six-point star over practice trials. Experiment 1 participants ( $N = 16$ ) were randomly assigned to either a no break time interval between sessions or 24 hr break between sessions; and all practice trials were performed under a distributed trials condition. Experiment 2 ( $N = 16$ ) followed identical groupings, but all practice trials were performed under a massed condition. Individual data were fit to a 6 parameter two time scale model (Newell et al., 2009) that isolates a persistent learning and a transient adaptation time scale to investigate the influence of practice schedule distribution in terms of these separate processes. Multiple one-way ANOVA were run on the time scale parameters. The results showed a significantly larger warm-up component for the groups with 24 hr time interval between practice sessions ( $p < .01$ ). The practice trials factor showed a significant difference for the exponent of the adaptation time scale ( $p < .05$ ), whereas the slow time scale growth rate did not differ significantly. The findings from the model fitting approach support the notion that practice trial distribution is largely a performance variable indicated by the influence on the faster time scale of adaptation rather than the slower learning time scale of persistent change.

### **Distinguishing between primary motor deficits and apraxic impairments in Parkinson's disease**

King, Lauren K., University of Waterloo; Quincy J. Almeida, Wilfrid Laurier University; Eric A. Roy, University of Waterloo

While recent research has suggested an association between apraxia and basal ganglia damage, these higher order impairments are rarely studied in disorders with subcortical pathology such as Parkinson's disease (PD). A key concern in a PD population is how apraxia might be distinguished from primary motor deficits, and while progression of cardinal symptoms is expected with advancing neurodegeneration, little is known about the progression of apraxia in this population. Leiguarda et al (1997), identified apraxia in 27% of 45 PD cases but noted that motor symptom severity did not correlate with praxis impairment in this group of mildly affected patients (UPDRS mean = 17.4,  $SD = 8.6$ ). The Unified Parkinson's Disease Rating Scale (UPDRS) is the gold standard for assessing motor symptom severity with scores ranging from 0-108. The aim of the current study was to provide insight into the course of apraxia in PD by determining if it correlates with severity of the elementary motor deficits. If this is a causal relationship, given the asymmetrical onset of motor symptoms

in PD we would expect a greater praxis deficit in the hand with greater primary symptoms. We assessed gestural performance in 48 right handed individuals with PD (UPDRS mean = 32.9,  $SD = 11.9$ ) across both hands, and converted it to a Z-score based on performance of 16 healthy controls. Separate Pearson correlations were conducted between the pantomime and imitation tasks relative to UPDRS ( $r = -0.45, p < .0014$  and  $r = -0.58, p < .0001$  respectively). *T*-tests were performed separately for left-side and right-side affected patients, comparing left and right hand gesture performance, with no significant differences found. Therefore, while apraxia correlates with motor symptom severity, it manifests itself equally across both limbs, rather than dominantly on the side most affected by PD. It seems that motor deficits of PD and apraxia impairments are dissociable, however their relationship hints to the involvement of the basal ganglia in normal praxis, as well as primary motor function.

### **Next-state comfort in learning a vertical stick transportation sequence**

Klostermann, Andre, University of Bern; Tobias Spinnler, University of Bern; Ernst J Hossner, University of Bern

Over the last decade, the end-state comfort effect (e.g., Rosenbaum et al., 2006) has received a considerable amount of attention. However, some of the underlying mechanisms are still to be investigated, amongst others, how sequential planning affects end-state comfort and how this effect develops over learning. In a two-step sequencing task, e.g., postural comfort can be planned on the intermediate position (next state) or on the actual end position (final state). It might be hypothesized that, in initial acquisition, next state's comfort is crucial for action planning but that, in the course of learning, final state's comfort is taken more and more into account. To test this hypothesis, a variant of Rosenbaum's vertical stick transportation task was used. Participants ( $N = 16$ , right-handed) received extensive practice on a two-step transportation task (10,000 trials over 12 sessions). From the initial position on the middle stair of a staircase in front of the participant, the stick had to be transported either 20 cm upwards and then 40 cm downwards or 20 cm downwards and then 40 cm upwards ( $N = 8$  per subgroup). Participants were supposed to produce fluid movements without changing grasp. In the pre- and posttest, participants were tested on both two-step sequencing tasks as well as on 20 cm single-step upwards and downwards movements (10 trials per condition). For the test trials, grasp height was calculated kinematographically. In the pretest, large end/next/final-state comfort effects for single-step transportation tasks and large next-state comfort effects for sequenced tasks were found. However, no change in grasp height from pre- to posttest could be revealed. Results show that, in vertical stick transportation sequences, the final state is not taken into account when planning grasp height. Instead, action planning seems to be solely based on aspects of the next action goal that is to be reached.

### **The relationship between motor planning and freezing of gait in Parkinson's disease**

Knobl, Patricia E, Wilfrid Laurier University; Lauren K King, University of Waterloo; Quincy J Almeida, Wilfrid Laurier University

Freezing of gait (FOG) is a severe mobility impairment that is poorly understood in Parkinson's disease (PD). While FOG is assumed to be a motor output problem, recent research has recognized that alternative mechanisms such as sensory or perceptual deficits might also contribute to FOG. Interestingly, the most common occurrences of FOG (e.g., while turning, in narrow spaces, and stressful or time constrained situations) all require a change

in motor plan. Thus, the aim of the current study was to examine how the need to change motor plans might influence gait in individuals with PD who experience FOG (PD FOG), compared to those without FOG (PD) and health controls. Thus we asked 10 healthy controls, 10 PD FOG, and 10 PD to walk straight through a narrow doorway in three experimental conditions i) no cue ii) early cue and iii) late cue. In both the early and late cue conditions, patients were instructed that if a cue appears on the ground (just beyond the doorway), they should change their plan of action from walking straight, to walking through the doorway, stepping on the cue light and then turning around to walk back to their start position. Since within-trial step-to-step variability is a common precursor to FOG, it was our main outcome measure. A significant main effect of group was found ( $F(2, 27) = 12.27; p < .01$ ), revealing that PD FOG walked through the doorway with significantly more variability than both the PD and healthy control group. A main effect was also found between conditions ( $F(2, 54) = 7.97, p > .01$ ) demonstrating that all participants were most variable when the cue was presented early (i.e., gait initiation) and least with no cue to prompt a change in motor plan. No significant interactions were found between conditions and group, although a trend shows that PD FOG walked with greater step length variability during the late cue condition compared to both the no and early cue conditions. While it is clear that PD FOG are profoundly affected by narrow doorways, motor planning is an important issue that needs to be considered further in FOG.

#### **Attention and time constraints in performing and learning a table tennis forehand shot**

Koedijker, Johan M., University of Bern; Jamie M. Poolton, Hong Kong University; Jon P Maxwell, Hong Kong University; Raoul R.D. Oudejans, VU University Amsterdam; Peter J. Beek, VU University Amsterdam; Rich S.W. Masters, Hong Kong University

Evidence suggests that novice performance of a motor skill is harmed if attention is distracted away from the task, but not if it is focused on the task, whereas the opposite pattern occurs for expert performers (e.g., Beilock, Carr, MacMahon, & Starkes, 2002). Beilock and colleagues (Beilock, Bertenthal, McCoy, & Carr, 2004, Beilock, Bertenthal, Hoerger, & Carr, 2008) showed this phenomenon in golf putting by manipulating the time available for movement execution in a speeded (maximum 3 sec to complete each putt) versus an accuracy condition (take as much time as necessary). Novices were less accurate but experts more accurate in the speeded condition relative to the accuracy condition. In addition, the more time skilled players took to putt the worse they performed. In Experiment 1, we sought to replicate and extend the work of Beilock and colleagues from a closed, self-paced skill (golf putting) to a repetitive, externally-paced skill – the forehand shot in table tennis. In concordance with the previous findings, skill-focus conditions and reduced ball frequency disrupted the accuracy of experts, but dual-task conditions and increased ball frequency did not. For novices, the effects were reversed. In Experiment 2, we extended these findings by instructing novices either explicitly (five traditional training instructions that detailed how to hit a forehand) or by analogy (one instruction in the form of a metaphor encompassing the complete movement). Explicitly instructed novices were less accurate in dual-task conditions than in single-task conditions. Analogy instructed novices, however, maintained accuracy under dual-task conditions, implying that performance following an analogy instruction is less dependent on attention than performance following explicit instructions. Nevertheless, participants in both conditions lost accuracy when ball frequency was increased. This finding suggests that not attention, but motor dexterity, was inadequate under high temporal constraints.

### Using scanning trials to assess interpersonal coordination dynamics

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Interpersonal coordination dynamics have traditionally been investigated using only relative phase patterns of in-phase and anti-phase and, have been found to spontaneously show patterns of coordination similar to those found in within-person coordination with in-phase being performed more accurately and more stably than anti-phase. In the present study we found that single (within person) and pairs (between person) of participants could very effectively produce a large range of coordination patterns that typically act as repellers (from  $\Phi = 30\text{deg}$  to  $150\text{deg}$  in  $30\text{deg}$  increments) after only 6 minutes of practice. Two features of the experimental context allowed for the rapid tuning of patterns: (1) feedback was presented as a cursor that integrated the phase relation of the two participants moving around a Lissajous plot representing the required coordination pattern; and (2) the removal of perceptual (vision of limbs) and attentional (metronomes) distractions. The pattern of results within and between person coordination where not different from each other, with in-phase being less variable but all the other relative phases not being different from each other. It has previously been suggested that this pattern of results during within-person coordination might be due to a certain degree to the effect of neural crosstalk, which is supposedly complementary with the activation of homologous muscles during the in-phase pattern but not when performing other patterns of coordination. In the present experiment no direct neuromuscular linkage between the limbs of two participants was present, therefore the reduced variability observed during in-phase coordination may suggest increased stability resulting from neural crosstalk for the within person condition but not in the between person coordination. The notion that neural crosstalk can serve a stabilizing roll when the two limbs are doing the same thing but not destabilize coordination when the two limbs are doing different things, however, is not consistent with the current theoretical perspectives on bimanual coordination.

### Development of movement variability in unconstrained reaching movements

Krüger, Melanie, Thomas Eggert, Andreas Straube, Ludwig-Maximilians-University Munich

Reaching and grasping are elementary for daily life. At the same time, movements of the upper limb are very complex because of the high number of redundant degrees of freedom that need to be controlled. However, many results indicate that healthy subjects execute reaching movements with high consistency and only a small absolute error in final position accuracy. Recent research dealt with the variability in human motor control. Whereas most of this work focused on movement endpoint variability, less research has been done focussing on the development of variability during the execution of complex reaching movements. In this study we investigate the development of variability over the time course of execution in unconstrained reaching movements. Subjects repetitively had to reach for and grasp a cylindrical handle located at one of three possible positions within the anatomical range of motion. The availability of visual information was changed between experimental groups so that subjects were able to see the handle all the time (group 1), only before movement onset (group 2) or only 100ms at movement onset (group 3). In a further experimental condition subjects were challenged by a high accuracy demand while vision was permanently available (group 4). Movement in the 7 joint angles of the arm were recorded and the variance across trials was analyzed at 10 normalized points of time for each joint angle and handle position. Results show that the average variance across joint angles increased in the first half of the movement and stabilized in the second half in experimental conditions with low accuracy demand and independent of the availability of vision. With high

accuracy demand average variance decreased much stronger. Analysis of individual joint angle variance showed that this interaction also occurred for four out of the seven joint angles. This suggests that those four joint angles are controlled more closely under high accuracy demand than the others.

### **Variability in outcome performance and whole body movement pattern**

Ku, Ya-Ting, Hsiu-Hui Chen, Taitung University

It has been found the outstanding athletes could adjust their performance functionally to satisfy the task constraint. Purpose: This study examined the expertise in terms of variability on outcome performance and whole body movement pattern in badminton players of different skill level. Method: The participated players were two first level and two second level according to their competition performance. They were required to play 20 shuts of forehand dropshots, smashed and clears each to a 170cm wide and 170cm long target at both fix stoke position and moving stroke position. The landing location of each strokes and the three dimensions coordinates of the major segments of whole body were recorded. The mean and stander deviation (*SD*) of location of landing were calculated. The principle component analysis (PCA) was implemented on three dimensional coordinates. Results: The *SD* of landing position for players of first level was significantly lower than that of second level players in each kind of strokes. The distribution of smashes and clears were closer to the center than that of dropshots of first level players. Two eigenvalues could explained more than 90% of variance in each representative (those with similar landing positions) strokes. The projections for first level player showed more divergence than those of second level players in particular for minor components. The difference among strokes could be found in component vectors in which the lateral movement on right-shoulder, right-hip, left-ankle and right-knee weighted differently. The consistency of movement pattern decreased for second level players in moving stroke location in terms of projection and coefficients in component vectors. Conclusion: The expertise on badminton reveals in the pattern of variability when the players play in different strokes and changing the stoke conditions.

### **The hands tremor of piano players**

Lai, Shih-Chiung, National Taipei College of Nursing; Ru-Lin Lai, Nation Taiwan University of Arts

The purpose of the study was, via the Pullman spiral analysis (Pullman, 1998), that seeing the finger tremor as the index of movement variability researchers could examine the degree of severity (DOS), movement smoothness, and movement irregularity of the high skill piano players. Twenty piano major college-aged students (21.75 / 0.65 years old) with right dominant hands participated in the study. They were asked to hold an electronic pan and draw several spirals in natural position, both hands executing the task for 10 times. There was 2-hour piano practicing with a rather fast tempo between the pre- and post- tests. The before/ after piano playing and the right/left hands were the two independent variables in the current experiment. The major dependent variables included the DOS, movement smoothness, and the movement irregularity. The two-way ANOVA was applied to examine the effect of the piano playing and hands on the dependent variables above,  $\alpha \leq .05$ . It was found that: (1) no significant differences existed in piano playing,  $F(1, 19) = 2.15, p > .05$ , nor in right/left hands,  $F(1, 19) = 2.00, p > .05$ ; and (2) the right hands are apparently smoother than the left hands  $F(1, 19) = 59.68, p < .05, \eta^2 = .76$ , however, the left hands showed more regular features than the right ones  $F(1, 19) = 24.37, p < .05, \eta^2 = .56$ . The conclusion

of the study was that although there seems no tremor effect on the piano players' hands, their right hands represent higher irregularity with smoother playing, but synchronously their left hands imperfectly playing regular chords.

### **The geometry of the swing path in experts and novices**

Lan, Yu-Ching, National Yang-Ming University

The golf swing is a double pendulum movement involving coordination between two arms (hands) and club (Cochran and Stobbs, 1968; Budney and Bellow, 1982; Milburn, 1982). In order to consistently and accurately hit the ball, the control and coordination of the degree of freedom of all joint movements versus space and time in the body became a crucial factor. When studying the swinging motion, the motion resembled a hub path by wrists and club. The purposes of this study were to compare golfers at a novice level to professional golfers in (1) the range of swinging motion, (2) was there significant variation in the movement pattern under swinging motion? This study used the Gypsy Gyro (IGS190) system to device with the measurement of 120Hz to collect 4 professional golfers and 3 non-experienced novices using the 9 iron club under full swing movements. Because of the sequences of body and arm actions in the downswing (BS) are the reverse of those in the backswing (DS). Describing the BS and DS relative to the arc phrasings are presented and were found that the arc of DS was inside the BS in the professional golfers with right and left hand. This phenomenon was coming from turning the body Linning (1994). As shown in the repeated measures ANOVA, the range to BS and DS in heights of swing before impacting (4.8cm, 12cm, 24cm, 36cm, 48cm) were significant in experts and novices ( $F(1,5) = 8.06, 8.017, 16.889, 13.983, 9.797; P < .05$ ). The swing planes of the professional golfers showed near co-planarity, as indicated by the degree to which the BS and DS through the swing planes were parallel. There were two coordinative strategies to the arc of DS and BS in novices that were (1) DS arc was outside-in the BS and (2) DS arc was inside-out the BS. There was more overlap in the arc of BS and DS to novices than professional golfers. Novices, who had a non-planar swing, experienced difficulty hitting the ball consistently and accurately. The results revealed that the coordinative strategy appeared to have utilized the planar geometry of the swing to achieve a successful ball-strike.

### **Questioning the continuous pursuit tracking task as explanatory of implicit motor learning**

Lang, Alexandre, University of Technologie of Compiegne

Pew's experimental paradigm (1974), which relies on continuous pursuit tracking tasks, is now recognized as an adequate paradigm for the study of implicit motor learning. Traditionally, tracking patterns are divided into three segments: the first and third segments are random patterns, whereas the second is repeated on each trial, unknown to the participant. Unfortunately, the specific improvement of the performances on repeated segment is not still observed during pursuit tracking. In this task, the participant has to deal with two simultaneous visual stimuli: a target to be tracked and a kinematic feedback of his/her movement. We consider that the conjunction of these stimuli form an augmented feedback related to a knowledge of results (KR) in terms of negative effects of guidance, i.e. it encourages the participant (i) to be dependent, (ii) to make corrections and (iii) to ignore sources of intrinsic sensory feedback. Indeed, the distance between the target and the kinematic feedback provide the participant with key information about the effects of his/her movement compared

to the objective of the task. We hypothesized that the presence of kinematic feedback in the tracking pursuit is harmful to the specific improvement of motor performances. Thus, we proposed a task during which the kinematic feedback remains invisible for the participant. It results in a clear differentiation of the performances between random and repeated segments. Indeed, deletion of kinematic feedback allows the participant to focus his/her attention on the general shape of the movement of the target, rather than on the relative position of those stimuli. However, the movement reproduction task does not allow the participant to constitute a motor learning because global performances degrade during practice, which is supposedly connected to the absence of KR. These results lead to question the relevance of continuous pursuit tracking as an appropriate task to treat implicit motor learning. Pew, R. W. (1974). Levels of analysis in motor control. *Brain Research*, 71, 393-400.

### **Quiet eye training in golf putting: Can motor skill be improved by perceptual skill training?**

Lee, Seungmin, Chungnam National Univ.; Dong-Wook Han, Jeon-Buk National University; Seungha Park, Ewha Womans University

The purpose of this research was to determine if quiet eye (QE) training would improve the putting accuracy of novice golfers. For this research, twenty-one undergraduate students who had no experience in golf putting participated voluntarily. Participants were randomly assigned equally to a QE training group, a physical training group, and a control group. QE is a final fixation or tracking gaze that is located on a specific location or object in the visuomotor workspace and viewed as an objective measure of optimal perceptual-motor coordination. The experiment consisted of pretest, training phase, and posttest. All participants were required to do putting on a sloped and non-sloped green at randomized distances of 2.5m. After pretest, the QE training group received feedback on their QE and viewed a professional golfer's QE pattern. The control group performed no training at all during the intervention period. Eight training sessions of 20 minutes duration were conducted over a three week training period between the pre and post testing. The participants QE, QE dwell time, gaze control pattern and accuracy were measured. The conclusion of this research were drawn as follows. QE training group and physical training group improved significantly, pre to post, in non-sloped putting accuracy. In sloped condition, QE training group significantly improved their accuracy in posttest compared with physical and control group. QE training group significantly changed their QE duration and QE dwell time in sloped and non-sloped condition. However physical training and control group did not significantly change QE duration and QE dwell time.

### **Visual search patterns and reaction movement in Taekwondo according to expertise**

Lee, Jonghwa, Seonjin Kim, Younghoon Song; Seoul National University

This study was to investigate the visual search patterns and reaction movement in Taekwondo according to expertise. In this study, subjects consisting of 5 experts, 5 intermediates, and 5 novices were selected to participate in this experiment. The 4 different kick images were given to subjects 5 times randomly. Visual search patterns of the phases in 1 and 2 were analyzed with using eye movement tracking system (EMR-9 of NAC). In addition, reaction movement was analyzed through video camera. The data was analyzed with One-way ANOVA and post hoc test (LSD). The results of this study were as follows: Firstly, in phase 1, experts illustrated the lower eye fixation frequency, longer eye fixation time, and lower



number of eye movement compared to intermediates and novices. In the location of eye fixation, experts showed longer fixation time on chest, and intermediates and novices showed longer fixation time on thigh. Furthermore, experts showed eye movement searching patterns from chest to head or abdominal, and intermediates and novices showed patterns from thigh to abdominal and abdominal to thigh. Secondly, in phase 2, there was no difference in eye fixation frequency and eye fixation time among groups, but the number of eye movement in experts was smaller than intermediates and novices. In the location of eye fixation, experts illustrated longer fixation time on chest. However, intermediates showed longer fixation time on abdominal and novices showed longer fixation time on thigh. Moreover, in eye movement pattern, experts showed patterns usually fixed their eye on chest, intermediates tended to fix their eye on abdominal and to move their eye from thigh to abdominal, and novices usually fixed their eye on abdominal and thigh. Finally, in reaction movement, reaction movement time of experts was faster than those of intermediates and novices. In reaction movement type, experts usually showed Dollyochagi (roundhouse kick), and intermediates and novices usually showed type of avoiding skill.

### **Skill-based differences in visual search strategy according to road complexity and secondary task during simulated driving**

Lee, Hye-In, Ewha Womans University; Seung-ha Park, Ewha Womans University; Jung-Hyun Ji, Ewha Womans University; Ji-Hea Lee, Ewha Womans University

The purpose of this study was to examine the skill-based differences in visual search strategy according to the road complexity and the mathematical question as secondary task for dual-task during simulated driving. A total of twenty subjects (10 experienced and 10 inexperienced drivers) participated in this experiment. All subjects performed driving task on simulated road with two different complexities (expressway vs. city street), and were required to do the addition with single or double digit, such as 6 9 or 77 25, simultaneously. For the experiment, an eye movement recorder (NAC EMR-9) and driving simulation system were used. Dependant variables for visual search strategy were mean fixation duration for verifying search rate, and fixation locations. Fixation locations were examined by analyzing the fixation duration and the number of fixation on far and near zone in running lane, both sides lane, rear view mirror, side mirror, and speedometer. Data were analyzed by ANOVA with repeated measure on situation complexities and secondary task levels, and fixation locations. Results showed that experienced drivers generally had lower mean fixation duration and gazed longer and frequently at far zone, not near zone. Experts' gaze behavior was not affected by the road complexity and the level of secondary task. On the other hand, inexperienced drivers mostly focused on near zone, which was more noticeable as the level of road complexity and secondary task increased. In conclusion, gaze behavior for expert drivers is characterized by higher search rate and by focusing on far zone of running lane. We also confirm that the road complexity and the secondary task have an effect on driver's gaze behavior, especially for inexperienced drivers.

### **Visuo-motor adaptation relies on kinesthetic representation of movement directions**

Lex, Heiko, Bielefeld University; Matthias Weigelt, Saarland University; Yaochu Jin, Honda Research Institute - Europe; Thomas Schack, Bielefeld University

The 'optimal integration model' suggests a weighting of information from different modalities in the brain. This study investigates the role of kinesthetic movement experience for the representation of movement directions. In the first part, 45 participants performed straight,

ballistic center out movements using a classical pointing paradigm (baseline condition), and then adapted to a disturbance of visual feedback in terms of a left-right reversal (adaptation phase). Their performance was recorded under two baseline conditions (without visual disturbance) and two adaptation conditions. In both cases, movements were executed with and without real time feedback about the actual hand position. To analyze differences in adaptation gain after the adaptation phase, participants were sub-divided into one of three groups (i.e., poor, moderate and good adapters) according to an adaptation index. In the second part, participant's kinesthetic representation of movement directions was measured with the structure dimension analysis-motorics (SDA-M). This method required them to perform pairwise movements into two out of twelve different directions (spread regularly around a full circle) and to compare these movement directions in terms of their kinesthetic similarity in a splitting procedure. Each single direction was compared to every other direction in the circle. The resulting representation structures of the three different adaptation groups, which were derived from a cluster analysis on the splitting decisions, were compared with an invariance measure. Good adapters clustered movements that represent the orthogonal axes of the circle, reflecting a global representation of directions. Poor adapters cluster directions within 30° around the circle, signifying a nearest-neighbor strategy and thus, a local representation of directions. In line with the optimal integration model, it is suggested that kinesthetic representations of the sagittal and horizontal axes (i.e., global representation) benefits sensorimotor adaptation to left-right reversal of visual feedback.

### **Neuromuscular activity of the lower extremities and fall in Chinese female elderly**

Li, Zongtao, Beijing Sport University / Wayne State University; Dongmei Luo, Beijing Sport University; Yimin Zhang, Beijing Sport University; Qin Lai, Wayne State University

Fall is an increased risk threatening health to the female elderly in China. Recent evidences revealed that the decline of neuromuscular functions in the lower extremities was one of the major factors contributing to fall (Lajoie & Gallagher, 2004). Although the latency of reaction to unexpected perturbation has been identified for prediction of fall, how the activities of specific muscles in the lower extremities are related to fall among the elderly remains to be investigated. The main purpose of the experiment was to determine whether fall history and repeated trials affected neuromuscular activities in the lower extremities on a perturbation task. 42 female volunteers (age: 60 – 80) without movement disabilities were classified with their falling history (fall vs. non-fall). Participants stood on a customized platform in order to maintain balance when the platform was unexpectedly tilted to one side for 3 trials. The surface EMGs of tibialis anterior (TA), peroneus longus (PL), and gastrocnemius lateralis (GL) were collected for analyses. The interested dependent variables were reaction time (from perturbation to initial EMG), peak time (from initial EMG to peak amplitude), integrated EMG, and peak amplitude. A 2 (fall vs. non-fall)  $\times$  3 (trials) ANOVA with repeated measures on trials demonstrated the elderly with fall history produced greater latency (RT) in neuromuscular reaction to perturbation,  $F(1, 40) = 4.09, p < .05$  for TA,  $F(1, 40) = 6.55, p < .05$  for PL, and  $F(1, 40) = 5.73, p < .05$  for GL, compared to ones without fall. However, the fall history didn't affect peak time, integrated EMG, and peak amplitude. In addition, the differences were significant for practice trials with faster reaction time on the last trial for all the three muscles. Practice also produced a reduction on peak EMG amplitude and the first 200 ms integrated EMG for TA and PL. The present findings indicated that the muscles' reaction time for unexpected perturbation was a key factor for falls and repeated trials effectively decreased response latency.

**Static balance tests in relation to fall risk index and fall history in the female elderly**

Li, Zongtao, Beijing Sport University / Wayne State University; Qin Lai, Wayne State University; Dongmei Luo, Beijing Sport University; Yimin Zhang, Beijing Sport University

Decline in balance caused by aging is highly related to fall in the older adults. Recent evidences demonstrated that the center of pressure (COP) movements in a static balance test was an effective tool for clinical diagnosis and fall prediction in the elderly (Era, et al., 2006). However, it was unclear which parameters in different static tests were reliably correlated to falls in the female elderly. The purpose of this study was to search for the relationship between static balance tests and fall risk and fall history. Healthy female older adults ( $n = 30$ , age: 60-80) from an urban setting in China were recruited to participate in the research. An informal consent was acquired prior to the tests. All the participants were assessed with a fall risk index on Biodex Balance System after a questionnaire screen about their fall history. Then, they were asked to stand on a triangular force platform (Metitur Good Balance System) for four different static balance tests including biped standing with eyes open and eyes close, tandem standing, and single foot standing. Each test lasted 15 s. Total distance and mean speed of the COP sway on lateral or horizontal direction were computed as dependent variables. A stepwise multiple regression analysis identified horizontal speed on tandem standing ( $F = 15.03, p < .01$ ) and lateral speed on single foot standing ( $F = 7.14, p < .05$ ) were the factors to predict fall risk. Further, Pearson's correlation analysis detected fall history had a strong relation with COP lateral movements on single foot standing ( $r = .433, p < .05$  for distance;  $r = .472, p < .05$  for speed), and with COP horizontal movements on tandem standing ( $r = .374, p < .05$  for distance;  $r = .386, p < .05$  for speed). A similar strong relationship was revealed for fall risk index too. The above findings indicated that lateral COP sway on single foot standing test and horizontal COP sway on tandem standing test were the predictors for balance risk and strongly related to fall history among the female elderly.

**On the postural and supra-postural tasks integration from contextual cues and task constraint**

Lima, Andrea C., Raymundo M. Azevedo Neto, Luis A. Teixeira, University of São Paulo

Central set is conceived to underlie indirect cortical control of postural responses on the basis of contextual cues given by extrinsic instruction and previous trials. Although the role of contextual cues in reactive postural responses has been demonstrated, scarce neurophysiological evidence has been provided on the interaction of predictability of postural perturbation and stability demand of a supra-postural task. In order to evaluate the effects of uncertainty on perturbation and supra-postural task constraint on postural control, young adults had their body balance perturbed while holding a tray in a horizontal position. Balance was perturbed by moving forward or backward a supporting platform, contrasting situations of certainty versus uncertainty of direction of displacement. Higher constraint on postural stability was imposed by a supra-postural task of equilibrating a cylinder on the tray. Performance was assessed through EMG of anterior muscles of the right leg, kinematics of the main joints involved in postural reactions and displacement of the tray. Results showed that both certainty on the direction of perturbation and high supra-postural task constraint led to decreased latency of muscular activation, and decreased angular displacement of the knee and the hip. Combination of certainty and high supra-postural task constraint produced the shortest latency of muscular activation. Such features of postural control were paralleled by decreased displacement of the tray hold in the hands. These results suggest that central

set primes and speeds up reactive postural responses from contextual cues and increased demand of stability from a supra-postural task, improving as a consequence supra-postural task performance.

### **Variation in the elite basketball player's gaze after a free-throw**

Lin, Ju-Han, Sheng-yu Hung, Jhih-Hang Song; National Dong Hwa University, Taiwan

Vickers (2007) defined three type of gaze control: targeting tasks, interceptive timing tasks, and tactical tasks. The basketball foul-shot (free throw) was defined as a targeting task, due to the fixation on the basket. When comparing expert and non-expert players, researchers found a significant difference in the distribution of the fixed location of the player's gaze (Harle & Vickers, 2001; Vickers, 1996a, 1996b, 1996c). That is, experts have a more centered distribution and a longer quiet eye. The goal of this study was to investigate this variation in gaze after free-throw shooting in elite basketball players. Twelve college basketball players ( $20\pm 2$  years,  $183\pm 6$  cm,  $73\pm 4.8$  kg) shot free throws for 5 sessions, 20 trials per session. The mobile eye was used to collect the gaze trajectory and gaze time. Entropy was used to measure the variability between hits and misses. When the players missed, their gaze trajectory changed from the anterior-posterior direction to the medial-lateral direction, and the gaze time was significantly different. These findings reveal that a shift in gaze location and the gaze time may be critical factors in successful free throws.

### **Task concatenation effect on movement speed and accuracy relation**

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

Fitts's law (Fitts, 1954) is one of the most successful models in describing the quantitative relations in human motor control. It describes the speed-accuracy trade off relation during rapid aiming tasks. Although many revisions of the speed and accuracy models have been published since the first appearance of the Fitts's law, the simple relation and the wide coverage of movement categories has provided Fitts's law a solid place in motor control research. One of the modification/violation of the Fitts's law relation has been observed in the bi-manual synchronous tasks where both hands had to move simultaneously with different Index of Difficulty (ID) (Kelso, Southard, and Goodman, 1979). In this situation, the different spatial constraints were compromised by the temporal synchrony. The purpose of the study was to extend the concept of synchronicity to examine the temporal concatenation effect on the speed and accuracy relations. Thirty participants were asked to perform the aiming tasks with 4 different sequences: 2 ID, 3 ID, 4 ID, and 6 ID sequences. Each sequence had 80 targets (repetitions). A customized computer program was used to run the tasks and collect movement time (MT) data in 1/1000 s. A traditional Fitts task was also implemented for 4 IDs for each participant to generate a base line relation between the ID and MT. The results showed that there is a systematic deviation from the linear relation of the ID and MT, namely, a non-linear relation emerged as the number of ID sequence increased. The findings are discussed in both the framework of information theory and the dynamical systems perspectives.

### **Exploring the sources of different timescale dynamics from the spatial-temporal task constraints**

Liu, Yeou-Teh, Graduate Institute of Exercise and Sport Science, National Taiwan Normal University; Karl M Newell, the Pennsylvania State University

The scaling of movement coordination that can already be produced in terms of time and space has been the most predominant task for study in motor control including the analysis of performance in movement speed and accuracy (e.g., Fitts, 1954). Newell et al. (2001) proposed that the multiple time scales of exponential functions can approximate a variety of functions of change observed in motor learning and development. The current research extended the scope of the time scale analyses to describe/explain the performance change arrived from the result of task constraints. 30 professional and 30 recreational basketball players were recruited for examination of the basketball spot shooting and the running shooting performances. 15 participants of each skill level were randomly assigned to the accuracy and the speed group. The performance score (PS) which was generated from a feedback function that had different weightings on shooting accuracy (SA) and shooting time (ST) was used to provide the feedback scores to the participants. All the participants were given the feedback scores after every 5-shot-set. ST, SA, and PS were analyzed using the next-step plot. The slope of the linear function fitted to the next-step plot was used to approximate the adaptation rate, and the de-trended data variability was used to approximate the system noise of the performance. The results showed that ST component had significantly larger slope than the SA component regardless of the weighting conditions. For the speed condition, the professional group showed the significantly smaller slopes in ST and PS and smaller de-trended variability in ST than the recreational group. For the SA component, no significant difference was found in either slope or de-trended variability between skill levels. These results provide an initial evidence of an adaptation dynamics in movement time domain and a more persistence dynamics in the spatial accuracy domain. The findings are discussed within the framework of timescale landscape and the relation between the space-time characteristics of motor tasks.

### **Force production and modulation in power grip: Chronic stroke and bimanual coordination**

Lodha, Neha, University of Florida; Stephen A. Coombes, University of Chicago at Illinois; Sagar K. Naik, University of Florida; James H. Cauraugh, University of Florida

Evidence suggests that stroke leads to a reduction in the magnitude of force produced by the impaired limb in bilateral tasks. For example, stroke survivors produce smaller forces with impaired hand in a bilateral grip task requiring equal force production on both hands in the absence of visual feedback. However, how the impaired and unimpaired limbs contribute to visually-guided bimanual force control in chronic stroke remains unclear. This study had two aims: (a) examine the influence of stroke on the execution of a bimanual isometric power grip task and (b) determine if the contribution of the impaired and unimpaired hand during task performance was related to the degree of motor impairments. Stroke and age-matched control groups performed bilateral isometric power grip contractions in a force-matching task with visual feedback. Sub-maximal force levels (5, 25, & 50%) are derived from bimanual maximum voluntary contractions. The magnitude and variability of force production for each hand was indexed by mean force and coefficient of variation (CV). Asymmetry in force production was indexed by the proportion of force contributed by the impaired hand during task performance. The degree of motor impairment was assessed by Fugl-Meyer upper extremity assessment (FMA). Two unique findings revealed that (a) relative to the unimpaired hand, the force produced by the impaired hand showed an increase in mean force and a decrease in variability and (b) the proportion of force contributed by the impaired hand approached 50% with a decrease in the degree of motor impairments. The findings suggest

that when controlling force bimanually, the impaired hand is more stable and produces a constant and higher level of force, leaving the unimpaired hand to disproportionately control the accuracy of the movement. Moreover, post-stroke motor impairments were correlated with an increase in the symmetry of bimanual force production. The findings are discussed within the scope of stroke rehabilitation and bimanual arm training.

### **Application of principal components analysis to ball trajectory data: A preliminary study on identifying rally patterns in professional tennis**

Loffing, Florian, University of Kassel; Norbert Hageman, University of Kassel; Bernd Strauss, University of Münster

Investigation of elite players' on-court performance is vital for a better understanding of the characteristics underlying exceptional achievement in racket sports. In tennis, the analysis of rally patterns (i.e., a sequence of shots) may provide players and coaches with helpful knowledge for training and match preparation (Hughes & Franks, 2004). For example, practitioners may be interested to know which components of a rally differed when (i) rallies started with a first vs. second serve, (ii) the serving vs. receiving player won the rally, or (iii) a left-/right-hander played a left-/right-hander. We chose an exploratory approach to address this issue by applying principal components analysis (PCA; Daffertshofer, et al., 2004) to time-dependent 3D ball tracking data gathered from 32 male singles professional tennis matches played on grass and hard court at major tournaments in 2005 to 2007 (data by courtesy of Hawk-Eye Innovations). PCA were run separately on trajectories that represented rallies comprising three (R3: 464 trajectories) and four (R4: 324 trajectories) shots. The eigenvector coefficients obtained from PCA for modes reaching a cumulative sum of explained variance > 90% (3: modes 1-4; R4: modes 1-5) were subjected to a total of  $54 \times 2$  (Number of Serve)  $\times 2$  (Rally Outcome)  $\times 4$  (Handedness Constellation) univariate ANOVAs, separately for service box (i.e., rallies starting with serve to the deuce vs. ad court) and the ball flight's Cartesian coordinates (x-, y- and z-direction). Overall, significant main effects were found for Number of Serve ( $\eta^2 = .024 - .099$ ) and Rally Outcome ( $\eta^2 = .020 - .258$ ) primarily on coefficients representing the trajectories' x- (longitudinal axis; i.e., from baseline to baseline) and z-coordinates (vertical axis). Handedness Constellation ( $\eta^2 = .042 - .081$ ) mainly affected trajectories in y-direction (lateral axis), indicating differences in the lateral placement of balls. From a methodological viewpoint, application of PCA to ball trajectory data proved to be useful for identifying patterns of play in tennis.

### **How changing the focus of attention affects performance, kinematics, and electromyography**

Lohse, Keith, David Sherwood, Alice F. Healy; University of Colorado

Research has found an advantage for an external focus of attention in motor learning and control; instructing subjects to focus on the effects of their actions, rather than on body movements, can improve performance during training and retention testing. Previous research has mostly concentrated on movement outcomes, not on the quality of the movement itself. Thus, we present two studies which combine surface electromyography (EMG) with motion analysis and outcome measures in a dynamic and isometric tasks. These are the first studies to include a comprehensive analysis of changes in motor performance as a function of attentional focus. An external focus of attention led to better performance (less absolute error), decreased preparation time between throws, and reduced EMG activity in the triceps

brachii. There was also some evidence of increased variability for kinematic measures under an external focus relative to an internal focus. These results suggest improved movement economy with an external focus of attention.

**The influence of attention on learning and performance: Two experiments in isometric force production**

Lohse, Keith, David Sherwood; University of Colorado

An external focus of attention (focusing on the effects of one's actions) compared to an internal focus (focusing on one's movements) is beneficial in a diverse set of tasks. We present two experiments that demonstrate this advantage for isometric plantar flexion. An external focus of attention led to improved short-term performance and reduced EMG activity (in Experiment 1). Training with an external focus of attention also led to a long-term learning advantage as well, with improved performance on retention and transfer tests one week later (with a new group of subjects in Experiment 2). Post test surveys suggests that part of this effect can be explained by subjects adopting the training focus during the testing session (in which no focus instructions were given) but mediation analysis suggests that improved retention and transfer performance is not simply a result of focus adopted in during the testing session.

**Auditory motor integration in oral and manual effectors**

Loucks, Torrey M., University of Illinois; Edward Ofori, University of Illinois; Christopher M. Grindrod, University of Illinois; Luc F De Nil, University of Toronto; Jacob J Sosnoff, University of Illinois

Introduction: The precision of volitional movements is based in part on the ability to utilize sensory information. The majority of research on sensory feedback for fine force control has focused on visuomotor processing, but not all sensory information comes from vision. Highly functional types of movement, including speech and music, are specified in auditory terms. Based on the notion that auditory-to-motor integration is a more typical form of feedback for oral articulators given their role in speech, we predicted that oral force generation would be more accurate and less variable than manual effectors in an auditory tracking task. Methods: Sensorimotor integration of auditory feedback was compared between lower lip force (oral) and index finger force (manual) control in 10 healthy subjects. The subjects were instructed to produce ramp force pulses or continuous force contractions with their lower lip and right index finger at 15% M and 30% M. A voltage controlled oscillator (VCO) generated a pure tone signal that increased linearly in frequency as force increased, which was presented to the subject's right ear. A pure tone target signal at a fixed frequency was presented to the left ear. The task was to match the dynamic signal in the right ear with the target signal in the left ear. Results: In contrast to our prediction, index finger force production was more accurate and less variable than lower lip force, particularly for rapid force pulses. In the ramp condition, subjects tended to overshoot the target with their lower lip, while finger force tended to undershoot the targets. Effector differences were not as prominent in the continuous force condition and at the higher force level. Discussion: These differences between oral and manual effectors potentially stem from physiological differences reflected in their respective functions. This pairing of continuous auditory feedback with the force tasks resembles the production and possibly early learning of musical notes or novel speech sounds.

### **A visual manipulation used to examine the neural processing underpinning skilled interceptive actions**

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Coupled interceptive actions are understood to be the result of neural processing - and visual information - which is distinct from that used for uncoupled perceptual responses. To date, the majority of studies examining skilled interception have relied on uncoupled perceptual responses; as a result it has been suggested that our current knowledge of the neural processes underpinning skilled interception is somewhat limited and biased (van der Kamp, Rivas, van Doorn, & Savelsbergh, 2008). Based on the distribution of the human visual pathways, it is understood that perceptual-cognitive responses produced by the ventral pathway rely on visual information of better quality than the relatively blurred information used for online interceptive responses produced by the dorsal pathway. As a result it was hypothesised that low levels of visual blur would adversely affect a coupled response, but not an uncoupled one. To examine the visual information used for action and perception, skilled cricket batters anticipated the direction of balls bowled towards them using a coupled hitting movement and an uncoupled verbal response in each of four different visual blur conditions (plano, 1.00, 2.00, 3.00). When anticipating outcomes with habitual (unblurred) vision, coupled responses were found to be more accurate than uncoupled ones ( $p < .01$ ), highlighting the importance of the relationship between perception and action when seeking to examine perceptual-motor skills. ANOVA testing revealed a significant interaction between coupling and blur ( $F(3,18) = 3.70, p < .05$ ). Low levels of visual blur did not affect coupled anticipation, a finding consistent with the relatively poorer visual information which online interceptive actions are proposed to rely on. In contrast, evidence was found to suggest that low levels of blur may enhance the uncoupled (verbal) perception of movement. This rather counterintuitive finding is considered in light of other psychological studies which have reported enhanced movement perception with the introduction of visual blur.

### **The effect of visual distractors on anticipatory actions**

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People must interact with moving objects on a daily basis while being bombarded by potentially irrelevant sensorial information. Empirical evidence shows that inattention can have serious consequences on peoples performance. Frequently, even though people are attentive to the task being performed (or to-be-performed), they are distracted by irrelevant visual stimuli in the environment. This study aimed to determine whether and when a to-be-ignored visual stimulus could disrupt performance in an anticipatory timing task. In Experiment 1, the participants were instructed to move their fingers in synchrony with the arrival of a moving object at a predetermined contact point on a monitor screen. On 15% of the trials, distractors appeared on the screen (beside the contact point) and the participants were instructed to ignore this event and perform the task as accurately as possible. The distractors appeared on the screen for 140 ms at various times prior to the arrival of the moving object at the contact point (-70 to -490ms). The results showed that the variable temporal error was greater than in control trials only when the visual distractor appeared 210 ms prior to the expected movement onset time (MOT). In Experiment 2, we varied the position of the



distractor according to its time of appearance so as to emulate the same spatial asynchrony between moving target and distractor which resulted in a significant effect in Experiment 1. This time the effects of the visual distractors were twofold. Firstly, the variable temporal error was greater than in control trials (CTL) when the distractor appeared at 280 and 210 ms prior to the expected MOT. Secondly, the constant temporal error showed that participants were consistently late in relation to CTL for distractors presented at 350 and 280 ms prior to the expected MOT. These results reveal that not only can we be distracted by an irrelevant stimulus during preparation for an anticipatory action, but also that the time course of the effect may depend upon the position of the distractor.

### **Self-efficacy and the development of automaticity in motor learning**

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As practice progresses, movement accuracy and attentional resources devoted to the preparation and execution of movement improve. Together, these changes support the development of automaticity and likely a growing sense of confidence in performing the learned skill. Little is known about the relationship of task-specific self-efficacy (SE) and automaticity in motor skill. The aims of this study were to investigate how task-specific SE changes across practice and to examine the relationship between SE and task performance during motor skill learning. Eighteen participants were randomized to either a Preparation or Execution group. A probe task (an audio-vocal simple reaction time (RT) task) was interpolated during the preparation or execution phase of the primary task to track the development of automaticity. The primary task consisted of a discrete arm movement with specific spatiotemporal goals. Participants practiced the primary task over 2 days with a probe frequency of 17% (48 probe trials/288 practice trials). Delayed retention tests without feedback, under single- and dual-task conditions, were administered on Day 2 and 3. Performance accuracy was assessed using the root mean square error (RMSE). Attentional demands were quantified using dual-task cost (probe RT - baseline RT). At the end of each day, participants rated their prospective SE for high accuracy performance on the primary task for the next day from 1 (low) to 5 (high). As RMSE and dual-task cost decreased, task-specific SE increased significantly, with no group effect. While Day1 task-specific SE was significantly correlated with RMSE for that day ( $r = -0.53$ ), prospective SE for future performance was not significantly correlated with RMSE on delayed retention. In contrast, prospective self-efficacy for future performance was significantly correlated with dual-task cost on retention tests ( $r = -0.54$  to  $-0.56$ ). Together, these results suggest that as automaticity is developed, the association between task-specific SE and performance may have shifted from movement accuracy to attentional cost.

### **Cortical and subcortical contributions to the control of posture and goal directed reaching after stroke**

McCombe Waller, Sandy A., George Wittenberg, Mark Rogers; University of Maryland

Reaching forward involves anticipatory postural adjustments (APAs) of the legs that precede and accompany the goal directed arm movement, and reactive responses that stabilize postural balance and prevent falling. Following stroke there are absent, delayed or diminished APAs and reactive postural responses, as well as, limitations in executing arm movements.

The extent to which impaired interactions between postural and goal intended components of movement contribute to impaired functional performance after stroke is unknown. In this case-control study we use acoustic startle and transcranial magnetic stimulation (TMS) to assess the subcortical and corticospinal contributions to posture and movement planning for a standing functional reach task. One subject with chronic unilateral ischemic cortical stroke and one healthy control participated. Subjects were presented a warning light to “get ready to reach” and a “go” light to execute the reach. To probe the subcortical and cortical control systems a startle burst (day 1) or TMS (day 2) was provided at -1500, -1000, -500, -200, 0, or 100 ms relative to the “go” cue in 30% of the reaching trials. Force plate center of pressure (COP), electromyographic and 3D motion capture were used to measure APAs made in preparation for and during the reach and to assess the kinematics of the arm, trunk, and legs during preparation and reaching. Movement of the COP preceding the reach was diminished and delayed in the subject with stroke. During startle trials, the control, but not the subject with stroke demonstrated a release of the APAs. In addition, the subjects with stroke had no response to startle in the paretic arm compared to the control who demonstrated release of a full reach. Deficits in both preparatory postural responses, as well as, goal directed reaching indicate loss of motor planning at the subcortical and cortical levels for the reach in a subject with a cortical lesion. These data demonstrate feasibility of this methodology to probe the central neural processes that control posture and goal directed movement.

**Abdominal drawing in maneuver training in healthy young adults using ultrasound imaging: Does the ability to activate the transversus abdominus in a supine position transfer to standing positions involving lifting and reaching tasks?**

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The abdominal drawing in maneuver (ADIM) is thought to engage the transversus abdominus (TrA) muscle that is important to stability of the lumbopelvic region and perhaps injury prevention. Since palpation of TrA is impossible, ultrasound imaging (US) is useful for visual and instant knowledge of performance of TrA movement and thickening. ADIM training using such feedback (FB) is taught typically in supine position. How well ADIM training in supine transfers to functional tasks in healthy adults is unknown. Thus, TrA contractions of healthy adults performing 3 trials of 5 tasks were examined pre- and post-training. Training was ADIM taught in supine position with success of contraction FB via physical therapist (PT) and visual FB via US of TrA. Inclusion criteria was met by 19 of 24 healthy adults (i.e., no ADIM training, no low back pain in past year, no abdominal surgery, BMI < 30, and ability to perform 3 successive TrA contractions during training). Five tasks (neutral standing, standing reach with object, standing extended reach with object, proper box lift, improper box lift) were performed randomly by each adult per session. Post-training tasks included goal of ADIM. TrA contractions were scored via digital recordings of each trial using software calipers ( $(\max \text{TrA} - \min \text{TrA}) / \min \text{TrA} \times 100 = \text{TrA}\%$ ). A PT and radiologist scored several randomly selected trials of 5 adults twice. ICCs were high; this PT scored remaining adults. Trials were masked to scorers. Data met RM assumptions;  $\alpha = .05$ . A 2 (pre/post training)  $\times$  5 (tasks) RM ANOVA on mean trial block TrA% indicated significant effects for training ( $p < .001$ ; ES = .81) and tasks ( $p = .04$ ; ES = .48) and no interaction ( $p = .4$ ; ES = .22). Thus, ADIM training in supine position with TrA FB via US resulted in transfer or a 46% increase in TrA contractions during functional tasks. Post hoc tests for tasks indicated neutral standing (47%) and standing reach (51%) were significantly

lower for TrA% than proper (64%) and improper (63%) box lifting. Functional task studies with ADIM training using TrA FB via US are needed.

### **Contextual interference and augmented feedback in young and old adults**

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Learning to perform a skilled behavior involving variations in task demands was found to be affected by the context of the practice session (the contextual interference effect [CI]) (Shea & Morgan, 1979) and the schedule of augmented-feedback (Young & Schmidt, 1992). Studies largely focused on young-adults found that learning under high cognitive load and/or a reduced feedback schedule enhanced learning, as measured by retention and transfer of skills. However, age-related cognitive decline occurs for a variety of tasks (Shea & Braden, 2006) making it unclear whether these effects can be generalized to elderly populations. This study examined the combined effect of practice and feedback schedule on parameter learning of young and old adults. A  $2 \times 2$  randomized factorial design was used to evaluate the effect of practice context and schedule of feedback in the acquisition of a ballistic, bi-directional lever movement pattern involving four different target locations, measured by performance in practice, retention, and transfer tests. Forty young-adults (21-30) and 35 old-adults (75) were randomly assigned to one of four conditions: low CI (targets presented in block order) or high CI (random order) and either augmented feedback after every trial or faded (systematically reduced during practice). The random practice groups had higher errors at the end of acquisition, but lower errors in retention and transfer compared to blocked practice groups. Young-adults were significantly more consistent, accurate, and faster in acquisition but not in retention and transfer. Despite expectations, faded feedback was beneficial for acquisition, but not for retention and transfer. The superior performance of random groups displays the benefits of the CI effect. This effect exists across young and old adults. Though we noted faster and more accurate acquisition performance for the Young-Adults, the beneficial effects of CI were robust for both age groups. Interestingly, results showed that reduced frequency of augmented-feedback did not enhance learning.

### **A simple weighting procedure eliminates distance effects on radial error for rifle marksmanship**

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The Army evaluates marksmanship by presenting a fixed number of targets and counting the number hit. Although this facilitates field assessments, it does not provide a detailed account of shooting accuracy. Efforts to assess accuracy by using the distance between a shot & target center of mass (TCM) introduce the problem that increasing distance magnifies the effects of angular displacement. For example, the distance between an aim-point &

TCM doubles at 100 m compared to 50 m. The purpose of this study was to determine if a weighting procedure based on trigonometric principles would allow direct comparisons of radial error (RE) for shots fired at 50, 100, & 150 m. A line drawn (bird's eye view) from the butt plate of the stock to the TCM, to the impact point, and back to the butt plate formed a right triangle, so weights were calculated as the ratio of 50 m to either 100 m or 150 m. Using an EST 2000 weapons simulator, 15 active-duty US Army soldiers each fired 10 shots from the kneeling-unsupported position with an adapted M4 Carbine. For each shot, the x- & y-coordinates with respect to TCM were recorded & used to calculate RE (straight-line distance on the target between shot & TCM). Weighted RE (WRE) was calculated by multiplying RE for the 100 & 150 m targets by .500 & .333, respectively. RE & WRE were analyzed using separate univariate ANOVAs with repeated measures. Results indicated a main effect for distance in RE ( $p < .001$ ) showing decreases in accuracy with increasing distance. Post hoc analyses revealed significant differences ( $p < .05$ ) between the 50 m ( $9.37 \pm 3.72$  cm), 100 m ( $19.64 \pm 5.08$  cm), & 150 m ( $25.89 \pm 10.08$  cm) distances. After weighting, no effects for distance were detected in WRE ( $9.27 \pm 3.21$  cm). Thus, a simple weighting procedure can be used to effectively eliminate distance effects on RE, thereby enabling the direct comparison of weighted RE scores for different target distances. This procedure provides a way to relate field-based measures with the more quantitative measures and statistical analyses used in research settings.

### **Look before you step back: A failure to replicate Koch et al. (2009)**

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Koch, Holland, Hengstler, & van Knippenberg (2009) reported a study in which locomotion direction interacted with cognitive task performance. Using a Stroop task, they found that taking several steps backwards prior to naming ink colors of stimuli facilitated performance (mean RT) relative to steps taken sideways or forwards. However, this backwards walking advantage only occurred on inconsistent trials (e.g., "blue" presented in red ink) rather than consistent trials (e.g., "red" presented in red ink) or filler trials (non-color words). The suggestion is that backwards walking is, in essence, an avoidance response and thus is naturally associated with enhanced cognitive function to deal with any implied threats. Our study represents an attempt to replicate and extend upon the Koch et al. study. We added a sitting condition in which participants sat down for several minutes prior to performing Stroop trials so as to reproduce the more typical Stroop task conditions; the original study left it unclear whether backwards walking was beneficial or sideways/forwards walking was detrimental to inconsistent trial performance. Sixty-one participants took part in a completely within-subjects design in which trial type (inconsistent, consistent, neutral) was crossed with movement condition (sitting, backward stepping, sideways stepping, forwards stepping). As with the previous study, we found a significant main effect of Stroop trial type (inconsistent trials were slower than consistent or neutral:  $p < 0.01$ ,  $\eta^2_{\text{partial}} = 0.594$ ). We also found a main effect of movement condition (sitting was associated with slower Stroop performance, but the stepping directions did not differ:  $p = .01$ ,  $\eta^2_{\text{partial}} = .061$ ). The trial type by movement condition interaction reported by Koch et al. was not replicated ( $p = 0.63$ ,  $\eta^2_{\text{partial}} = 0.012$ ). Thus we failed to reproduce the effects reported by Koch et al. suggesting that further investigation is warranted to clarify the relationship between stepping direction and cognitive processing.

### **Direction of attention can decrease the quality of gait patterns in patients with Parkinson's disease**

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Parkinson's disease (PD) often affects one side of the body more severely than the other: Such asymmetry between legs during gait is associated with gait instability and freezing in patients with PD (Plotnik, et al, 2005). Because directing attention to the dominant or non-dominant hand can exaggerate or minimize the effects of handedness on bimanual coordination patterns in healthy adults (Amazeen et al, 1997), we investigated whether the direction of attention could similarly affect gait patterns in PD. We recruited 19 participants with asymmetric PD symptoms, along with 11 age-matched healthy controls. Participants did not have dementia (defined as Mini-Mental State Exam >24). We assessed disease severity with the Unified Parkinson Disease Rating Scale (UPDRS). We used verbal cues to direct participants' attention towards their more-affected foot, less-affected foot, both feet, or straight ahead, and recorded their gait patterns with a Peak-Motus 6-camera motion capture system. Preliminary analysis of step length, velocity and frequency indicated that direction of attention affected both step length,  $F(3,48) = 2.74, p = .05$ , and step velocity,  $F(3,48) = 2.59, p = .06$ . Participants with PD took the longest, fastest steps when their attention was directed straight ahead. Step length did not differ significantly between the three conditions where participants looked at their feet. Step velocity, however, was lowest when participants directed their attention to the more-affected side of the body. Although directing attention towards the more-affected and less-affected side did not improve gait characteristics, directing attention towards the more-affected side may decrease the quality of gait in patients with asymmetric PD.

### **Auditory stimulus alters step width, but not step length gait characteristics of healthy young and elderly individuals**

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Gait requires higher level control. Step length and step width variability have been identified as markers of motor control that are related with falls, but is unknown which one is the best predictor. Furthermore, the anterior-posterior walking movement is probably passively controlled, but the medial-lateral movement requires higher control. This latest hypothesis is supported by simple dynamical models that require active control to maintain stability in the medial-lateral direction. In these relationships we also have to consider sensory input. Therefore, our goal was to determine the effect of auditory stimulus on step width and step length (mean and variability) in healthy young and elderly adults. Twenty healthy young and 11 healthy elderly subjects walked on the treadmill for 3 minute each during 3 conditions of a dichotic listening test and while walking alone (WA). A  $2 \times 4$  ANOVA with Tukey's post-hoc test was used to determine differences due to group and condition. Mean step width was decreased during the auditory conditions as compared to the WA condition. The young had greater step width variability during the forced-left (FL; focused attention to left ear) condition compared to WA and non-forced (NF; free attentional focus) conditions and the forced-right (FR; focused attention to right ear) condition was greater than the NF condition. Regarding sensitivity of gait variables to the different auditory conditions, the FL condition led to greater changes in step width variability than the NF and FR conditions. There were

no significant differences in step length. These results support the hypothesis that auditory input does effect gait control, namely in the medial-lateral direction. Interestingly, the most difficult cognitive condition (FL) had the greatest effect on gait. These results indicate that auditory sensory input is important for medial-lateral control, and that the sensitivity to auditory stimulus depends on the level of cognitive demand.

### **The role of multisensory information in estimating the landing time of a flying ball**

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To catch a flying ball, a fielder must gather locomotion information as to when and where the ball will land. A large body of related research has emphasized the role of optical variables to control this catching behavior (e.g., Linear Optical Trajectory, McBeath et al., 1995); however, the contribution of other sensory information (i.e., proprioceptive and vestibular information) in the catching has been overlooked despite the fact that multisensory information can play an important role in complex motor control (e.g., Oudejans et al., 1999; Gray, 2008). Therefore, this study aims to examine multisensory contributions in estimating the landing time of a flying ball. Participants comprised 4 baseball experts and 4 novices. They were tasked to manually press a button concurrently with the arrival of a target. The target was raised from the eye level and fell to the same level with a gravitational acceleration of  $9.8 \text{ m/s}^2$ . The initial projection speeds of the targets were 5 m/s, 10 m/s, and 20 m/s. The participants could only see the initial information regarding the raising of the target to a height of 2 m from eye level but not any other information related to the raising or falling of the target. In the fixation condition, they fixated on the light-emitting diode placed at the point of projection while performing the task; this was done to eliminate any proprioceptive and vestibular information. In the pursuit condition, they were asked to pursue the target by moving their eyes and extending their neck. As a result of the absolute timing error (AE), there was a marginally significant interaction between response condition and skill level ( $F(1, 12) = 6.77, p < .10$ ). The analysis of the simple main effect showed that the baseball experts had smaller AE in the pursuit condition than in the fixation condition, but the opposite was true for novices. The results indicated that the experts used proprioceptive and vestibular information to estimate the target's falling time. Moreover, multisensory integration was a characteristic feature of sports experts.

### **Functional principal component analysis: A statistical method to distinguish muscle activation between sedentary and active older adult activity-groups**

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Sedentary older adults have a greater reduction in power than active older adults. Our central question was, Do older adults compensate by using more coactivation of agonist-antagonist muscle pairs, compared with young adults? Coactivation can be a useful or counterproductive strategy for motor control tasks. The main purpose of our first study was to find the link between habitual activity and performance during a maximal power task and determine coactivation differences between activity groups of older adults. The primary purpose of study two was to determine the coactivation differences between sedentary and active older adults during submaximal power cycling at different speeds. Functional Principal Component Analysis (fPCA) was used to extract frequency information from sEMG coactivation muscle pairs at the thigh (3) and lower leg (3) to extend the work of Lauer et al., 2007. In Study 1, 14 active (OAACT;  $68.4 \pm 3.4y$ ) and 14 sedentary (OASED;  $68.1 \pm 2.4y$ ) older adults performed a maximal power pedaling task in comparison with a reference group of 14 young

active adults (YA;  $24.6 \pm 2.6y$ ). Maximal power differences were confirmed between the OA groups ( $F(1,26) = 3.90, p = .054$ ). The active older adult group used coactivation of the lower leg (tibialis anterior-medial gastrocnemius,  $F(1,23.640) = 4.030, p = .056$ ). In Study 2, the same group of older adults performed a submaximal power pedaling task at 60, 90 and 120 rpm. The OAACT coactivated at the thigh during the slow speeds for rectus femoris-biceps femoris (60 rpm;  $F(1,15.273) = 8.119, p = .012, ES = -0.79$ ). The OASED controlled the lower leg at fast speeds for tibialis anterior-soleus (120 rpm;  $F(1,17.371) = 10.535, p = .005, ES = 1.55$ ) using coactivation. The results expand our understanding using fPCA of how older adults' with different physical activity history selectively use coactivation to enhance performance during more demanding tasks (maximal) and as a stabilization strategy during control tasks (submaximal). Supported by: NSF Grant No. 9986221, TPTA Research Foundation, APTA Adopt A Doc, Berenice Costella Aging.

### **Auditory and visual feedback in oral and manual force control**

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The purpose of this investigation was to examine differences in force control in oral and manual effectors as a function of sensory modality. It was hypothesized that an oral-motor effector (lower lip) would be less variable in force production with auditory feedback than with visual feedback while variability of a manual effector (index finger) would be less variable with visual feedback. To test this hypothesis, participants produced constant force via index finger flexion and lower lip elevation to 2 force levels (10 and 20% maximal voluntary contraction (MVC)) and received either online visual or auditory feedback. Visual feedback of force production was provided with a compensatory visual display and auditory feedback was provided using a binaural tracking method. A compensatory visual display provides visual feedback about force amplitude in relation to the criterion force level where as the binaural tracking method provides simultaneous auditory feedback to both of the participant's ears. A pure target tone was provided to one ear while the pure tone coupled to the participants' force production was provided to the other ear. Mean, standard deviation (*SD*), coefficient of variation (*CV*), and approximate entropy (*ApEn*) of force output were calculated. Overall, it was found that the lip was more variable (i.e., *CV*) than the finger regardless of sensory modality. Force output was less variable (i.e., *SD*) with visual feedback compared to the auditory feedback condition. Moreover, the visual feedback condition resulted in less structured force output (i.e., *ApEn*) than auditory feedback across effectors. In conclusion, our findings suggest that distinct control processes regulate visuomotor and audiomotor feedback processing in force production across oral and manual effectors.

### **Effects of relative frequency of knowledge of results (KR) in motor skill acquisition: Absolute frequency or number of trials fixed**

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Practice and knowledge of results (KR) have been known as important factors to the acquisition of motor skills. Although they influence each other they can have different effects upon

learning when analyzed separately. Moreover, motor learning can be related to the relative frequency of KR provided during learning phase, which was the aim of this study. The number of trials and absolute frequency were manipulated. Fifty subjects performed a positioning task. It was developed an apparatus consisted by a wooden box with six recipients and a key button to start and finalize the task. The closest recipients were named by 4, 5, and 6 and the far recipients were named 1, 2, and 3. In acquisition phase, the subjects should press the key start button and wait for the led lights on. After that, subjects should move three tennis balls from the closest recipients to more distant ones in a sequence 4-2/5-3/6-1 and in a target time of 2.700 ms. Twenty four hours after acquisition phase there was a retention test with the same sequence and target time without KR. Five groups were organized: 100 KR (100% KR in thirty trials); 66 KR (66% KR in thirty trials) 33 KR (33% KR in thirty trials); 66 AF (30 KR - absolute frequency fixed in 45 trials); 33 AF (30 KR - absolute frequency fixed in 90 trials). The results showed that 100 KR and 33 KR were worse than 66 KR, 66 AF and 33 AF. We conclude that intermediate frequencies are better for skill acquisition. However, the amount of practice can influence this process as showed by the 33 AF group that even with a lower frequency it had a higher amount of practice, which could compensate its low frequency.

### **What does observation tell us about visuomotor adaptation and the processes necessary for learning?**

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It has been suggested that observational practice engages neural mechanisms for movement planning and execution similar to physical practice. In 3 experiments we investigated observational practice during adaptation learning to a novel visuomotor environment. Participants were tested before and after observation in a novel (30° rotation) and a normal environment. In the former, learning would be seen by immediate performance benefits from watching. In the latter, negative aftereffects in the normal environment would suggest an updating of motor commands based on the visuomotor discordance, arguably a more robust index of learning. In Exp1, observers showed benefits in the novel environment, but no aftereffects. Because aftereffects are believed to be a result of perceived discrepancies between sensory input and predicted sensory consequences we hypothesised that observational practice might not engage covert simulation of motor planning and executive processes to the same degree as initially implied. To more thoroughly test this idea, in Exp2 we encouraged more active observation (or simulation) through conditions requiring imagery and error estimation. Despite these manipulations, only actors showed aftereffects. In Exp3, a group of observers was also passively moved during observation, allowing us to determine whether the absence of aftereffects was more linked to afferent feedback instead. However, this condition still failed to yield aftereffects. A second observer group also imitated the movements of the actor during observation but this group's performance was not different to passive observers. Because this final group moved and hence engaged in motor prediction, execution and received sensory feedback, we concluded that observational practice likely involves covert planning and executive processes, but alone these processes only result in improvements in the novel environment and not updating of motor commands. For aftereffects to be observed a conflict between motor output and reafference (visual input from self-produced action) needs to be perceived.



### **Observation and coding of simple motor sequences**

Panzer, Stefan, University of Muenster; Nicole Gruetzmacher, Leipzig University; Yannick Balandin, Poitiers University; Charles H Shea, Texas A & M; Melanie Krüger, LMU Munich

Previous research provided empirical evidence that complex multi-element sequences are coded in visual-spatial coordinates, while relatively simple spatial-temporal movement sequences are coded in motor coordinates (e.g., joint angles, activation patterns). Additionally a recent experiment has demonstrated that observation of complex, multi-element sequences were coded in visual-spatial coordinates. The purpose of the present experiment was to determine the coding-system used during observation on later performance of a simple spatial-temporal movement sequence. The task in the present experiment was to reproduce a 1.3 sec spatial-temporal pattern of elbow flexions and extensions. An inter-manual transfer paradigm with two transfer tests was used; a mirror transfer test where the same pattern of muscle activation and limb joint angles was required while in the non-mirror transfer test the visual-spatial pattern of the sequence was reinstated. In contrast to the results of our previous experiments (Boutin, Fries, et al. under review), which used complex multi-element movement sequences, the results clearly indicated a strong advantage only for participants in the physical practice condition who transfer to a mirror condition in which the motor code has been reinstated. The observation group shows no transfer advantages. The results provide additional experimental evidence that the optimal movement code depends on the movement sequence characteristics (e.g., difficulty, number of elements, type of control). Observation a short motor sequence shows no coding advantages. These results are also interesting because they indicate that the motor code can be developed relatively quickly for rapid movement sequences and this code is effector dependent but only for the physical practice group.

### **Context effects in the learning of two similar movement sequences**

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Many researchers have demonstrated that the surrounding context has an important influence on information processing and learning. Altering the surrounding context for example by adding background music, different physical states, physical environment, or colors often results in performance decrements. The primary purpose of the present two experiments was to determine if the memories underpinning the learning of two similar complex movement sequences, which are practiced in different incidental context will be stored in distinct memory states relative to when practiced in the same context. In Experiment 1 participants have to learn two sequences S1 and S2 on two separate days. Sequence 2, which was practiced on Day 2, was created by switching the positions of 2 of 16 elements in Sequence 1, which was practiced on Day 1. The incidental context consisted on different display colors for each sequence. A proactive, retroactive interference design was used. In line with our previous experiments (Panzer, Wilde & Shea, 2006), results indicated a strong retroactive interference effect only in the changed elements (Experiment 1). In Experiment 2 we explicitly directed participants' attention to the incidental contexts. Results again indicated retroactive and additionally proactive interference effects under explicit context conditions. The results of the two experiments clearly demonstrated that implicit and explicit incidental contexts do not reduce interference effects noted in previous research. In contrast explicitly directing participants' attention to the contextual information appears to induce an overload and results in decreased performance in both learned sequences.

### **Aging effects in coding simple movement sequences**

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Recent experiments have demonstrated that complex multi-element movement sequences were coded in visual-spatial coordinates even after extensive practice (Kovacs, Muehlbauer, & Shea, 2009), while relatively simple spatial-temporal movement sequences are coded in motor coordinates after a single practice session (Panzer, Krueger, Muehlbauer, Kovacs, Shea, 2009). The purpose of the present experiment was to determine if aging interacts with the coding of a simple spatial-temporal movement sequence. An inter-limb practice paradigm was designed to determine coordinate system (visual-spatial: Cartesian or motor: joint angles, activation patterns) used to code the movement sequence. Participants' task was to reproduce a simple spatial-temporal (1.3 sec) movement sequence involving elbow flexions and extensions by moving a lever to sequentially presented target positions on Day 1. The movement sequence was produced by the contra-lateral limb on Day 2. Practice across the two days involved either the same visual-spatial or the same motor coordinates. Retention tests on the tasks practiced on Day 1 and 2 were conducted on Day 3. Results indicated that keeping the motor coordinates the same during acquisition resulted in superior retention only for younger adults, while older adults show an advantage when visual-spatial code was reinstated. Results also indicated the overall slowing of sequential movement production in older adults.

### **The effect of relative frequency of knowledge of results on the acquisition and retention of simple motor skills in the contextual interference paradigm**

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Contextual Interference and Knowledge of Results (KR) have been central research topics in the motor learning literature. Both paradigms have demonstrated enhanced performance for less difficult practice conditions, blocked practice schedule and 100% frequency of KR respectively. However, both paradigms have also demonstrated that this effect may be transient in nature, demonstrating depressed retention performance for both of these conditions. These common findings may suggest that both paradigms may be controlled by similar processes or mechanisms which may facilitate performance and/or learning. A simple key pressing task was performed in a common contextual interference paradigm, with 54 acquisition trials, 18 of each of the 3 experimental tasks, a 10-minute retention interval and 18 no-KR retention trials. Blocked and Random practice schedules were crossed with 100% and 33% KR schedules during acquisition. In the 33% KR schedule, KR was provided on every third trial and an equal number of presentations were received on each of the three experimental tasks. Log-CE and VE were analyzed using a 2 (KR)  $\times$  2 (Schedule)  $\times$  3 (Task)  $\times$  6 (Trial Block) mixed model analysis of variance (ANOVA) with repeated measures on the last two factors. Analyses revealed a significant main effects for KR ( $F(1, 68) = 11.21, p = .001$ ), Schedule ( $F(1, 68) = 4.12, p = .046$ ), Trial Block ( $F(5, 340) = 22.09, p = .001$ ), Time ( $F(2, 136) = 47.78, p = .001$ ) and a significant Time  $\times$  Schedule interaction ( $F(2, 136) = 3.11, p = .048$ ). No other main effects or interactions, including the KR  $\times$  Schedule ( $F(1, 68) = 1.349, p = .563$ ) approached significance. Findings similar to previous contextual interference research were demonstrated but no interaction between practice schedule and KR was observed. However, a graphical trend was observed with the blocked-100%

condition having the least error and the random-33% having the greatest error. This suggests the paradigms may be additive in nature and may contribute to the performance and learning of simple motor skills in a similar manner.

### **Learner-controlled KR: Does repetition order matter in multi-task learning?**

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Evidence from the extant literature examining a learner-controlled practice context has unequivocally supported its motor learning advantages. However, the utility of a learner-controlled context has been concluded from performers acquiring the spatiotemporal requirements for a single motor task. Thus, in practice contexts requiring the acquisition of multiple motor tasks, the utility of a learner-controlled practice context is expected to be differentially impacted by the structure of the repetition schedule. To examine this gap in knowledge, participants in the present experiment were required to learn three separate 5-key pressing sequences, each with an associated movement time goal. One group controlled their receipt of KR after every acquisition trial, with the sequences being presented in a blocked order (SELF-BLOCKED), while another group controlled their receipt of KR with the sequences presented in a random order (SELF-RANDOM). Two yoked conditions were also utilized (YOKED-BLOCKED, YOKED-RANDOM) where participants received KR on the same trials as their self-control counterparts, without the choice. Knowledge of results consisted of the goal time along with the participants just completed time. Comparing the differences between the three key-pressing patterns, as a function of practice condition, |CE| measures were converted to a percent absolute constant error (%|CE|) by dividing |CE| by the corresponding target movement time and multiplying by 100. The results of the retention data showed an interaction between group (SELF / YOKED) and repetition schedule (RANDOM / BLOCKED). The post hoc analysis revealed those in the SELF-RANDOM group demonstrated superior retention performance compared to the other experimental conditions. These findings offer a novel contribution to the extant motor learning literature, and extend our theoretical interpretations of the factors modulating a learner controlled practice context.

### **Intermanual asymmetry in intralimb coordination when drawing circles**

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Lateral dominance of the preferred hand for motor control has been proposed to be due to a superior capacity of that limb to deal with motion dynamics (dynamic dominance hypothesis). From this conjecture, it is expected an improved interjoint coordination within the preferred limb as compared with the nonpreferred limb when voluntary movements are executed. Moreover, such advantage of the preferred limb should be more evident in fast movements, when a feedforward mode of control is required. To test that hypothesis we assessed interjoint coordination between the shoulder and the elbow in circle drawing tasks, comparing performance between the preferred and the nonpreferred arm. The study was conducted with 10 young adults, who performed the task in five movement frequencies, ranging from 40% to 100% of their individual capacity in steps of 15%. Angular motion of the joints was recorded through reflective markers attached at the shoulder, elbow, and wrist of both arms. Markers were tracked automatically by using an optoelectronic system, with data sampling frequency set at 240 Hz, and further 3D analysis. Analysis of relative phase between peak flexion of the joints showed a significant effect of hand, with decreased delay

of peak flexion of the elbow regarding peak flexion of the shoulder in the preferred arm ( $M = 128.3$  deg; nonpreferred arm,  $M = 144.4$  deg). Analysis of variability of relative phase indicated decreased values for the preferred arm ( $M = 7.1$  deg; nonpreferred arm,  $M = 10.1$  deg), and for the lowest frequency as compared with the others. These results indicate that movements of the preferred and the nonpreferred arm are coordinated in different modes, with the pattern of the former being more stable than the pattern of the latter across different movement frequencies. Thus, we observed an advantage in intralimb coordination favoring the preferred arm independent of frequency of movement execution.

### **Standing long jump performance is enhanced when using an external focus of attention**

Porter, Jared M, Southern Illinois University Carbondale; Erik Ostrowski, Southern Illinois University Carbondale; Russell Nolan, Southern Illinois University Carbondale; Will F.W. Wu, California State University, Long Beach

Several experiments have demonstrated that focusing a performer's attention externally (i.e., on the effects of a movement) rather than internally (i.e., on specific parts of the body) enhances performance when the task requires object manipulation (i.e. throwing a ball to a target). The purpose of this experiment was to investigate if whole body movements, without object manipulation, are influenced by an internal or external focus of attention. The experimental task required participants ( $N = 120$ ) to complete a standing long jump which was preceded by a short warm-up. Participants were assigned to either an internal (INT) or external (EXT) focus of attention group. All participants completed five standing long jumps separated by a two-minute seated rest. Prior to each jump, participants in the INT condition were read the following instructions "When you are attempting to jump as far as possible, I want you to focus your attention on extending your knees as rapidly as possible." Participants in the EXT condition were read the following instructions "When you are attempting to jump as far as possible, I want you to focus your attention on jumping as far past the start line as possible." An independent samples t-test revealed a significant difference ( $p = 0.003$ ) in the average distance jumped between the EXT ( $M = 187.37$ ,  $SD = 42.66$  cm) group and the INT group ( $M = 177.33$ ,  $SD = 40.97$  cm). The results suggest that providing instructions that focus attention externally enhance whole body actions, with no object manipulation, over an internal focus of attention. This finding is valuable for practitioners that use jumping tests to evaluate performance.

### **Instructions that promote an external focus of attention benefit agility performance**

Porter, Jared M., Southern Illinois University Carbondale; Gabriele Wulf, University of Nevada, Las Vegas; Russell Nolan, Southern Illinois University Carbondale; Erik Ostrowski, Southern Illinois University Carbondale

Numerous experiments have demonstrated the benefits of directing a learner's attention externally when performing a motor skill. However, it has not been established if these benefits exist when the practiced task is a whole body movement requiring agility. The primary purpose of this study was to investigate if focusing attention externally produced faster movement times compared to instructions that focused attention internally or a control set of instructions that did not explicitly focus attention. A second purpose of the study was to measure participant's focus of attention during practice by use of a questionnaire. Using a within participant design, participants ( $N = 20$ ) completed 15 trials of an agility "L" run following instructions designed to induce an external (EXT), internal (INT) attentional focus

or a control (CON) set of instructions inducing no specific focus of attention. Movement time was measured using infrared timing gates. Following each timed trial participants had a two minute seated rest. During this resting period participants wrote a response to the following question: What did you focus on while performing? Analysis of movement time results revealed when participants followed the EXT set of instructions they had significantly faster movement times compared to when they followed the INT and CON set of instructions. The analysis also revealed that movement time was not significantly different following the INT and CON instructions. Questionnaire data showed when participants were in the external condition they focused externally 65% of the time. When they were in the internal condition they focused internally 76% of the time, and when they were in the control condition they did not use an internal or external focus of attention 84% of the time. Consistent with previous findings, these results demonstrate that providing instructions that induce an external attentional focus, rather than internal or no attention directing, enhances agility performance.

### **The effects of self-controlled feedback on participant motivation and motor skill learning**

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Self-controlled (SC) feedback (Fb) has been shown to benefit motor learning for a variety of skills (Chiviacowsky & Wulf, 2002; Janelle et al., 1995, 1997). However, the mechanism underlying this effect is presently unknown. One possibility is that SC Fb increases motivation (Chen, Hendrick, & Lidor, 2002). This study examined motivation (Intrinsic Motivation Inventory or IMI; Ryan, 1982; McCauley, Duncan, & Tammen, 1989) in SC and yoked (YK) Fb groups that learned a sequential timing task. The procedures replicated those reported by Chiviacowsky & Wulf (2002) with a few exceptions—the IMI was given four times during the study, acquisition trials were increased from 60 to 120, and the post-training questionnaire was reformatted to use a Likert scale. The results provided no support for the hypothesis that SC Fb enhances learning in either absolute or relative timing. Results for the IMI revealed moderate responses (“somewhat agree”) for all four subscales and no differences between the groups. The post-training questionnaire results indicated that SC participants reported requesting Fb more frequently after “good” (accurate) trials while YK participants reported receiving Fb more frequently after “bad” (inaccurate) trials ( $p < .05$ ). In addition, both groups stated a preference about when they preferred to receive Fb (after “good” or “bad” trials) that was consistent with their report of when they actually received it. These results indicated that SC Fb did not affect motivation & that the benefits of SC Fb on learning sequential timing might not be as robust as previously believed. The failure to replicate earlier findings regarding learning also suggested that SC Fb effects are sensitive to as yet unstudied factors. For example, motivation in the present study might have been low because participants were recruiting from a pool that gave psychology students course credit for participating in research studies.

### **Effects of the level of learning in motor skill adaptability**

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The ability to respond to perturbations is an important characteristic of human motor behavior and it is influenced by the level of skill learning (level of skill stabilization) and the type of perturbation. We investigated how two different levels of learning respond to unpredictable perturbations. Before starting the experiment it was controlled anthropometric characteristics and starting point of the throw. The task consisted of throwing a dart to a 22 cm of radius target placed on the ground with the center 2.50m far from the edge of the throwing area and divided in scores ranging from 1 to 40. Sixteen subjects were randomly divided in stabilization and super stabilization groups (EG and SG, respectively), which had different criterion of performance to end the first phase without perturbations: GE performed one block of three trials in a row with the score ranging from 27 to 40 and GS repeated the same criterion for six times. After each subject finished the first phase, they performed 158 more trials in a new phase with 18 unpredictable perturbations trials introduced after the movement onset. The perturbations were characterized by variation of the target to be reached: in perturbation 1 (P1) the center position of the target was 3.00m and in perturbation 2 (P2) the center position of the target was 2.0m from the limit of the throwing area. The targets had one a pair of diodes indicating which target subject should throw the dart. Results from the first phase showed that the peak of acceleration and the release point in the launch plan did not change. However, the hand displacement was smaller at the beginning of the first phase than when reached stabilization, super stabilization and with perturbations. The peak of negative acceleration was lower for P2 than for P1, showing difference in the throw corrections among perturbations. It indicates that both groups had similar strategies to respond to the perturbations providing evidences that the point of release is planned and relatively independent of the corrections of the displacement of the limb.

### **The Advantages of Intuitive Decision-Making in Expert Sports**

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Intuitive decision making in sports is often considered to be as effective as decisions based on deliberate, planned judgments. In this laboratory study involving handball players making decisions in an attack situation, we investigated whether decisions were faster and better if they were intuitive rather than deliberate. Our hypothesis was that when there are multiple options, the affective nature of intuition will lead to both faster and more effective decision being made, as long as the process is based on expertise. In a lab-experiment, video-based scenarios in a team handball attack situation were shown to 54 male and female handball players of different expertise levels. The video was stopped in a freeze frame where the participants could see the playmaker in an ill-defined situation, and the participants were asked to intuitively state an option for this player. Experts rated the quality of the decision made, and the decision time was measured in milliseconds. Following the intuitive decision, the participants were asked to generate further options and then pick the best one of the list. A PID questionnaire helped assess the preference between intuitive and deliberative decision making. In line with our hypothesis, the analysis showed that athletes who preferred deliberative decision making made slower and less qualified decisions than the athletes classified as intuitive decision makers. A further important result was that the more expertise a player had the more intuitive decision making was adopted. All in all, our results support adopting a Take-The-First heuristic defining the process of searching for, stopping the search and choosing an option. This allows faster and better decisions to be made and expert players appear to develop this ability by relying on their intuition. Thus, ideas for training intuitive decision making should be developed since the choice between intuitive and deliberative decision making seems to be an important moderator in sports at a high level.

### **The effects of mental practice when administered early and late in practice on the cognitive and motor components of a motor skill**

Raisbeck, Louisa D., Michigan Tech; John B. Shea, Indiana University; Bill Wyatt, Indiana University

Research concerning the effects of mental practice on the learning of motor skills has shown it may be superior to no practice but less effective than physical practice, it may be beneficial when used with physical practice, and that it may be most beneficial when used either early or late in practice (Feltz & Landers, 1983; Driskell, Copper and Moran, 1994). Recent research (Wohldmann, Healy, & Bourne, 2007, 2008), however, has reported a mental practice superiority effect. The present study addressed the incongruence of this finding with those of earlier studies. A within-subjects design was used with four practice conditions: either physical or mental practice throughout 128 practice trials, physical practice early (first 64 trials) and mental practice late (second 64 trials) in practice, or mental practice early (first 64 trials) and physical practice late (second 64 trials) in practice. Retention was measured 20-min. after the practice trials. The learner performed four sequential key pressing tasks on a computer keypad. Each task was paired with a different colored stimulus light. Initiation time (IT) and execution time (ET) were considered to be measures of response planning and execution processes, respectively. IT and ET measures were analyzed using a fully repeated linear mixed model. ET was faster for physical practice than for mental practice during practice trials ( $p < .01$ ). For retention, ET was equivalent for the mental and physical practice conditions, but slower than the other conditions with a combination of mental and physical practice ( $p < .01$ ). In contrast, IT was faster for the physical practice condition than for the other conditions ( $p < .01$ ). Findings are discussed with reference to those of Wohldmann, Healy, and Bourne (2007, 2008), and an interpretation is offered in which independent processing structures are enabled by mental and physical practice.

### **Is Reduction in Movement Variability a Sign of Optimization?**

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Several studies have shown that there is a general reduction in movement variability with learning. Many approaches assume this as evidence for the idea that an optimal solution has been learned, where the learned solution is modeled as the consequence of optimizing various cost functions (e.g., minimum-jerk). In order to further test the existence of an optimal solution, we examined the structure of variability in a task which shows reduction in movement variability with learning. The task involved using a pen on a digitizing tablet to intercept a stationary target (15 mm diameter) that was displayed on a screen. Participants performed this task for 800 trials spread over 4 days. The results revealed: (1) improvements in task performance with target-hit rates at the end of the last practice session approaching about 80%; and (2) a decrease in spatial variability of the movement path with practice. However, when we examined the structure of variability by computing the correlations between adjacent locations on the path, there was a decrease in the correlation with learning but only at certain points along the path. Further, when the sequential structure from trial to trial was analyzed, paths from successive trials in a block were more similar compared to paths from randomly chosen trials in a block. These results suggest that even when movement variability is reduced, the observed behavior is not reflective of the repetition of one particular solution – a condition of the optimization hypothesis. Instead, there is a systematic variation in the solutions generated even after extended learning that reflects the exploration of redundant solutions.

### **Learning through observation: combination of expert and novice models**

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Observation of an expert model favors the formation of a “perceptual blueprint” of the task (Sheffield, 1961), whereas observation of a novice model favors the development of “error detection and correction mechanisms” (Blandin et al., 1999). If so, then observing both expert and novice models should result in the development of both processes and, thus, better learning of the task. In two experiments, we determined the effects of observation of a combination of expert and novice models (called mixed observation) on learning of a four-segment timing task (300 ms for each segment). In Experiment 1, there were five different groups (physical practice, control, and three observation groups: novice, expert, or mixed). Experimental phases were: Pre-test, Acquisition (60 trials; rest for the control group), immediate and delayed (24 hr) retention/transfer tests. In the mixed group, observation of the novice and of the expert model was alternated every five trials. Results of the retention tests revealed that all three observation groups and the physical practice group outperformed the control group. Importantly, participants in the observation-mixed group outperformed all other groups in transfer (i.e., 375 ms for each segment of the task). In Experiment 2, we wanted to determine whether there is a type of novice performance that would favor learning in a mixed observation schedule. In addition to physical practice and control groups, there were three groups of mixed observation. The observation schedule and the expert model were the same as in Experiment 1. The novice model did not improve his performance during practice, was very variable, or gradually improved his performance as practice increased. In both retention and transfer tests, all observation groups and the physical practice group outperformed the control group. The three mixed observation groups did not differ significantly from one another. Thus, a schedule of mixed observation favors motor learning regardless of the performance of the novice model.

### **Asymmetrical and Symmetrical Ankle Loads Reduce Local Dynamic Stability in Walking**

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Over the past 25 years rhythmical coordination in many different tasks has supported the predictions of the Haken, Kelso and Bunz (HKB) model (1985). However, efforts to apply this model to the ubiquitous activity of human walking have been met with only partial success. Russell et al. (2005) created leg asymmetries by placing different ankle weights on either leg during treadmill walking. Relative phase between the legs deviated from 180 degrees as predicted, but contrary to the HKB model, asymmetries between the leg loads did not reduce stability. The lack of a stability effect may be due to walking on a treadmill, or the use of a linear measure to index movement stability (standard deviation of relative phase - SDRP). The current study revisits this hypothesis, with two methodological changes: 1) overground walking task, and 2) both linear and nonlinear analyzes. To assess local dynamic stability we computed the maximum Lyapunov exponent (LyE), which quantifies the degree of divergence of infinitesimally close trajectories in phase space. Greater divergence of trajectories indicates a less stable attractor (higher LyE). Ten participants (5 men) walked along a corridor (45.3 m) under 4 asymmetrical and 3 symmetrical load conditions, created by 0, 3 or 6 kg on the left or right leg. Participants walked at their most



comfortable speed and stride frequency (control), and at their no load preferred stride frequency (metronome), to assess whether stride frequency changes influenced stability. Joint motion of both knees was recorded by electrogoniometers. No difference in stability was observed between the metronome and control conditions. As predicted by the HKB model, LyE significantly increased as leg asymmetry increased. LyE also increased for greater symmetrical loads on the ankles. This finding suggests that load rather than asymmetry may have a more important influence on local dynamic stability in walking, contrary to the HKB model. SDRP showed similar results, suggesting that using a treadmill in prior research reduced the stability effects of ankle loads.

### **Sleep related enhancement in motor performance: gross vs. fine motor tasks**

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Several studies show that sleep enhances performance in sequential finger-tapping tasks (e.g., Walker, 2002). Those results, however, could not be replicated with other motor tasks, like a sub-maximal force impulse (Counter Movement Jump), or a continuous visuo-motor Pursuit-Tracking Task (Blischke et al., 2008). It seems that positive sleep effects might be specific to the original task, which required participants to tap a five-element sequence with four fingers of one hand repetitively on a standard keyboard. One possible explanation for these equivocal findings might be that finger tapping compared to jumping or tracking is a fine motor skill. The tasks, however, vary in several features, which makes it difficult to address the differences between fine vs. gross motor tasks. To test this notion, we ran three experiments with 24 participants in each study. First, we replicated the original finger-tapping task used by Walker (2002). For Experiment 2 and 3, the original task was adapted to a hand-tapping task. Here participants had to tap the sequence on a smart board, attached on the wall in front of them, using their non-dominant hand (Exp 2) or both hands (Exp 3). Half the subjects in each study initially learned the skill in the morning, the other half in the evening. Either group underwent two retention tests (12h and 24h after initial learning). Results show significant improvement after sleep only for the finger-tapping task - regardless if subjects slept during the first ( $p = .002$ ;  $\eta^2 = .59$ ) or second ( $p = .027$ ;  $\eta^2 = .37$ ) 12h retention interval. For both hand-tapping studies sleep yields p-values of  $p = .19$  or larger. These findings suggest that sleep-related enhancements of motor learning are not in general linked to tasks, which require sequential movements to different spatial targets. One rationale for these findings might be the different neural activations (e.g., number of involved motor units) when using fingers to perform a fine motor task versus the use of the whole arm and shoulder to perform a gross motor task.

### **Multi-joint coordination underlies the stability of upright standing**

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Recent investigations of postural control during quiet standing and during support surface perturbations suggested that the stability of upright stance results from movement coordination of multiple joints along the body axis, rather than being the result of a simple ankle joint or ankle-hip control strategy, combined with the stiffening of other joints. The current work provides additional support for this hypothesis by showing that positional stability

of both the head and center of mass (COM) results from the covariation of multiple joints. Subjects either stood quietly for 5 minutes or tracked a vertically moving target (> 60 cycles) at 0.8-Hz with a laser pointer mounted on the brim of a baseball cap while the motion of their body was captured with an 8-camera VICON motion measurement system at 120-Hz. The Uncontrolled Manifold (UCM) approach was used to partition joint variance into 'good' variance, which reflects the use of motor equivalent joint combinations consistent with a stable value of the head or COM position across time (quiet standing) or across cycles at each point in normalized time (head tracking), and 'bad' variance, which leads to variability of the head or CM position. UCM effects, i.e. good variance > bad variance can arise partly due to the geometry of the system as well as covariation. UCM analysis was performed using the computed joint angles as well as after removing joint covariation by randomization. Results based on the original joint angles were consistent with previous studies, revealing that "good" variance was substantially larger than "bad" variance during quiet standing, but also during the tracking task. Comparison of results of UCM analyses performed with computed and randomized angles indicate that most of the UCM effect came from joint covariation; the UCM effect was largely destroyed when performed with randomized angles. Thus, the new results continue to question the validity of single or double inverted pendulum models of postural control.

### **Controllability of motor imagery in neglect patients**

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A large proportion of right-hemisphere stroke patients show unilateral neglect, a deficit of perception, representation, and/or performing actions within their left-sided space. This induces many functional incapacitating effects on everyday life, and is responsible for poor functional recovery and ability to benefit from treatment. There is evidence that mental practice can lead to improvements in reaching, grasping and object manipulation of the impaired upper limb. One of the challenges of using mental practice is that after the patient was instructed to imagine a certain movement, no possibility exists to control whether the patient is doing what he/she was asked for. In the present study we employed a test concerning the controllability of motor imagery in neglect patients (CIMneglect). Twenty persons with neglect from right hemisphere stroke (NG;  $55.9 \pm 11.7$  years), and 20 age-matched healthy persons (CG;  $56.2 \pm 11.6$  years) completed the CIMneglect with two conditions (RECOgnition and REGeneration). In both conditions the participants had to perform five or six following instructions. They were asked to imagine the posture of their own body. On the REG-test the participants had to actually execute a movement to the final position. On the REC-test, they were required to select among four pictures the one, which fits to the imagery they have. The Cronbach alpha values for the two subscales of the CIMneglect ranged from 0.63 to 0.82 for the patient group. A 2 (condition)  $\times$  2 (group) mixed design ANOVA revealed a significant interaction for condition by group,  $F(1, 36) = 4.08, p = .050, \eta^2 = .102$ . Comparisons between subscores for the REG- and the REC-test within each group indicated higher REG than REC subscores in the neglect group ( $6.84 \pm 2.83$  vs.  $5.70 \pm 2.41, p < .05$ ), but not in the control group ( $8.30 \pm 1.52$  vs.  $8.20 \pm 1.11, p < .05$ ), indicating that neglect patients produced more errors than the control group. Our results demonstrate that neglect patients showed a better ability to control their body scheme (REG) than to transform a visual imagery (REC).

### **Motor hysteresis in continuous posture space**

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Previous studies focusing on motor hysteresis were restricted to end-effector position or the binary selection of posture. According to the plan-modification hypothesis, motor hysteresis emerges from a trade-off between the cognitive cost of creating a new movement plan from scratch and the biomechanical cost of remaining in a suboptimal posture. Due to the binary switch of posture enforced in previous studies, however, the relevance of hysteresis as a motor control strategy in posture space might have been overstated. We asked whether two motor control strategies that were established in binary tasks, the end-state comfort effect and the hysteresis effect, would hold for a sequential motor task with continuous grasp solutions. To this end, we created a perceptual-motor task (opening a column of drawers with protruding knobs), which offered a continuous space of grasp posture solutions for each movement trial. In two Experiments, participants were tested in predictable ( $N = 21$ , average age 23.4 years) and non-predictable ( $N = 15$ , average age 23.6 years) sequences of trials. The pro-/supination movement of the hand was measured with an optical motion capture system. Results of Experiment 1 supported end-state comfort and motor hysteresis effect as general motor control strategies under predictable continuous conditions. Effects of motor hysteresis were absent, however, under non-predictable sequences of trials in Experiment 2. Both experiments extend previous findings to grasp selections in continuous posture space and support the original plan-modification hypothesis. Experimental results further revealed an artificially restricted range of pro-/supination motion of the hand. The restriction was reproduced for the dominant and the non-dominant hand and cannot be attributed to mechanical constraints of the motor system.

### **Does rhythm enhances the flexibility of upper extremity post stroke?**

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Stroke is a leading cause of adult disability in the United States (American Heart Association, 2008). Up to 85% of individuals with stroke exhibit upper extremity (UE) impairments post stroke (Olsen, 1990): impaired motor control at isolated joints and timing of muscle activity patterns in UE. Flexibility of UE motor control as measured by Approximate Entropy (ApEn) is reduced in shoulder and elbow flexion post-stroke hemiparesis versus healthy controls (Sethi, et al. 2009). Thaut, et al. (2002) suggested that reaching to the beat of metronome, may achieve better UE movement composition post stroke. Specifically, rhythmic training reduces trunk displacement and increases shoulder and elbow joint excursions. Therefore, purpose of this study was to investigate whether the shoulder and elbow ApEn is also enhanced when reaching to a metronome beat metronome. Kinematic data were collected using a 12 camera VICON Motion Analysis System from 12 individuals post-stroke during a seated reach-to-point task, performed initially at their comfortable pace, followed by as fast as

possible and lastly with a metronome with their paretic UE. Three trials were collected in each condition. ApEn was computed for shoulder and elbow flexion joint angles. Wilcoxon Signed Ranks test revealed significantly greater ApEn shoulder in the metronome condition as compared to other two conditions ( $p < 0.05$ ). However, significantly greater ApEn elbow was only observed between reaching at comfortable pace versus reaching to metronome ( $p < 0.05$ ). These results suggest that rhythm induced reaching increases the flexibility of the affected UE post stroke. Greater flexibility provides the ability to adjust movement patterns and successfully meet the demands of everyday changing tasks. Thus interventions based on rhythmic entrainment principle might be beneficial in UE rehabilitation post stroke.

### **Concurrent Visual Feedback, Practice Organization, and Spatial Aiming Accuracy in Rapid Movement Sequences**

Sherwood, David E, University of Colorado; Brian Duffell, University of Colorado

The effect of concurrent visual feedback (CVF) and practice organization on aiming movement accuracy was investigated in the dominant limb of 40 college-aged participants. Participants performed “triplets” of rapid aiming movements with a lightweight lever in the sagittal plane involving short (20°), medium (40°), long (60°) distances and were randomly assigned to one of four groups ( $n = 10$ ) in a 2 (Group: Blocked Practice, Random Practice)  $\times$  2 (Vision: CVF, no CVF) factorial design. Participants performed 24 triplets in acquisition and 10 triplets of a novel pattern (15°-45°-15°) on transfer. Movement time was controlled by a metronome set at 1.43 cycles per second resulting in a cycle time of approximately 700 ms per movement. The constant error and overall error in distance were calculated for each distance and analyzed with separate 3 (Group)  $\times$  2 (Vision)  $\times$  3 (Movement) ANOVAs with repeated measures on the last factor. When CVF was available, contextual interference effects were shown by better accuracy for the blocked practice groups during acquisition compared to the random practice group. Without CVF, participants tended to overshoot the targets and contextual interference effects were minimized during acquisition and on the first transfer trial. Random practice resulted in better transfer performance compared to blocked practice for both vision conditions when all transfer trials were included in the analysis. The findings contributed to the current literature by demonstrating the importance of practice context and visual feedback to aiming accuracy.

### **The Acquisition and Learning of Computer Tasks in a Contextual Interference Paradigm: Using Functional Near Infrared Spectroscopy to Examine Prefrontal Cortex Activity**

Shewokis, Patricia A., Drexel University; Hasan Ayaz, Drexel University; Meltem Izzetoglu, Drexel University; Nancy Getchell, University of Delaware; Kurtulus Izzetoglu, Drexel University

A cognitive effort interpretation of contextual interference suggests that during acquisition a random practice order (RAN) involves more cognitive processing than a blocked order (BLK) because of the number of tasks/features compared in working memory. Our aim was to characterize the neural activity of the prefrontal cortex (PFC) during the acquisition and learning of computer tasks for BLK and RAN orders. Six right-handed adults (19- 38 yrs) were randomly assigned to either a BLK or RAN order. Each performed 35 acquisition trials of three 3-D computer mazes (MazeSuite; Ayaz et al., 2008) across three days. Seventy-two hours following acquisition, 30 retention and 20 transfer trials (2 mazes) were

performed in a random order. PFC activity was monitored during all phases using 16-channel functional near-infrared spectroscopy, an optical imaging technology which measures changes in cortical hemoglobin concentration associated with neural activity. Dependent measures included relative changes in the mean oxygenated hemoglobin (HbO<sub>2</sub>), deoxygenated hemoglobin (Hb), and oxygenation (Oxy = HbO<sub>2</sub> - Hb). Our findings of practice order by task interactions during acquisition and retention supports King et al.'s (2005) work in which they reported a decrease in prefrontal activity during context-dependent memory and posited that Brodmann's area 10 "is the prefrontal region most involved in dealing with contextual interference (p. 264)". Decreased activation patterns of mean HbO<sub>2</sub> for BLK and RAN practice across retention trials indicated reduced activity in the PFC. This finding is expected as there is less activity of the PFC during the later stages of learning (Shadmehr & Holcomb, 1997). During transfer BLK had more Oxy than RAN indicating increased effort. Discussion focuses on the roles of cognitive processing and PFC metabolic neural activity during the learning of multiple tasks with different practice orders. Funding for this work was provided by the Pennsylvania Dept of Health Tobacco Formula Funds.

### **The effect of goalkeepers adopting Müller-Lyer postures**

Shim, Jaeho, Baylor University; Rich S.W. Masters, The University of Hong Kong; Jamie M. Poolton, The University of Hong Kong; John van der Kamp, VU University

The posture that a goalkeeper assumes can influence perceptions of his or her size and the motor behavior of an opponent. Van der Kamp & Masters (2008) showed that postures that mimicked an amputated Müller-Lyer illusion in a wings-out/arms-up configuration resulted in larger estimates of goalkeeper height than a wings-in/arms-down configuration. Furthermore, when participants threw to score in a handball goal, the shots were placed further from the arms-up goalkeeper, presumably because he was thought capable of covering a greater area of the goal. We aimed to verify that throwing behaviour was related to (mis-)perceptions of goalkeeper height and, by association, goalkeeper reach. A 1.9 m animated representation of a goalkeeper was projected onto a blank screen. The goalkeeper was shown in an arms-up (45 degrees above horizontal), arms-out (horizontal), or arms-down (45 degrees below horizontal) posture. The 3 postures were each shown 10 times in a random order. For each presentation 34 participants made two estimates of the goalkeeper's maximum static reach, which was defined as the position of middle finger of the goalkeeper in the arms-out posture. Estimates were made by aiming a laser pointer and throwing a ball. The horizontal displacements of the aiming and throwing estimates from the actual position of middle finger (75 cm from the midline of the body) were measured. For the horizontal displacement measure, there was no significant difference between aiming and throwing estimates ( $p > .05$ ), but a significant effect of posture,  $F(2, 66) = 10.1$ ,  $p < .01$ . Participants perceived the hand closer to the midline of the body in the arms-down posture (67.4 cm) than the arms-up posture (75.2 cm). The findings corroborate previous work in suggesting that the goalkeeper can influence perceptions of his maximum reach and the motor behaviour of an opponent by adopting illusory postures. Further investigations need to address whether the effects are also mediated by hand position or perceptions of arm length rather than body height.

### **Nonlinear time series analyses of seated postural control in young adults with spinal cord injury**

Shin, Sunghoon, UIUC; Jacob J. Sosnoff, UIUC

The complex output of the neuromuscular system results from the interaction of multiple control processes operating at unique timescales. When the neuromuscular system is damaged (i.e., decrease in control processes) there is a decrease in physiological complexity. Complexity of neuromuscular system are not quantifiable by traditional distributional techniques, but rather is indexed by various non-linear techniques including approximate entropy (ApEn) and largest Lyapunov exponent (LyE). Seated postural control is a not simple passive alignment of body segments, but rather a complex motor task dependent on sensorimotor integration. Sitting is one of the most frequent and fundamental postures of daily life in individuals with spinal cord injury (SCI). However, there have been minimal examinations of seated postural control dynamics in individuals with SCI. Based on the loss of complexity hypothesis of aging and disease, it was expected that individuals with SCI would have reduced complexity as indexed by ApEn, and LyE compared to healthy controls. To test this hypothesis, a total of 16 young adults (8 with SCI and 8 non-SCI) had their seated postural control recorded. The SCI group was divided into a high injury group (3 persons having greater than T10) and a low injury group (5 persons from T11 to L4). All subjects sat on a force plate with their eyes open for 20s. Results: As predicted individuals with SCI had less complexity in their COP dynamics. The high injury group had lower ApEn compared to the control in both the AP and ML axis (AP: 0.48 vs. 0.44 vs. 0.73 ( $P < .05$ ); ML: 0.38 vs. 0.43 vs. 0.49). Additionally, the high injury group had smaller LyE than the other groups (AP: 0.44 vs. 0.46 vs. 0.58; ML: 0.29 vs. 0.57 vs. 0.73 ( $p < .05$ )). Conclusion: SCI has an effect on the complexity of seated postural control. The lower complexity observed is congruent with the reduced muscular control of individuals with SCI. The findings suggest that individuals who have injury in spinal cord have different dynamic properties to maintain their seated posture.

### **The effect of visual feedback on controlling ROM of leg press exercise**

Song, Ting-Hsuan, National Taiwan Normal University; Yeou-Teh Liu, National Taiwan Normal University

To control of the range of motion (ROM) is the key factor for optimal effect of strength training. Optimal ROM not only ensures the most effective strength training result (Charteris & Goslin, 1986) but also prevents potential injuries due to inappropriate pressures (Prentice et al., 2003). The purpose of this study was to investigate the effect of the augmented visual feedback on controlling the ROM of knee joint during leg-press exercise (Plate loaded hack squat, Cybex). Sixteen healthy participants were divided into visual and intrinsic feedback groups and asked to perform 3 sets of leg press for both light and heavy resistance set. Each set consisted of 8 repetitions. A 2-axial Biometrics' sensor (Goniometer-SG110, 100fps) was attached to the lateral side of the right knee joint to measure the angle of knee movement during the leg press exercise. The visual feedback group was provided with the digital angular displacement of the knee movement shown on a 22-inch computer monitor. The intrinsic feedback group was asked to use their proprioceptive feedback to control the ROM of the knee movement. The absolute error (AE) of the minimum (extension) and maximum (flexion) angular displacement was analyzed separately with the 2 way mixed design ANOVA. For the flexion result, there was a significant resistance level effect, showing a larger AE for the heavy resistance level regardless of the feedback conditions. For the extension, the significant interaction effect indicated a hyperextension tendency in the no-vision group. The results showed a significant feedback mode effect and significant interaction between resistance levels and feedback modes. In conclusion, appropriate resistance and visual feedback both play important roles in controlling ROM of knee during leg press. These findings could

apply to training program for better training outcome, and the future study could explore the long term, transfer effect of the visual feedback condition.

### **Surgical Boot Camp: A novel approach to teaching basic technical skills to surgical trainees**

Sonnadara, Ranil R, University of Toronto; Aaron Van Vliet, University of Toronto; Oleg Safir, University of Toronto; James Burkitt, McMaster University; Richard Reznick, University of Toronto

The traditional model used to train surgeons is one based on the master-apprentice relationship. Trainees are taught operative skills by observing staff and being allowed to gradually perform more of the procedure. The degree of involvement of trainees is limited by the subjective rating of their knowledge by supervising staff, which means that first and second year trainees have few opportunities to participate in any but the most basic of procedures. We examine whether an intensive laboratory-based skills course at the start of training is an effective means for teaching core technical skills. Incoming trainees were divided into three groups (on service (ON),  $n = 5$ ; off service (OFF),  $n = 4$  and new training method (NEW),  $n=3$ ) and baseline surgical skills were assessed prior to training. The NEW group was then given a lab-based surgical skills course, while the other two groups embarked on traditional residency programs. Following the surgical skills course, all trainees had their core surgical skills assessed using an observed structured assessment of technical skills (OSATS) procedure. Pre-training scores revealed no initial differences between the groups of trainees using both checklist ( $F(2,9) = 1.78, p = 0.223$ ) and GRS scores ( $F(2,9) = 0.70, p = 0.52$ ). Post-training scores revealed significant differences between the groups, with trainees from the NEW group performing better on both the checklists (ON = 80.3, OFF = 77.8, NEW = 93.4;  $F(2,9) = 27.94, p < 0.001$ ) and GRS (ON = 3.47, OFF = 3.44, NEW = 4.28;  $F(2,9) = 23.92, p < 0.001$ ) than the other groups who showed no differences between them. The data shows that the course used in this study was effective at developing targeted surgical skills in first year orthopaedic trainees despite small sample sizes. Since practice allows motor skills to be performed with far less cognitive load and attentional focus, we predict that allowing trainees to acquire key technical skills early in training will greatly facilitate learning at the later stages.

### **Sub-maximal force control as a function of shoulder pain in manual wheelchair users**

Sosnoff, Jacob, University of Illinois at Urbana-Champaign; Karla Wessels, University of Illinois at Urbana-Champaign; Steve Serio, University of Illinois at Urbana-Champaign; Jeremy M Butler, University of Illinois at Urbana-Champaign

The majority of manual wheelchair users report shoulder pain. It is not clear if this pain negatively influences muscular force control. The purpose of this investigation was to examine the effect of chronic shoulder pain on force control in manual wheelchair users. Nine manual wheelchair users, four with and five without shoulder pain participated in the investigation. During testing subjects were supine and grasped a manipulandum which placed their shoulder in 90 deg abduction and the elbow secured in a restraint at a 90-deg angle. Force contractions (MVC) of internal and external shoulder rotation were measured using a Humac dynamometer. Subjects produced continuous isometric force output at two force levels (15% and 45% MVC) for 20 s. Visual feedback of their force trajectory was provided in half of the trials. In the remaining trials, visual feedback was occluded after 5 s. The amount of force variability was quantified with standard deviation ( $SD$ ), and coefficient of variation

(sd/mean), while the structure of force variability was indexed with approximate entropy (ApEn). It was found that subjects scaled their force output to the required force targets (15% (.8 N) and 45% (3.6 N)). Overall, subjects were less variable with visual feedback (0.035) compared to no-feedback condition (0.083). The pain group had greater relative variability at lower force levels compared to the no pain group (0.08 vs. 0.05, respectively); however, there was no difference in the structure of force variability between groups (pain (0.35) vs. no pain (0.42)). The findings are in line with the proposition that distinct processes contribute to the amount and structure of force variability. The observations raise the possibility that indices of force variability could be used as a screening tool or marker for shoulder pain in wheelchair users.

### **Self-efficacy for reach actions after stroke: a pilot study**

Stewart, Jill C, University of Southern California; Rebecca Lewthwaite, University of Southern California; Carolee J Winstein, University of Southern California

After stroke, persistent deficits in the ability to incorporate the paretic arm into functional activities are common. In other contexts, self-efficacy (SE) predicts functional recovery, however, little is known about SE for goal-directed reaching after stroke. The purpose of this pilot study was to describe SE for reach actions after stroke and determine the relationship between SE and reach performance. Twelve individuals with chronic stroke and 6 age-matched, non-disabled adults reached to 3-D virtual targets with each arm in a single session. Prior to each of 7 blocks of 24 trials, participants rated SE for reaching to the target 'accurately' and 'quickly' on a scale from 0 ('not very confident') to 10 ('very confident'). Overall, the Control group reported a significantly higher SE for speed than accuracy for both arms (mean right 7.6 vs. 5.7; left 7.1 vs. 5.6,  $p < .05$ ); this difference was not present in the Stroke group (nonparetic 7.8 vs. 6.8; paretic 5.8 vs. 5.1). Instead, SE for reaches with the paretic arm was significantly lower for both accuracy ( $p = .04$ ) and speed ( $p = .04$ ) than for reaches with the nonparetic arm. To examine the relationship between SE and reach performance, correlation analysis was applied to the first 2 blocks of reach trials across all 18 participants. As expected, SE for reach accuracy was inversely correlated with endpoint error ( $r = -.45$ ,  $p < .01$ ) such that when SE was higher, endpoint error tended to be lower. A similar relationship was found between SE for speed and movement time ( $r = -.42$ ,  $p < .01$ ); participants with higher SE for speed reached with shorter movement times. After stroke, SE for reach accuracy and speed was diminished for the paretic compared to the nonparetic arm. A moderate correlation between SE and reach performance was found; future analyses will investigate the strength of these relationships within the Stroke group with additional subjects to determine the degree to which individuals have insight into their capacity for skilled reaching and whether differences exist based on side of hemiparesis.

### **Interlimb transfer as a function of task perception and bilateral practice order**

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The ability to perform motor skills with the non-practiced hand after practicing on one hand, is explained by interlimb transfer of learning (ITL). This phenomenon was reported in many studies, but partly with opposite results. While on the one hand researcher provide evidence for higher transfer from the dominant to the non-dominant side of the body, another group reports opposite findings. It seems undisputed, that ITL is asymmetric in its quality. Further, it is supposed that the direction of higher transfer depends on inherent task demands and the



workspace location in the brain and should be contrary for tasks with high demand on force production and tasks requiring high spatial accuracy and coordination. According to this notion, in the present study two experiments have been carried out, which required subjects to learn precisely controlled pushing movements with the lower limbs in a fully-crossed transfer paradigm with one group initially practiced with the right leg and changed to the left and another group practiced in opposed foot-order. In the “spatial” experiment the learning process was facilitated through information on the covered distances, whereas in the “force control” experiment subjects got information about the impulse realized by pushing on the dynamometric platform (lying in supine position on a horizontal swing). Although both experiments required the activation of the same motor units and muscles, the patterns of interlimb transfer are contrary. While in the “spatial” experiment the left leg benefited from initial practice with the right side and initial right leg practice interfered with left leg performance, in the “force control” experiment ITL occurred in opposite direction. The findings are in line with previous results and the notion, that ITL depends on inherent task demands. Moreover, present data indicates, that the effects are rather caused in the cognitive than in the motor system, since the actual task requirements were equal under spatial and force control condition.

### **Emergent timing is robust for self-paced circle drawing**

Studenka, Breanna E., McMaster University; Howard N. Zelaznik, Purdue University

Timing theorists believe that a clock guides timed repetitive finger tapping. Tasks whose variability correlates with that of table tapping use clock (event) timing, whereas other tasks are timed emergently (Robertson et al., 1999). Kinematics have been used to delineate discrete (event) and continuous (emergent) timing. In tapping, however, perceptual events are unavoidably confounded with kinematic events; contact with the table makes the movement discrete. We showed that, regardless of task, tactile feedback at one place in a movement cycle elicited characteristics of event timing, but reducing tactile feedback elicited more emergent timing. The crucial distinction between event and emergent timing was a perceptual, not a kinematic, event in the movement cycle (Studenka & Zelaznik, NASPSPA 2009). In a follow-up study, we examined individual difference correlations between tapping and circle drawing with tactile feedback events. 40 participants performed 12 trials each of tactile tapping, tactile circle drawing, non-tactile tapping, and non-tactile circle drawing. Participants tapped coincident with 10 tones of a 2 Hz metronome, then continued to move at 2 Hz for 30 un-paced taps. A significant correlation in overall variability, but not clock variability, was found between tactile feedback tapping and circle drawing, indicating shared non-clock timing. A significant correlation in clock variability between non-tactile feedback tapping and circle drawing indicated shared timekeeping. A significant clock variance correlation within tapping and within circle drawing indicated that both kinematic and perceptual events may influence clock variability. In sum, inserting an event into the circle-drawing task did not elicit clock timing for continuation. For circle drawing, events may be needed for accurate synchronization, but for self-paced timing, the event is not useful and can be “ignored.” While clock timing is dependent on the presence of events in movement, the insertion of an event into an emergently timed task does not demand the use of event timing.

### **Examining Impulse-Variability in Overarm Throwing**

Urbin, Michael A., Auburn University; David F. Stodden, Texas Tech University; Rhonda L. Boros, Texas Tech University; David M. Shannon, Auburn University

The purpose of this study was to test the prediction of an inverted-U function according to Impulse-Variability Theory in overarm throwing (Sherwood & Schmidt, 1980). Thirty subjects (20-25 years: 16 skilled, 14 unskilled) were instructed to throw a tennis ball at seven specified percentages of their maximum velocity (40-100%) in random order (9 trials per condition) at a target 30 feet away. Throwing velocity was measured with a radar gun and interpreted as an index of overall systemic force output. Within-subject variability was determined by calculating a composite variable error score from the nine trials collected at each percentage of maximum. Data were analyzed using a within-subjects repeated measures ANOVA (7 repeated conditions) with built-in polynomial contrasts. Results indicated a quadratic fit with variability in throwing velocity increasing from 40% up to 60%, where it peaked, and then decreasing at each subsequent interval to maximum ( $p < .001$ ,  $\eta^2 = .555$ ). Although both skilled and unskilled groups demonstrated similar trends in variability, the unskilled group was significantly less variable ( $p < .037$ ). Overall, these data support Schmidt's contention that variability in force output may decrease as effort approaches maximum, even in a complex, multi-joint ballistic skill. These results also correspond with those of a previous study examining kinematic and kinetic variables associated with the golf swing. Greater standard deviations were exhibited in these variables during partial-effort golf swings (50% effort) as compared to maximum-effort swings (Lemak et al., 1994). Further study of kinematic and kinetic variables associated with overarm throwing and other complex motor skills is necessary to determine if Sherwood & Schmidt's inverted-U hypothesis of force variability is supported.

### **Grip Force Production Linked to Upper Extremity Kinematics Describes Impairments in Bimanual Motor Control in Children with Hemiplegic Cerebral Palsy**

Valvano, Joanne, The Children's Hospital Denver; Jessica Davis, The Children's Hospital; Nancy Denniston, The Children's Hospital; Timothy Nicklas, The Children's Hospital

Independence in children with hemiplegic cerebral palsy (HCP) is influenced by the ability of the affected upper extremity (AUE) to assist in functional bimanual tasks. Practice strategies to improve bimanual performance should address motor control impairments in the AUE that limit these assisting functions. This pilot project identified motor control impairments in the AUE of children with HCP during performance of a functional bimanual task. The study paradigm quantified grip force patterns, which have been previously linked to motor control impairments in these children (Eliasson et al., 1991). It also quantified upper extremity movement patterns with three dimensional kinematic analysis. Participants included 10 children with HCP between 5 and 12 years of age (8.90  $\pm$  2.29) and 15 typically developing children of similar age, who provided a reference for comparison. In the experimental task, the assisting hand reached for and supported an instrumented cup as the dominant hand filled it with tiny objects, and then released the cup onto a surface. Five trials were presented. A typical force profile with mean grip force values corresponding to kinematic events in the experimental task was generated. The HCP group demonstrated significant differences relative to the typical group in grip force events such as peak grip on initial contact ( $p = 0.0025$ ), magnitude of grip during the support phase ( $p = 0.0022$ ) and grip stability measured by the coefficient of variation during the support phase ( $p = 0.0422$ ). The pattern of relationships between kinematic measures of coordination and grip force measures in the HCP group is complex and dependent upon characteristics of the grip force measure. For example, measures of grip force magnitude show moderate to good relationships to proximal trunk and shoulder control while the measure of grip stability did

not and was more related to inter-segmental coordination. The analysis of impairments on the proximal to distal continuum afforded by this novel paradigm confirms the individual expression of impairments in HCP.

### **Gaze focus during bimanual transport and rotate tasks**

Vlasic, Josh, Wilfrid Laurier University; Pamela J Bryden, Wilfrid Laurier University; Michael Cinelli, Wilfrid Laurier University; Andrea Mason, University of Wisconsin

Previous experiments on upper limb bimanual coordination and object rotation have provided some interesting results. In the case where the non-dominant hand is required to perform a more difficult rotation, such as 45 degrees, it completes the rotation component of its movement before the dominant hand (Mason and Bryden, 2009). In order to determine why this is, the current study investigated a similar type of movement while measuring focal points using a gaze-tracking system. Two small objects were to be placed in either two separate target wells, or one single well into which they fit tightly together. Movements were performed in one of two directions: away from the body (into far peripersonal space) and towards the body (into near peripersonal space) with varying degrees of rotation. Movement kinematics were recorded using a system of 8 LED markers placed on the hands as well as the objects. In addition, gaze data was collected for each trial in order to determine focal points during object transport and placement. Fifteen (15) subjects were recruited from Wilfrid Laurier University and gave their full consent for participation. During trials of incongruent rotations, gaze data suggests that participants focus their attention on the non-dominant hand for the majority of the movement until the target is nearly reached, at which point, focus is shifted to the dominant hand in order to confirm its location relative to the desired target. This overt focus on the non-dominant hand is required in order to properly coordinate the more difficult rotation, which in this case is 45 degrees. In the case where the rotation component is the same between the two hands, participants remain focused on the end goals throughout the majority of the trial.

### **Visuomotor adaptation generalizes from bilateral to unilateral movements despite bilateral interference.**

Wang, Jinsung, University of Wisconsin-Milwaukee; Robert L Sainburg, Pennsylvania State University

“Coordinative structures,” thought to be involved in maintaining tight synchrony between the arms during bilateral movement, are less stable for asymmetrical movements requiring non-homologous joint motions between the two arms, which often cause bilateral interference. We previously demonstrated that adaptation to novel visuomotor rotations can generalize from bilateral to unilateral movements, despite the presence of strong bilateral interference. We now investigate how the symmetry of arm movement direction and visual rotation direction between the arms influences the pattern of bilateral interference, as well as the pattern of generalization of visuomotor adaptation from bilateral to unilateral conditions. Subjects first adapted to a 30° visual rotation with one arm, then with both arms, and finally with the arm that was not used in the first session. During the bilateral session, the direction of targets was either intrinsically or extrinsically consistent between the arms, and so was the direction of visual rotations. In general, bilateral adaptation was often accompanied by a large interference effect, which deteriorated performance, especially with the left arm. Despite the lack of improvement during bilateral adaptation in some conditions, however, substantial generalization occurred from the bilateral to unilateral sessions, indicated by a superb

performance in the beginning of the post- unilateral session. Interestingly, the target and rotation directions had interactive effects, showing the least bilateral interference when both types of directions were consistent either intrinsically or extrinsically. Whereas the bilateral control system is known to have a preference for maintaining “mirror-imaged” joint motions between the two arms during continuous tasks, our findings suggest that the preference of the system can change depending on the compatibility between the directions of reaching movement and visual rotations when the visuomotor tasks involve discrete movements.

### **Preferred patterns of joint motions and control strategies during arm movements in 3D**

Wang, Wanyue, Arizona State University; Young-kwan Kim, Arizona State University; Natalia Dounskaia, Arizona State University

Preferences to move in certain directions have been previously revealed during production of arm movements in the horizontal plane. We studied whether similar preferences exist when strokes are produced in other planes. A stroke-drawing task similar to that used previously in the horizontal plane was performed in five different planes: horizontal, sagittal, frontal, left-diagonal and right-diagonal. The task was to produce fast, discrete strokes with the fingertip from the center to the circle perimeter in as many different directions as possible, choosing directions in a random order. Seven degrees of freedom of unconstrained shoulder, elbow and wrist motion were available. Individual histograms of stroke orientations demonstrated directional preferences that were specific for each plane and consistent across the majority of subjects. Analysis of joint kinematics for strokes in the preferred directions revealed a common preference to perform planar movements via flexion/extension of the shoulder and elbow. Other DOFs were minimally involved. Kinetic analysis was performed to compute muscle torque (MUS), interaction torque (INT) and gravitation torque (GRA) at these two major joints. This analysis was limited to the horizontal, sagittal and frontal planes. Movements in the preferred directions were characterized by three major strategies: (1) one joint was actively driven by MUS and the other joint moved largely passively, i.e. due to INT GRA; (2) one joint moved actively (due to MUS) and the other joint was fixed, producing minimal motion; (3) both joints moved passively due to GRA. These results do not fully comply with the traditional hypotheses that muscle effort is minimized during human movement. They rather suggest a preference to simplify neural control by exploiting biomechanical properties of the limb.

### **Coordination of Foot Center of Pressure in the Control of Upright Standing**

Wang, Zheng, The Pennsylvania State University; Kimberlee Jordan, The Pennsylvania State University; Karl M Newell, The Pennsylvania State University

Studies of upright standing typically use a single force platform to evaluate subjects' whole body center of pressure (COPnet) motion. The coordination of the right and left foot center of pressure (COPL and COPR) and its relation to COPnet is neglected by using this traditional approach. In our study, two AMTI force platforms were synchronized for posture testing. It was hypothesized that a weaker coupling of COPL and COPR trajectories would lead to more complexity of COPnet while stronger coupling of the two separate foot trajectories would produce a more predictable motion of the COPnet. 12 young adults (6 males, 6 females) participated in the study by standing still in 5 postures: side-by-side, tandem (left or right foot forward) and staggered (left or right foot forward); and with or without visual information. There were two 60s trials collected for each subject in each condition. Quantification of the variability of COPL and COPR trajectories and their associations with COPnet were

conducted by analysis of *SD*, approximate entropy and relative phase. The results revealed that *SDs* of COPL, COPR, and COPnet were significantly ( $p < .05$ ) influenced by postural mode and to a lesser degree vision. Moreover, the pattern of *SD* for AP and ML motion on each COP variable was different. ApEn showed a different pattern ( $p < .05$ ) as a function of postural mode and AP/ML direction of motion, and was also influenced by vision. ApEn was higher for vision in the normal standing mode than for no vision as previously shown, but the pattern of influence of vision on ApEn was strongly task dependent. Circular statistics of the relative phase angular difference between the pressure patterns of each foot showed significant differences for posture mode and vision, with a larger set of phase angles visited in the less stable postures. The two-platform analysis of postural control reveals different foot center of pressure coordination patterns for different postural modes.

### **The use of attentional focus, and examination of affect and arousal during motor performance and learning**

Williams, Brian M., Southeastern Louisiana University; Jennifer J. Jeansonne, Southeastern Louisiana University; Daniel B. Hollander, Southeastern Louisiana University; Bovorn Sirikul, Southeastern Louisiana University

This present study examined dart throwing performance across five sessions (baseline (30 trials), 3 practices (120 trials/practice), and 2 retentions (30 trials/retention)) between low-skilled performers instructed to use an external (EAF:  $n = 10$ ) or internal (IAF:  $n = 10$ ) attentional focus. A modified dartboard was utilized to measure performance (score range: 1 (center) to 22 (outer-edge); 24 = miss). Additionally, perceived-affect (Feeling Scale), perceived-arousal (Felt Arousal Scale), and heart rate epochs (Polar WindLink system) were recorded before each session and after every 10 trials to assess emotional and arousal differences between the two groups. An ANOVA with repeated measures analyzed performance ( $\alpha = .05$ ) in each session (10 trials  $\times$  block), with independent samples t-tests used for post-hoc testing. Affect, arousal, and heart rate were analyzed via independent samples t-tests. At baseline (no focus use), no significant difference in performance, affect, or heart rate was present, but significance was found with arousal – IAF was lower than EAF ( $p < .05$ ). During the practices, only in the third was performance significantly different, with EAF superior in blocks 1, 4, and 6 ( $p < .05$ ). Affect and arousal scores for IAF were significantly lower than EAF in all three practices. Heart rates for EAF were lower than IAF ( $p < .05$ ) in practice 1 and 3. During the two retention tests, IAF showed better performance; however, the differences were not significant. No differences were reflected in affect and arousal as well. Only with heart rate were there such differences, with EAF lower than IAF ( $p < .05$ ) in both retentions. Contrary to previous research, this study observed no benefit of an external over an internal attentional focus on motor performance and learning. Any differences observed during practice disappeared in retention testing, indicating the probable benefit of both strategies. Furthermore, the emotional and arousal differences among the two groups offer further insight of the impact of these foci on cognitive demand during performance.

### **Use of Nonlinear Gait Analysis Methods to Elucidate Inter-Segmental Coordination Dynamics of Stiff Knee Gait in Children with Cerebral Palsy**

Worster, Kate, The Children's Hospital; Joanne Valvano, The Children's Hospital; James Carollo, The Children's Hospital

In his seminal article, Sutherland et al. (1993) characterized stiff knee gait (SKG) in children with cerebral palsy (CP) by reduced peak knee flexion in swing and slow rate of knee

flexion using kinematic analysis. SKG is associated with tightness and increased activity in the biarticular rectus femoris muscle and is commonly combined with hamstring tightness. More recent research of this common gait pathology indicates precursor events in terminal stance and preswing significantly contribute to limitations in peak knee flexion (Goldberg, 2006). The purpose of this retrospective study was to demonstrate how low-dimensional nonlinear descriptors of gait compliment existing conventional descriptors and elucidate the coordination mechanisms of SKG. A custom program analyzed 3D motion capture data to generate kinematics, phase planes (PP), and continuous relative phase (CRP) angles of 17 subjects diagnosed with spastic CP, ages 4-23, with kinematic indicators of stiff knee gait and no concomitant gait pathologies requiring surgical intervention aside from hamstring tightness. A sample of 30 typically developing subjects provided a comparative reference. Consistent with traditional kinematic descriptors and proposed preswing mechanisms, PP provided insight into the faulty coordination of the thigh in SKG. PP also showed significant differences ( $p < .001$ ) in percent gait cycle of zero point crossings and preswing curvature characteristics associated with late foot off and low angular velocity. The CRP angles of SKG was attenuated at the point in preswing corresponding to the acceleration of the thigh relative to the shank ( $p < .0001$ ), the point in swing corresponding to shank advancement relative to the thigh ( $p < .0001$ ), and slope between these extrema ( $p < .0001$ ). The application of dynamic systems measures complements conventional methods and provides sensitive, low-dimensional descriptors of complex coordination dynamics that are not as easily ascertained from traditional measures and aid clinical interpretation of symptomatic gait.

### **Self-Controlled Learning: Is Self-Regulation Responsible for the Learning Benefits?**

Wu, Will F, California State University, Long Beach; Richard A Magill, New York University

Several studies have demonstrated an enhanced learning effect of self-controlled motor learning in a variety of skill acquisition paradigms, such as augmented feedback (Chiviacowsky & Wulf, 2002; Janelle, Kim, & Singer, 1995), observational learning (Wrisberg & Pein, 2002; Wulf, Raupach, & Pfeiffer, 2003), the use of physical assistance devices (Wulf & Toole, 1999), and practice variability (Wu & Magill, in review; Keetch, & Lee, 2007). Many suggest self-regulatory processes are the driving force behind these observed learning benefits. To investigate the role of self-regulation within self-controlled motor learning this study had forty undergraduate university students learn a three-keystroke pattern with 3 different relative time structures. Participants were randomly assigned to either a self-control or self-control-before condition in which both groups chose the design of their practice schedule. Each participant in the self-control condition chose their respective practice schedules on a trial-by-trial basis during practice; participants in the self-control-before condition chose their practice schedule prior to the start of practice. Results revealed that the self-control group performed better on a 24-hr transfer test than the self-control-before group. These findings support the role of self-regulatory processes within self-controlled motor learning.

### **Impact of blocking factors and analysis methodology on the interpretation of acquisition trials in a simple study of KR frequency.**

Wyatt, William, Indiana University; John B. Shea, Indiana University

One of the most common research designs in the field of Motor Learning utilizes a series of acquisition or practice trials followed by a delay interval and some sort of retention or

transfer test. The analysis dictated by this design usually involves a “block” or trial grouping variable. Commonly ANOVA is utilized and the blocking variable is run as one of the repeated independent variables. Over the years statisticians have debated the validity of a “block” variable. Many authors support the assumption that blocks are fixed or controlled factors and should be analyzed as such. Other authors suggest that trial blocks are arbitrary. The number of trials per block and the number of blocks per condition are selected differently and mostly by convention. Block choice can have a strong impact on the pending analysis. Frequently early blocks have higher variance than later blocks. Small block sizes can suffer from the effects of one or two outliers while large block sizes may inadvertently smooth the data and hide important features. The very nature of the learning process implies that trials are related. That is previous trials impact the current trial just as the current trial will impact future trials. The view of this data as a Time Series is not theoretically novel, however the analysis of learning data through such techniques is rare. By accepting the linked nature of learning data we can utilize advanced statistical procedures to analyze the learning process as a continuous function. Not only can we gain statistically validated insights on learning rates by looking at the derivatives of these functions, but we can be certain that our findings are not biased by grouping procedures designed to condense the data for a specific analysis. Utilizing a simple data set from a study of KR frequency I have shown that not only does block size impact the statistical findings, but the analysis of this data using a Principle Component FDA technique provides further insight into the learning process not previously captured by traditional blocking methods.

### **Comparison Feedback after Good and Poor Trials in Self-Control and Instructor-Control Condition in Acquisition and learning of Force-Production Task**

Zeidabady, Rasool, Elahe Arab Amery, Mahmood Sheikh, Meysam Ebrahim Motesharreyi; University of Tehran

**Objective:** This study aimed to compare feedback after good and poor trials in self-control and instructor-control condition on acquisition and learning of force production task. **Subject:** sixty Subjects were randomly divided into three groups: instructor-control feedback after good and poor trials and self-control feedback groups. **Procedure:** All participants produced 15 kg force in acquisition phase. They could not see the produced force and received KR on two trials in each 6-trial block. At the end of acquisition phase, subjects of self-control feedback group were divided into 2 groups of self-control feedback after good and poor trail. After 24 hour, they performed a retention and transfer tests without KR. **Statistics:** To analyze data, one-way ANOVA and repeated measure test was used (Pd5%). **Results:** Results showed in the instructor-control condition, feedback after good trials group and in the self-control condition, subjects who asked for the feedback after their poor trials, had better learning, and in comparison of two conditions, self-control feedback after poor trials group was better than the other groups. **Conclusions:** It seems in instructor-control condition, learning is facilitated when feedback is provided after good trial. The finding is explained as evidence for a motivational function of augmented feedback. But in self-control condition which have motivational role in nature, the request for feedback after good trials and again using the role of motivational of feedback has no significant effect on learning, in return, subjects who asked for the feedback after their poor trials, because of use simultaneously from motivational and informative role of augmented feedback in this group led to more learning.

**EEG coherence between the verbal-analytical region (T3) and the motor-planning region (Fz) increases under stress in explicit motor learners but not implicit motor learners**

Zhu, Frank F., Institute of Human Performance, The University of Hong Kong; Jamie M. Poolton, Institute of Human Performance, The University of Hong Kong; Richard S.W. Masters, Institute of Human Performance, The University of Hong Kong

Implicit motor learning refers to the acquisition of a motor skill with little accumulation of knowledge that can be verbalized (Masters, 1992). Electroencephalograph (EEG) studies show that compared to novices, experts exhibit low coherence between the left-temporal verbal-analytical region (T3) and the motor-planning region (Fz) in tasks such as rifle shooting (e.g., Deeny et al, 2003). This finding implies that experts have less cognitive engagement with their motor processes. Additionally, Hung et al. (2005) noted that T3-Fz coherence increased significantly under stress in a dart-throwing task, suggesting disrupted psychomotor efficiency (Hatfield & Hillman, 2001) under stress. Implicitly learned motor skills have been shown to remain relatively unaffected by stress (e.g., Masters, 1992). Implicit motor learning may reduce the potential for T3-Fz communication by limiting cognitive engagement in movement. Thus, in implicit learners, psychomotor efficiency may not be disrupted by stress because T3-Fz coherence does not increase. We predicted that participants who acquired a motor skill implicitly would show little or no increase in EEG coherence under psychological stress, compared to participants who learned explicitly. Participants learned a golf putting task either in an errorless learning condition ( $n = 10$ ), previously shown to cause implicit motor learning (e.g., Maxwell et al, 2001), or in normal, explicit, learning conditions ( $n = 9$ ). Coherence between the temporal regions (T3, T4) and the motor planning region (Fz) was calculated for the low-alpha (8-10 Hz), high-alpha (10-12 Hz), low-beta (12-20 Hz) and high-beta (20-28 Hz) bands, and was separately subjected to  $2 \times 2 \times 2$  (Group  $\times$  Condition  $\times$  Pairing) ANOVAs with repeated measures. Compared to coherence values collected in a retention test, which was carried out after learning, T3-Fz coherence for the high-alpha band increased under stress in the group that learned explicitly, but not in the group that learned implicitly. Low EEG coherence may be a signature of implicit motor learning.



### **Smoking Cessation in Women with Severe Mental Illness: Acceptability of Exercise as an Adjunct Treatment**

Arbour-Nicitopoulos, Kelly P, University of Toronto; Guy E Faulkner, University of Toronto; Tony A Cohn, Centre for Addiction and Mental Health; Peter Selby, Centre for Addiction and Mental Health

Previous research supports the use of exercise as an aid for managing acute cigarette cravings and withdrawal symptoms in the general population (e.g., Taylor et al., 2007). Whether these findings extend to smoking cessation among women with severe mental illness (SMI) remains to be examined. The present study involved a qualitative investigation of the role of exercise in smoking cessation for women with SMI enrolled in an established cessation program. Specifically, the aims of the present study were to determine: (1) a framework for understanding exercise and smoking cessation in women with SMI; (2) the specific components of an exercise-smoking cessation program for women with SMI; and (3) the role for healthcare providers (HCPs) in the program. Interviews were conducted with 12 women diagnosed with SMI, all of whom were seeking smoking cessation treatment. Interviews were audiotaped, and then transcribed and coded using a standard thematic analysis approach (Braun & Clarke, 2006). Results indicated three factors (disease/disability vulnerability, mood/affect, weight management) that were important to understanding the role of exercise for assisting smoking cessation in this population. The majority of women preferred moderate-intensity exercise (e.g., walking, yoga, and swimming) that was performed in a group-based format and led by an exercise specialist. HCPs were reported to play an important, supportive role in facilitating smoking cessation and exercise in women with SMI. Forming a collaborative relationship between HCPs and an exercise specialist was an important feature for some of the women. Together, these findings support a potential role for exercise for facilitating smoking cessation in women with SMI. Further inquiry into the utility of the three-factor framework for developing and testing interventions that use exercise as a smoking cessation strategy in women with SMI is recommended.

### **A 6-week Weight Management Program for Women with Schizophrenia: The need for women-centred interventions.**

Arbour-Nicitopoulos, Kelly P, University of Toronto; Guy E. Faulkner, University of Toronto; Venus Shyu, University of Toronto; Tony A. Cohn, Centre for Addiction and Mental Health; Natasha Golding, Centre for Addiction and Mental Health; Ruth Hsueh, Centre for Addiction and Mental Health

Physical inactivity and poor diet are two of the most common, reversible risk factors of cardiovascular disease (CVD) among people with severe mental illness (SMI). Women are often overrepresented in the diagnosis of the most severe forms of mental illness, are less physically active than men, and have higher rates of obesity, placing them at an increased CVD risk.

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\*The abstracts are alphabetically arranged by the first author's surname within each of the three sections—Motor Development, Motor Learning and Control, and Sport and Exercise Psychology.

Gender-based weight management programs may be one effective strategy for improving the health of women with SMI. Our group developed a 6-week, group-based diet and physical activity (PA) program, the Healthy Lifestyle Promotion Program (HELPP), for women with severe mental illness. Female patients ( $n = 23$ ) diagnosed with schizophrenia were recruited from the Centre for Addiction and Mental Health. Overall, 19 of the 23 women (82.6%; age = 41.7  $\pm$  12.0) completed the program, and 10 (43.5%; age = 43.0  $\pm$  9.2) returned for a follow-up booster session. Primary outcomes were self-reported weekly minutes of PA (moderate and vigorous) and daily servings of fruits/vegetables, dairy, meat, grains, and fats. Secondary outcomes were BMI, waist circumference, body image satisfaction, self-efficacy (diet and PA), and quality of life. Mean program attendance was 61.3% pre- to post-program analyses indicated improvements in daily servings of fruits and vegetables ( $p < .05$ ) and fat ( $p < .10$ ), and weekly minutes of moderate PA ( $p < .10$ ). Secondary improvements were also shown for perceived general health ( $p < .05$ ), social and physical functioning ( $p$ 's  $< .10$ ), body image, and self-efficacy ( $p$ 's  $< .05$ ). No changes in BMI or waist circumference were found. At the 6-week follow-up, quality of life (mental health [ $p = .05$ ], and role-physical [ $p < .11$ ]) had improved in comparison to post-program values, while declines were reported in daily servings of grains ( $p < .02$ ), physical functioning ( $p < .02$ ), and weekly minutes of moderate PA ( $p < .13$ ). Lessons learnt from this exploratory study are now being applied to further research on weight management in women with SMI.

### **Braggin' Bruises: A Symbolic Interactionist Approach to Understanding Female Rugby Selves Through Pain, Contact and Aggression**

Baird, Shannon M, The University of Iowa; Kerry McGannon, The University of Iowa

Some behaviors in sport may be labeled: bad, unnecessary and distasteful. Sport psychologists have used concepts of aggression to understand and diminish these behaviors. To date, most research has conceptualized aggression as a product of individual cognition (e.g., intent) and based upon take-for-granted conceptions of aggression as male, physical and other-directed. To better understand sport aggression, it has been argued that symbolic interactionism, viewing aggression as a social construct given meaning through interaction with self and others, has much to offer (Baird & McGannon, 2009). The present study used symbolic interactionism to explore female rugby players' experiences of aggression and how they interpret, define and structure experiences relative to self development. In conjunction with participant observation, 17 semi-structured interviews with female rugby players ages 18-45 ( $n = 12$  on observed team,  $n = 5$  on other teams) were conducted to explore: (1) how women define and experience aggression and (2) how aggression experiences were used in self-construction in and out of rugby. Data emerging from interviews and observations suggested that athletes defined and experienced behavior in ways challenging contemporary sport psychology aggression conceptualizations, with pain, contact and aggression emerging as important in the construction and (re)production of self-related experiences within, and outside of, rugby. Within rugby, these characteristics indicated a player's "rugby-ness". The participants explained, outside of rugby these characteristics were lauded as proof that rugby is a male sport. Rather than (re)define rugby by other female characteristics, these athletes used their rugby selves to say that pain, contact and aggression are not male only behaviors. The women used the bruises on their bodies to claim their rugby selves and prove, "I'm more than you think I am." This presentation concludes with a discussion of how and why this research offers a unique glimpse of female collision athletes' experiences of aggression.

### **The Effects of Exercise on Cognitive Function across the Life Span: A Meta-Analysis**

Barnes, Kelly A., Arizona State University; Chad Rethorst, University of Rochester Medical Center; Jennifer Etnier, University of North Carolina at Greensboro; Bradley Wipfli, Oregon Health & Science University; Daniel Landers, Arizona State University

Prior research on the effects of chronic exercise on cognition have shown inconsistent results and this may be due to differences in study quality, the use of small sample sizes, and limited age ranges. This meta-analysis was conducted with the inclusion of only randomized, controlled trials (RCTs) to examine the effects of exercise on cognitive function among individuals across the lifespan. The analysis of 29 RCTs with 2,541 participants showed that exercise training produced an overall effect size (ES) of 0.25 compared to motivational and no treatment control groups. These results indicate that exercise elicits a small positive effect on cognitive performance that is significantly different from zero ( $p < .05$ ). The pre-post intervention gain score ES for the exercise intervention was 0.39, while the gain score ES for the no treatment control and the motivational control groups were 0.19 and 0.16, respectively. Analysis of moderating variables revealed significant effects for age and exercise frequency. Individuals under the age of eighteen and those who exercised 5 days a week or more were found to show the greatest improvements in cognitive function. Contrary to previous research, the effects of exercise on executive function tasks were not significantly greater than the effects on other cognitive tasks. Due to the inclusion of only RCTs and the large number of participants, this study provides Level 1, Grade A evidence for using exercise as a treatment to improve or slow the decline of cognitive functioning. Given the results of these findings, further examination should be considered in regards to cuts in participation time for physical education in school-aged children as well as more specific exercise programs designed towards dementia and Alzheimer's disease.

### **Self-determination theory and the prediction of ill-being in the sport context: The role of psychological need thwarting**

Bartholomew, Kimberley J., University of Birmingham; Nikos Ntoumanis, University of Birmingham; Cecilie Thøgersen-Ntoumani, University of Birmingham

The current paper aims to explore the social-contextual antecedents of athlete well-being/ill-being based upon the framework of self-determination theory (Deci & Ryan 2002). In particular, it will question whether low scores on measures of psychological need satisfaction adequately tap the intensity of need deprivation that Deci and Ryan (2000) describe as states of need thwarting. The findings from two independent samples will be presented. The first sample consisted of 294 athletes competing at club through to international level. The concurrent relationships between athletes' perceptions of autonomy-supportive and controlling coaching behaviors, psychological need satisfaction and thwarting, positive and negative affect, and burnout symptoms were examined. The second sample consisted of 303 female athletes drawn from aesthetic and/or weight-related sports and explored additional outcomes associated with sport participation, including vitality, depression, and disordered eating behaviors. In both samples, structural equation modeling analysis supported latent factor models in which need satisfaction was better predicted by autonomy-supportive behaviors and need thwarting was better predicted by coach control. Athletes' perceptions of need satisfaction predicted positive outcomes associated with sport participation (vitality and positive affect) whereas need thwarting consistently better predicted maladaptive outcomes (burnout, depression, and negative affect). Further, disordered eating was predicted by need

thwarting only. These findings have important implications for the operationalization and measurement of psychological needs in sport and highlight the importance of future work investigating the consequences of need thwarting.

### **An Expectancy-Value Approach to Coach and Parent Influence on Adolescent Girls' Developmental Experiences in Sport**

Bhalla, Jennifer A., University of Minnesota; Maureen R. Weiss, University of Minnesota

Several studies have examined parental influence on youth development in sport within Eccles' expectancy-value framework (Fredricks & Eccles, 2004), but limited research has investigated the interactive influence of parents and coaches on adolescents' developmental experiences. The purpose of this study was to examine coaches and parents together as sources of adolescent female athletes' psychosocial outcomes through sport using expectancy-value theory as a framework. A qualitative design was used to assess youths' perceptions of coach and parent influence on expectations of success and subjective task values. Seven Caucasian and eight African American girls (ages 14-18 years) on competitive basketball teams participated in an in-depth interview that tapped questions relating to parent and coach influence on expectancy-value constructs. Inductive and deductive content analyses revealed that girls from both groups believed that coaches and parents inspired their interest in, usefulness of, and importance of success in basketball by offering social support, providing access to opportunities, making connections between current play and future goals, and teaching life skills. For example, girls said that coaches and parents connected current participation with future opportunities such as earning a college scholarship, and coaches and parents taught them life skills, which boosted interest and utility value for basketball. Racial differences also emerged; Caucasian girls indicated that some coaches showed a negative attitude, lowering their interest, whereas African American girls reported that coaches made basketball fun, improving their interest for continued participation. Findings extend the knowledge base on significant adults' behaviors that promote perceived competence and subjective task values by examining girls' perceptions of coaches and parents together and by considering differences for girls who vary in racial and ethnic diversity.

### **The Prosocial and Antisocial Behavior in Sport Scale: Further Evidence of Reliability and Validity**

Boardley, Ian D, University of Birmingham; Maria Kavussanu, University of Birmingham; Nicholas Stanger, University of Birmingham; Christopher Ring, University of Birmingham

Kavussanu and Boardley (2009) developed the Prosocial and Antisocial Behavior in Sport Scale (PABSS) to measure prosocial and antisocial behaviors toward teammates and opponents. However, although they provided evidence for some aspects of construct validity and reliability, they did not examine convergent validity or test-retest reliability. This research aimed to provide initial evidence for the convergent validity and test-retest reliability of the PABSS, and further evidence for its concurrent and discriminant validity in two studies. In Study 1, male ( $n = 73$ ) and female ( $n = 56$ ) team-sport athletes completed the PABSS as well as measures of aggression, hostility, anger, moral identity, and empathy, and a subsample ( $n = 111$ ) completed the PABSS again one week later. Antisocial behaviors toward teammates and opponents were positively related to physical and verbal aggression, hostility, and anger, and negatively related to moral identity and empathy. Prosocial behavior toward opponents was positively related to moral identity, and both prosocial behaviors were unrelated to

aggression, anger, and hostility. Test-retest reliability ranged from .71 to .86. In study 2, male ( $n = 53$ ) and female ( $n = 36$ ) team-sport athletes completed the PABSS along with sport-specific measures of aggressiveness, anger, moral attitudes, moral disengagement, goal orientations, and anxiety. The antisocial subscales were positively correlated with aggressiveness, anger, cheating, gamesmanship, and moral disengagement whereas with the exception of a moderate positive relationship between prosocial teammate behavior and gamesmanship the prosocial subscales were not. The only significant relationship between the four types of behavior and goal orientation and anxiety was a moderate negative relationship between task goal orientation and antisocial opponent behavior. Overall, the results from these two studies provide evidence for the convergent, concurrent, and discriminant validity, as well as the test-retest reliability of the PABSS.

### **Morality in sport versus university**

Boardley, Ian D., University of Birmingham; Maria Kavussanu, University of Birmingham; Chris Ring, University of Birmingham

Previous research (e.g., Bredemeier & Shields, 1986) has suggested that moral reasoning may be less mature in sport than in everyday life. The current research extended this work by examining the stability and change of a number of moral variables across sport and university contexts. Specifically, male ( $n = 210$ ) and female ( $n = 162$ ) student athletes competing in the sports of hockey, netball, basketball, soccer, American football, and rugby, completed questionnaires assessing prosocial and antisocial behaviors and moral disengagement in the sport and university contexts. Prosocial and antisocial behaviors in sport were assessed using the Prosocial and Antisocial Behavior in Sport Scale (Kavussanu & Boardley, 2009) and an adapted version of this scale was used to assess respective behaviors in the university context. Moral disengagement in sport was assessed using the Moral Disengagement in Sport Scale – Short (Boardley & Kavussanu, 2008) and in university using an adapted version of the scale developed by Bandura et al. (1996). Contextual stability for all variables was evidenced through large positive cross-context correlations ( $r$  range = .46 to .60). With respect to cross-contextual differences, analyses indicated that: (a) antisocial behavior toward opponents and prosocial behavior toward teammates were more frequent in sport than university context, (b) prosocial behavior toward opponents occurred less frequently in sport than university, and (c) moral disengagement was higher in sport than in university.

### **Coaching for Character: Development and Initial Validation for a Measure of Coaching Behaviors Focused on Sportsmanship**

Bolter, Nicole D, University of Minnesota; Maureen R Weiss, University of Minnesota

While extensive knowledge exists about how coaches influence youth sport participants' motivational outcomes, less is known about mechanisms for promoting sportsmanship. The purpose of this study was to create a valid measure of coaching behaviors focused on sportsmanship by initiating four phases: (a) literature review, (b) focus groups, (c) expert panel, and (d) pilot study. In Phase 1, a review of over 150 journal articles and 30 book chapters uncovered six behaviors by which coaches influence athletes' sportsmanship. In Phase 2, six focus groups were conducted with 30 high school athletes. Interview questions were guided by the six coaching mechanisms identified in Phase 1 by asking youth if and how coaches teach for sportsmanship. Using inductive and deductive content analysis, nine higher-order themes emerged about coaching behaviors focused on sportsmanship. In Phase 3, an expert panel of 10 professionals provided feedback on a pool of items generated from

focus group responses in Phase 2. Based on panelists' feedback, a 55-item measure was created representing nine coaching behaviors: (a) sets expectations for sportsmanship, (b) reinforces good sportsmanship, (c) punishes poor sportsmanship, (d) discusses sportsmanship, (e) teaches good sportsmanship, (f) teaches poor sportsmanship, (g) models sportsmanlike behaviors, (h) models unsportsmanlike behaviors, and (i) prioritizes winning over sportsmanship. In Phase 4, a pilot study was conducted with 34 high school athletes, who completed the measure created in Phase 3. Item analyses (squared multiple correlation, item-total correlation, inter-item correlations, alpha coefficient) were inspected to determine whether individual items and subscales were reliable. One subscale, teaches poor sportsmanship, and associated items were deleted and other subscales were trimmed by 1-2 items. These modifications resulted in a final measure including 8 subscales and 40 items. Collectively, results from all four phases provide initial validation for a measure of coaching behaviors and youths' sportsmanship outcomes.

### **Self-regulation Depletion and Exercise Endurance: A Test of the Energy Conservation Hypothesis**

Bray, Steven R., McMaster University; Courtney Clayton, McMaster University; Kathleen A. Martin Ginis, McMaster University; Jeffery Graham, McMaster University

The limited strength model describes self-regulation as a limited, consumable internal resource that is depleted when people control their emotions, thoughts or behaviors (Baumeister et al., 1998). Muraven et al. (2006) suggest people make efforts to conserve self-regulatory strength prior to performing tasks requiring high self-regulation. We examined effects of self-regulation strength depletion on physical stamina as well as strength conservation strategies when anticipating future self-regulatory strength depletion. Individuals were expected to show greater declines in physical endurance following self-regulation depletion compared to a non-depleting control task. It was also predicted that participants who had experienced high levels of depletion would alter their strategies in order to conserve self-regulation strength when anticipating self-regulation demands on a similar task. The study used a 2 × 2 cross-over design. Participants ( $n = 31$ ,  $M$  age = 21.72  $\pm$  2.57 yrs) performed two isometric ankle dorsiflexion endurance trials at 50% maximum voluntary contraction (MVC) separated by either a cognitive depletion (modified Stroop) or control (colour word reading) task in the first testing session. They then crossed over to the alternate condition in a second testing session one week later. Greater endurance performance declines were observed in the cognitive depletion condition ( $M$  Delta = -14.70 s) compared to control ( $M$  Delta = -4.74 s),  $F(1,29) = 2.65$ ,  $p = .11$ , Cohen's  $d = .27$ . A time × condition interaction revealed participants who experienced cognitive depletion during the first session significantly reduced their endurance performance on the pre-test from one session to the next ( $M$  Delta = 20.56,  $p = .02$ ), while the control group did not ( $M$  Delta = 6.44,  $p > .10$ ). Results suggest cognitive self-regulation depletion impairs physical performance under novel conditions; however, people may modify physical effort regulation in order to conserve self-regulation strength when anticipating future depletion from both mental and physical tasks.

### **Brain Drain: Cognitive Task Performance Depletes Maximum Voluntary Effort for Exercise**

Bray, Steven R., McMaster University; Jeffrey Graham, McMaster University; Kathleen A. Martin Ginis, McMaster University; Audrey L. Hicks, McMaster University

Early observations by Mosso (1891) and recent data show that performance of cognitively-depleting, executive control tasks causes mental fatigue that can have negative spillover effects on submaximal exercise performance (Bray et al., 2008). The purpose of this study was to investigate spillover effects of demanding cognitive task performance on intermittent maximal exercise performance. Participants ( $n = 38$ ;  $M$  age = 21.47  $\pm$  3.16) performed 5 brief (4-sec), maximum voluntary handgrip force contractions (MVC) separated by 1-min rest and were then randomized to perform either a modified Stroop task (Depletion condition) or a color word reading (Control condition) task for 22 min. After the first min and at 3-min intervals thereafter, participants took a 10-sec break from reading to rate feelings of fatigue and perceived mental exertion and to perform a 4-sec MVC handgrip squeeze. To control for inter-individual differences in handgrip strength, baseline performance ( $M$  of 5 squeezes) was used to determine the proportional force (% of baseline) generated on each of the subsequent squeezes. A  $2 \times 8$  mixed ANOVA on the force generation data showed a significant group  $\times$  time interaction,  $F(7, 259) = 2.43, p = .02$ , with a significant linear reduction in MVC force production over time in the Depletion condition ( $p = .01$ ) and no change in force production for Controls ( $p > .50$ ). Separate 2 (group)  $\times$  8 (time interval) mixed ANOVAs showed no between-groups differences in fatigue, but a significant interaction for perceived mental exertion,  $F(7, 252) = 2.39, p < .05$ . Mirroring the findings for force production, there was a linear increase in perceived mental exertion for the Depletion condition over time ( $p < .001$ ), but not for the Controls ( $p > .20$ ). Findings support current views that performance of cognitively-demanding tasks diminishes a common pool of central nervous system resources that govern self-regulation of tasks requiring maximal voluntary physical effort (Baumeister et al., 2007). Implications for exercise performance will be discussed.

### **Breast cancer survivors' goal adjustment processes: Associations with physical activity behavior and subjective well-being.**

Brunet, Jennifer, McGill University; Catherine M. Sabiston, McGill University; Carsten Wrosch, Concordia University

The purpose of this cross-sectional study was to examine the influence of goal adjustment processes (goal disengagement and goal reengagement) on physical activity behavior and indices of subjective well-being (posttraumatic growth, positive affect, stress, negative affect) among breast cancer survivors. This pilot study was designed on the basis of theories of adaptive self-regulation (Carver & Scheier, 1998; Wrosch et al., 2003, 2006). Eighty-two breast cancer survivors (mean age = 55.10,  $SD = 9.47$  years) completed scientifically validated questionnaires and wore a pedometer for seven consecutive days. Separate hierarchical regression analyses, controlling for age and time since treatment, accounted for 4% to 23% of the total variance in physical activity and indices of subjective well-being. Goal reengagement was positively associated with self-reported physical activity ( $\beta = .26$ ), posttraumatic growth ( $\beta = .25$ ), and positive affect ( $\beta = .49$ ), and negatively linked with stress ( $\beta = -.33$ ) and negative affect ( $\beta = -.19$ ). Goal disengagement was negatively associated with posttraumatic growth ( $\beta = -.22$ ). Findings provide insight into the association between breast cancer survivors' goal adjustment processes, physical activity, and subjective well-being. Specifically, they support the notion that goal disengagement and goal reengagement should be studied as distinct constructs as they are differently linked to indicators of quality of life. Furthermore, they highlight the important role of adaptive goal-related coping in maintaining breast cancer survivors' physical health and psychological

well-being. This study was funded by a 2008 NASPSPA Graduate Student Research Award and subsidized by a CIHR grant.

### **Effects of an Acute Exercise on Executive Function in Middle-Aged Adults**

Chang, Yu-Kai, National Taiwan Sport University; Jeffrey D. Labban, University of North Carolina at Greensboro; Chun-Chin Wang, National Taiwan Sport University; Feng-Tzu Chen, National Taiwan Sport University

Research examining the effects of exercise on cognitive performance has received more attention recently. These beneficial effects of exercise on cognition have been evidenced in empirical and meta-analytic reviews. However, such research also demonstrates discrepant findings, or else only minor benefits are found to exist in test participants. Types of cognitive ability and populations might be considered as responsible methodological factors having variable influence. Therefore, the purpose of this study is to explore the effects of an acute bout of exercise on executive functions using two popular neuropsychological tests, the Wisconsin Card Sorting Test (WCST) and Tower of London Test (TOL) among middle-aged adults. 24 adults (age = 44.29 yrs,  $SD = 5.18$ ) were randomly assigned into either exercise ( $n = 12$ ) or control condition ( $n = 12$ ) groups, and were instructed to perform the WCST and TOL with random order at the baseline and immediately following performances of the treatment. The exercise conditions involved 30 minutes of ergometer cycling at a 60% heart rate reserve based on each individual's physical activity level. A two-way mixed AONVA was computed between conditions and times on subcomponents of WCST and TOL, separately. The results indicate that the time factor has a significant main effect, which indicates the learning effect. In addition, although those in the exercise condition group tended to register better performance scores than those in the control condition group, non-significant differences were found in interaction between the condition and time factor. The findings suggest that there is a limit to the beneficial effects of acute exercise on executive functions measured specifically by WCST and TOL among middle-aged adults. Possible interpretations for the present study and future research are discussed.

### **The effects of acute exercise on cognitive performance: A comprehensive meta-analytic review**

Chang, Yu Kai, National Taiwan Sport University; Jeffrey D. Labban, University of North Carolina at Greensboro; Jennifer I. Gapin, University of North Carolina at Greensboro; Jennifer L. Etnier, University of North Carolina at Greensboro

There is a substantial body of literature related to the effects of a single session of exercise (acute exercise) on cognitive performance. This literature has been reviewed narratively on several occasions and, although the research findings are mixed, researchers have generally concluded that there is a positive effect. Results of a previous meta-analysis (Etnier et al., 1997) are consistent with this conclusion in that a small positive effect was reported from 55 studies ( $ES = 0.16$ ). The purpose of this meta-analysis was to provide an updated comprehensive analysis of the extant literature on acute exercise and cognitive performance. Searches of electronic databases and examinations of reference lists from relevant studies were used to identify 162 studies initially deemed to be relevant. When further examined, 75 studies met the inclusion criteria and had sufficient data to calculate effect sizes. Statistical analyses of the data indicated that the overall was small ( $g = 0.07$ ,  $n = 1052$ ) which is generally consistent with past findings. Examination of cognitive task type as a moderator of the effects showed that larger effects were evident for measures of executive function ( $g = 0.15$ ,



$n = 159, p < .05$ ) than for measures of memory ( $g = 0.08, n = 198, p < .05$ ) and information processing ( $g = 0.09, n = 168, p < .05$ ) which were larger than for measures of reaction time ( $g = 0.02, n = 305$ ). Examination of the influence of exercise intensity on the effects indicated that across cognitive tasks, effects were largest for the very light (<50% max) intensity exercise ( $g = 0.09$ ) and for maximal exercise ( $g = 0.10$ ) and were smaller for all other exercise intensities. In conclusion, the effects of acute exercise on cognitive performance have been repeatedly shown to be small. However, future analyses designed to further our understanding of variables that impact the size of this effect and of mechanisms that explain this effect remain important. It is conceivable that even these small effects could have a meaningful impact on cognition if performed appropriately and by groups with cognitive challenges.

### **The Chinese Version of Students' Perceptions of Teacher Feedback in Physical Education: Developing Validation and Reliability**

Chang, Lu-Chun, Graduate Institute of Physical Education, National Taiwan Sport University; Ho-Cheng Chou, Department of Adapted Physical Education, National Taiwan Sport University; Ya-Wen Hsu, Graduate Institute of Physical Education, National Taiwan Sport University

Although a number of previous systematic observation literatures revealed that teacher feedback was an important element in motor-skill learning in physical education, findings of teacher feedback were still controversial. One of the possible explanations of the inconsistent results was that most of previous research did not take the students' perception of teacher feedback into account. Given that students' perception of teacher feedback is a link between the teaching-learning processes, it is essential to understand the perception of students. The purpose of this study was to confirm the overall fit, reliability, and convergent validity of a Chinese version of Students' Perceptions of Teacher Feedback Questionnaire (PTFQ). Two studies were conducted with two independent samples ( $N1 = 591$  and  $N2 = 546$ ) from junior and senior high schools in Taiwan. Two different versions of PTFQ (i.e. Nicaise's English version questionnaire and Koka and Hein's (2005) questionnaire) were chosen for the initial comparison. 14 items were added to Nicaise's PTFQ in order to merge the original feedback categories. The first study analyzed the underlying constructs of students' perceptions of teacher feedback. Through a series of back-translation analysis, item analysis, and exploratory factor analysis, the first version of Chinese PTFQ with revised 12-items was generated from Nicaise's questionnaire. Subsequently, the second study confirmed a first-order model of 10 items representing 3 factors, including positive verbal and nonverbal feedback, negative verbal feedback, and negative nonverbal feedback through confirmatory factor analysis. Besides, convergent validity was tested by motivation in physical education as a criterion. Finally, a 10-item, Chinese version of questionnaire measuring "Students' Perceptions of Teacher Feedback in Physical Education" was developed. More studies are needed to examine the factorial stability and the generalizability for students from different developmental stages.

### **The relationships between hope and competitive state anxiety among tennis players: A mediation effect of sense of control**

Chen, Chien-Wei, National Taiwan Sport University; Li-Kang Chi, National Taiwan Normal University; Chien-Chih Hong, Tamkang University

The present study combined Snyder and his colleagues' (1991) hope theory and Jones's (1995) model of debilitating and facilitative competitive state anxiety to examine the

relationships between hope, sense of control, and intensity and direction of state anxiety among collegiate tennis players. Participants were 145 Division II collegiate tennis players (84 males and 61 females) aged 21.61 years recruited from different college tennis teams in Taiwan. Their experience in practicing tennis was 4.06 years. After received the informed consent, participants were asked to complete a questionnaire which assessed their hope, sense of control (including expectations of ability to cope and goal attainment), and intensity and direction of state anxiety about one hour before their matches. The results indicated that hope, and sense of control (expectations of ability to cope and goal attainment) were significantly positive correlated with direction of state anxiety, and were significantly negative associated with intensity of state anxiety among tennis players. Furthermore, the structural equation modeling was used to examine the hypothetical model. It was hypothesized that hope positively predicted sense of control and then positively predicted the direction of state anxiety and negatively predicted the intensity of state anxiety. The chi-square value of this model was 9.90 (8),  $p > .05$ . The value of the four fit indices suggested by Hu and Bentler (1999) in this model were all acceptable (CFI = .99; NNFI = .98; RMSEA = .041; SRMR = .033). All parameters were significant ( $p < .01$ ) in this model. In accord with the theories of Jones' model of state anxiety and hope theory, the results indicated that hope indirectly affected the intensity and the direction of precompetitive state anxiety through their impact on the sense of control (expectations of ability to cope and goal attainment). The implication of this study indicated that hope can be an important antecedent in terms of predicting sense of control and intensity and the direction of precompetitive state anxiety.

### **The EEG characteristics of distraction prior to the imperative stimulus in table tennis players**

Chen, Ling-Chun, National Taiwan Normal University; Tsung-Ming Hung, National Taiwan Normal University

Distraction is the key factor that influences athletes' performance. The purpose of present study was to compare the EEG activity prior to the imperative stimulus in a cued reaction time task between no response (distraction) condition and correct response condition to shed light on the EEG characteristics of distraction. Ten pre-elite table tennis players were recruited and requested to perform cued reaction time task. Alpha, beta and theta power of EEG at Fz, Cz, Pz and Oz two seconds prior to the presentation of imperative stimulus were analyzed. 2(conditions)  $\times$  4(epochs)  $\times$  4(electrodes) ANOVAs with repeated measures were employed. The results showed that there is a condition by electrodes interactions in alpha, beta, and theta activity. Specifically, both alpha and theta power are higher while beta power is lower in no response condition at Fz. The alpha and theta power is higher in no response condition at Cz. The beta power is higher in no response condition at Pz and Oz. In addition, it's interesting to note that no epochs effects on the EEG data. Taking the findings together, higher alpha and theta, and lower beta at the anterior brain while simultaneously accompanied by higher beta at the posterior brain seems consist of the distractive brain. And the lack of epoch effect suggests the brain is distracted throughout the entire reaction time trial. This finding will be useful to understand the cortical mechanism of distraction and shed light on the possibility of intervention.

### **Effects of an Acute Exercise on Cognitive Aspects of the Tower of London Test**

Chen, Feng-Tzu, National Taiwan Sport University; Yu-Kai Chang, National Taiwan Sport University; Chun-Chih Wang, National Taiwan Sport University; Kuei-Hui Chan, National Taiwan Sport University; Shih-Hsien Yen, National Taiwan Sport University

Considered literature has evidenced the positive effects of acute exercise on cognitive functions; however, specific cognitive categories influenced by exercises have only been recently explored. Therefore, the purpose of this paper is to extend the knowledge of these investigations by examining the effects of an acute bout of aerobic exercise on a specific cognitive category, executive function. 21 College participants (age = 22.71 yrs,  $SD = 2.05$ ) were randomly assigned into either exercise condition ( $n = 12$ ) or control condition ( $n = 9$ ) groups, and were instructed to perform the Tower of London Test, a popular neuropsychological assessment for measuring executive functions, at baseline and immediately following performances of the treatment. The exercise conditions involved 30 minutes of ergometer cycling at a 60% heart rate reserve. A one-way ANOVA was computed between the two condition groups, in which a pre-test was used as covariate. The results indicate that the exercise group achieved significant improvement in subcomponents of the total moves score and time of total execution and total problem-solving. No significant differences were found in violation related scores and initiation time. The findings suggest an acute bout of moderate intensity exercise might have specific effects for facilitating both spatial and object working memory, and overall planning and executive speed.

### **The prediction of coach-athlete relationships on coach's and athlete's satisfaction, motivation, and performance.**

Chi, Likang, National Taiwan Normal University; Yen-Hun Chiang, National Taiwan Sport University; Yun-Chi Ye, National Taiwan Sport University

The purpose of this study was to examine the prediction of coach-athlete dyadic relationships on coach's and athlete's motivation, satisfaction, and performance by using Jowett's (2006) 3 + 1Cs model. Sixty-two collegiate athletes and their coaches were asked to complete questionnaires which assess coaches' and athletes' direct measures of coach-athlete relationship, satisfaction with the relationship, motivation, and performance. The analyses include three different approaches: athlete's direct perspective, coach's direct perspective, and coach-athlete assumed similarity of co-orientation. In terms of the athlete's perspective, the results of multiple regression analyses indicated that closeness and complementarity significantly predicted athlete's satisfaction with coach. Commitment and complementarity significantly predicted athlete's motivation. Athlete's performance was only predicted by complementarity. The total explained variance of the predicting utility of closeness, commitment, and complementarity on satisfaction, motivation, and performance were 81%, 86%, and 62% respectively. In terms of the coach's perspective, the results indicated that commitment and complementarity significantly predicted coach's satisfaction with athlete and motivation. Coach's performance was only predicted by commitment. The total explained variance were 87%, 92%, and 79% respectively. In terms of the coach-athlete assumed similarity perspective, the results indicated satisfaction was predicted by the interaction of assumed similarity and athlete direct measure of closeness. Specifically, athletes reported high satisfaction when they perceived high closeness and high assumed similarity of closeness. Furthermore, athletes' performance was significantly predicted by the interaction of assumed similarity of commitment and athlete direct measure of com-

mitment. Specifically, athletes performed better when they perceived high commitment and high assumed similarity of commitment

### **The Predictive Strength of Emotional Intelligence on Emotional Stability of Basketball Players**

Choi, Youngjun, Korea University; Seunghyun Hwang, Michigan State University

There have been researches investigating emotional stability in sport as one of the factor to predict better performance. However, researchers have little focused to identify the antecedent of player's emotional stability. The purpose of this study was to examine the effect of emotional intelligence on emotional stability of basketball players, within the Individual Zone of Optimal Functioning (IZOF) model proposed by Hanin (1993, 1995, 1997). The participants were 180 from men's collegiate basketball teams in South Korea ranging from 19 to 28 years of age ( $M = 22.31$ ,  $SD = 2.11$ ). Emotional intelligence was measured by the MVSEIS (Austin, Saklofske, Huang, & McKenney, 2004). It has 28 items on a 5-point Likert scale and three factors, which are regulation, utilization, and appraisal of emotions. And, the data for emotional stability was collected longitudinally, 4 weeks apart. It was evaluated by calculating the amount of overlap scores (Karahe, 1986) in the two lists of emotions selected from the list of stimulus example of emotion, which has been developed by Hanin (see, Hannin, Jokela, & Syrja, 1998). The results indicated that the players' emotional intelligence partially predicted the emotional stability. Only the ability to appraise emotion significantly predicted stability of positive emotion when they recalled the best competition ( $\beta = .21$ ) and the worst competition ( $\beta = .22$ ). This finding suggests that players who have a higher level of ability to appraise their emotional status tend to show better emotional stability in the positive moods when they recall their performance.

### **The relationships between coaching efficacy, collective efficacy, team performance and satisfaction in youth softball teams**

Chou, Yen-hsin, National Taiwan Normal University; Chen-an Yu, National Taiwan Normal University; Li-kang Chi, National Taiwan Normal University

The purpose of this study was to determine the relationship between coaching efficacy, collective efficacy, team performance and satisfaction in softball. Participants were female youth softball athletes ( $n = 105$ , 22 pitchers, 41 infielders and 42 outfielders) and their coaches in 7 different Taiwan youth softball teams. Athletes' average age and training experience were 14.6 and 2.77 years; coaches' average age and coaching experience were 35.78 and 9.11 years, including 1 male and 6 females. The athletes were administered Collective Efficacy Questionnaire for Sports (CEQS) to measuring collective efficacy and also their team satisfaction; coaches were administered the Coaching Efficacy Scale (CES). Regression analyses showed that there were no significant relationship between coaching efficacy and collective efficacy. Collective efficacy significantly predicted team performance and satisfaction, respectively. According to the result of this study, data support our hypothesis that collective efficacy can predict team performance and satisfaction. Further study is needed to confirm the coach efficacy in youth sport.

### **Examining the influence of social interaction on collective efficacy dispersion using social network analysis**

Chow, Graig M, UCLA; Deborah L Feltz, Michigan State University

Previous studies have focused almost exclusively on the magnitude of collective efficacy, while treating the degree of within-team variability or dispersion as merely a statistical prerequisite to justify aggregation. Thus, little is known about why some teams develop more interrelated collective efficacy beliefs, while other teams develop more dispersed collective efficacy beliefs. Researchers have speculated that substantial social interaction within teams is a necessary precondition for the development of shared collective efficacy beliefs (Jung & Sosik, 2003; Lindsley, Brass, & Thomas, 1995). This study utilized a social network analysis framework to investigate the influence of social interaction, conceptualized as communication and friendship networks, on collective efficacy dispersion. The sample consisted of 46 intercollegiate women's softball teams. A longitudinal design was employed with two time points: beginning of the season and middle of the season. Collective efficacy beliefs were assessed at both time points, while social interaction was assessed at Time 2 using a sociometric questionnaire. Based on the sociometric data, group-level social network metrics were calculated (density and centralization) for communication and friendship ties and cohesive subgroups were identified using Clique Finder (Frank, 1995). Results demonstrated that teams with communication subgroups had more collective efficacy dispersion than teams without communication subgroups. In addition, teams with decentralized communication structures had less collective efficacy dispersion than teams with centralized communication structures. Follow-up analyses using multilevel modeling revealed that subgroups aligned by collective efficacy, indicating that members of cohesive subgroups held similar collective efficacy beliefs. The findings provide support for a relationship between social interaction and the degree of shared collective efficacy beliefs within teams.

### **The relationship among sport-specific threat cues, life-related threat cues, trait anxiety and competition trait anxiety in archers**

Chuang, Lan-Ya, Department of Physical Education; Tsung-Min Hung, National Taiwan Normal University

According to cognitive models of anxiety, anxious individuals show preference for threatening information. The main purpose of the study was to investigate whether sport-specific threat cues and life-related threat cues induce various degrees of attentional bias, and to further explore the relationships among different properties of threat cues, trait anxiety and competition trait anxiety in archers. Twenty-three undergraduate and high school archers with a mean age of 17.65 years ( $SD = 1.94$ ) were administered STAI-T (State-Trait Anxiety Inventory, Trait version) and SCAT (Sport Competition Anxiety Test) tests three days before the experiment. Three participants were excluded due to low self-reported anxiety. The assessment task (dot-probe) consisted of two sections, each of which contained three blocks (144 trials). Induced attentional bias scores (ABS) between sport-specific threat cues and life-related threat cues were compared by paired t-test. Pearson correlations were calculated with STAI-T scores, SCAT scores, ABS induced by archery-related threat cues and life-related threat cues. The results showed that different threat cue properties induced similar degree of attentional bias, but the ABS induced by archery-related threat cues were negatively correlated to SCAT. The present study did not observe the difference of attentional bias between sport-specific threat cues and life-related threat cues, but a negative relationship between attentional bias induced by archery-related threat cues and competition trait anxiety was found. This indicates that athletes who possess higher competition trait anxiety are more likely to demonstrate attentional avoidance from threatening information pertaining to their sport.

### **Imagine that! Investigating the relationship between exercise experience and imagery use among females**

Cooke, Lisa M, University of Windsor; Krista Munroe-Chandler, University of Windsor

Given the prevalence of inactive Canadian women (CFLRI, 2005), it is imperative to examine motivational sources that may influence exercise behaviour. One such source is imagery (Hausenblas et al., 1999). The current study examined a proposed relationship in Munroe-Chandler and Gammage's (2005) applied model of imagery use in exercise, particularly the role of an exerciser's experience (length of time one has been exercising) on her use of imagery. Female exercisers ( $n = 300$ ,  $M$  age = 34.2 years) completed a demographic questionnaire as well as the Exercise Imagery Inventory-Revised (EII-R; Giacobbi et al., in press). Using a tertile split, participants were grouped into three levels of experience, with the extreme groups reflecting less ( $n = 100$ , < 2 years) or more ( $n = 108$ , > 10 years) experience. A multivariate analysis of variance revealed a significant difference between the two extreme groups of exercise experience and imagery use ( $F = 3.81$  (5, 202),  $p < .05$ ). Specifically, less experienced exercisers employ exercise self-efficacy imagery more frequently than more experienced exercisers ( $p < .05$ ). Results from this study will contribute to the literature which supports the relationships outlined in the applied model of imagery use. Furthermore, results can be extended to interventions aimed at improving less experienced exercisers' imagery use to ensure continued maintenance of exercise behaviour.

### **An Exploration of Social Physique Anxiety in Physical Education**

Cox, Anne E, Illinois State University; Joe Madonia, Illinois State University; Katie Witty, Illinois State University

Social physique anxiety (SPA; Hart, Leary, & Rejeski, 1989) has been shown to associate with maladaptive behaviors such as avoiding physical activity participation and practicing dangerous dieting methods in order to manage the stress associated with social evaluation of one's body (e.g., Sabiston et al., 2007). Since these behaviors can pose a serious health concern, research has begun investigating potential antecedents of SPA including motivation regulations and social sources of influence (Mack et al., 2007; Sabiston et al., 2005). Physical education (PE) students may be likely to experience SPA given the public display of competence required during class coupled with heightened concern for social evaluation during adolescence (Harter, 1999). Although research on SPA in adolescents has begun to proliferate, no research has yet examined this phenomenon in the PE setting. Therefore, the purpose of this study was to explore theoretical antecedents and other correlates of SPA in high school PE students. Students ( $n = 146$ ;  $M$  age = 15.9 years) completed an online questionnaire assessing body satisfaction, motivation regulations, social relationship variables, effort, enjoyment and perceived comfort in class. Results of two multiple regression analyses revealed that body satisfaction ( $\beta = -.62$ ), self-determined motivation ( $\beta = -.30$ ), peer acceptance ( $\beta = -.27$ ), and introjected regulation ( $\beta = .34$ ) were significant predictors of SPA in PE. While body satisfaction accounted for most of the explained variance ( $R^2 = .44$ ) in SPA, motivation and social relationship variables explained an additional 5-6%. In addition, higher SPA was associated with lower effort ( $r = -.18$ ) and enjoyment ( $r = -.31$ ) in PE and less comfort getting dressed for class ( $r = -.58$ ) and wearing a PE uniform ( $r = -.62$ ). Results illustrate the unique associations of different motivation regulations and popularity among one's peers to SPA and the potential detrimental influence that SPA may have on behavior and affect in the PE setting.

### Acute effects of indoor cycling exercise on mood state

Craciun, Marius, Babes Bolyai University; Claudia Lenuta Rus, Babes Bolyai University; Serban Dobosi, Babes Bolyai University

Empirical research suggests that engaging in physical activity is associated with a broad variety of health benefits, including prevention of various diseases and cancers (Warbuton, Nicol, & Bredin, 2006), reducing negative mood symptoms such as depression (Blake, Mo, Malik, & Thomas, 2009) and anxiety (Johansen, Hassmen, & Jouper, 2008), improving psychological well-being (Edwards, 2006) or positive affect (Bryan, Hutchinson, Seals, & Allen, 2007). Considering the broad positive effects of the various physical exercises, the purpose of this study was to investigate the acute effects of the 50 minutes of indoor cycling exercise on the six mood states (tension-anxiety, depression-dejection, anger-hostility, vigor-activity, fatigue-inertia, confusion-bewilderment) and the total mood disturbance. Thirty-five volunteers who attended regularly a cycling centre filled in The Profile of Mood States (POMS; McNair, Lorr, & Droppleman, 1992) ten minutes before, ten minutes and three hours after the indoor exercise completion. Ulterior, the pre- and the two post-measurements were compared. Using repeated ANOVA, we found that indoor cycling exercise reduced the negative moods such as tension ( $F(2,68) = 28.18, p < .01$ ), depression ( $F(2,68) = 23.21, p < .01$ ), anger ( $F(2,68) = 20.69, p < .01$ ), fatigue ( $F(2,68) = 6.38, p < .01$ ), confusion ( $F(2,68) = 18.82, p < .01$ ) in the two post-measurements. The indoor cycling exercise increased the positive mood represented by the vigor in the two post-measurements ( $F(2,68) = 31.49, p < .01$ ). Also, the vigor decreased significantly between the two post-measurements ( $F(1,34) = 36.40, p < .01$ ). The total mood disturbance decreased between the pre-measurement and the two post-measurements ( $F(2,68) = 15.94, p < .01$ ). There were no significant differences between the two post-measurements regarding the negative moods and total mood disturbance score. The results suggest that this type of exercise reduces the negative moods and induces positive mood effects even after three hours of its completion.

### Exploring the Advantages of Informal Athlete Leadership in Team Sports

Crozier, Alyson J., University of Windsor; Todd M. Loughead, University of Windsor; Krista J. Munroe-Chandler, University of Windsor

Athlete leadership has been defined as an athlete occupying a formal or informal role within a team who influences a group of team members to achieve a common goal (Loughead et al., 2006). Formal athlete leaders are those athletes who are designated by the organization as a leader (e.g., team captain). In contrast, informal athlete leaders are those who are not prescribed by the organization but emerge through interactions with teammates. While the majority of research to date has focused on formal athlete leaders (e.g., Dupuis et al., 2006), there is some empirical evidence on informal athlete leaders. For instance, Loughead and Hardy (2005) examined the percentage of athlete leaders on sport teams and found the highest percentage (65.1%) were comprised of both formal and informal leaders. Given the high percentage of informal athlete leaders, very little research has examined this type of athlete leadership separately. Therefore, the purpose of the present study was two-fold. First, to determine how many informal athlete leaders constitute an ideal number for optimal team functioning. Second, to examine the benefits of having this ideal number. The participants were 104 (68 male and 36 female) varsity level athletes competing in a variety of team sports. The mean age of the sample was 20.31 years ( $SD = 1.81$ ). The participants completed an open-ended questionnaire designed specifically for this study that yielded a total of 159 meaning units. The ideal number of informal leaders was calculated for each

sport sampled. Overall, the findings indicated that 66% of athletes should ideally occupy an informal leadership position. Results also revealed that having the ideal number of informal athlete leaders influenced team member attributes (e.g., team resources), team structure (e.g., norms), cohesion, team processes (e.g., communication), team outcomes (e.g., productivity), and leadership styles (e.g., social support). The results are discussed on how informal athlete leaders can impact the team environment.

### **Self-Regulatory Strategies to Overcome Boredom in the Gym: Development and Validation of the Interest-Enhancing Strategies for Exercise Questionnaire (IESEQ)**

Cumming, Jennifer, School of Sport and Exercise Sciences; Joan L Duda, University of Birmingham

When activities are not inherently interesting but important to perform (e.g., exercise), Sansone, Weir, Harpster, and Morgan (1992) suggest that individuals will engage in strategies to raise their interest as a means to self-regulating their motivation. Based on Green Demers, Pelletier, Stewart, and Gushue's (1998) study with figure skaters, the interest-enhancing strategies used by exercisers were investigated in the present research through the development of a valid and reliable 12 item questionnaire. In Study 1 ( $n = 367$ ;  $M$  age = 23.34,  $SD = 8.26$ ; 219 females, 147 males), a principal component analysis with direct oblimin rotation indicated the existence of 4 factors (music, dissociation, rationale, and variety) that explained 56.57% of the variance in the data. In Study 2, structural equation modelling confirmed the 4 factors across two samples (Sample 1:  $N = 343$ ;  $M$  age = 31.02,  $SD = 12.31$ ; 157 females, 182 males; Sample 2:  $N = 343$ ;  $M$  age = 30.48,  $SD = 12.30$ ; 153 females, 187 males). The internal reliabilities for these factors were also found to be good ( $\alpha = .73$  to  $.91$ ). Combining both samples for Study 3, a repeated measures ANOVA showed that exercisers reported using rationale significantly more than the other interest-enhancing strategies. A MANOVA followed by univariate tests indicated that females reported greater use of dissociation and music than males (all  $p < .001$ ). Finally, partial correlations controlling for gender revealed relationships between the interest-enhancing strategies and other exercise-related variables (self-reported exercise behaviour, perceived behavioural control, interest/enjoyment, feeling states, and exercise self-efficacy). Rationale and variety displayed a uniformly adaptive pattern, dissociation displayed a uniformly maladaptive pattern, and music displayed a mixed pattern. These results point to the potential usefulness of the Interest-Enhancing Strategies for Exercise Questionnaire (IESEQ) for examining different ways exercisers overcome boredom and increase interest in their gym activities.

### **A Qualitative Investigation of the Psychosocial Factors Apparent in Transitions from College to Post-College Careers Within a Male NCAA Division-1 Basketball Sample**

Cummins, Paul G, Edinburgh University

Primary objective: To investigate the psychosocial factors that impact upon NCAA Division-1 male basketball athletes as they transition from college to post-college athletic, or non-athletic careers. Secondary Objective: To investigate the psychosocial factors associated with successful transitions from college to post-college careers within the male NCAA Division-1 basketball domain. Design and Method: Participants ( $n = 9$ ) were current/former NCAA (National Collegiate Athletic Association) Division-1 basketball players. Four prospective participants were selected based on their current transition status and 5 retrospective participants were selected based on a previous transition success criterion (current annual income). Qualitative semi-structured interview and quantitative standardised questionnaires were used



to examine participants' prospective and retrospective perceptions on their post-college transitions. Interviews were based on the developmental model (Wylleman & Lavalley, 2004) and the model of human adaptation to transition (Schlossberg, 1981). Using grounded theory methodology (Strauss & Corbin, 1998), data analysis followed several coding procedures geared towards theory development. Results and conclusion: Five categories have been identified (motivation to transition, overall college experience, perceptions of transition, career direction, identification with basketball), which follow the process of transition as experienced by the athletes. Four categories have been identified (balanced college experience, openness to alternatives, positive social support, pre-transition planning), which follow the process of successful transitions as experienced by the retrospective athletes. These results are compared to existing athletic transition research and a grounded theory of the psychosocial factors that impact on NCAA Division-1 male basketball athletes' transition process from college to post-college athletic or non-athletic careers is presented. Research limitations and implications arising from this exploratory theory are discussed.

### **Examining Implicit Attitudes Towards Exercisers with a Physical Disability**

Dionne, Cassandra D., Queen's University; Deborah O. O'Malley, Queen's University; Heather L. Gainforth, Queen's University; Amy E. Latimer, Queen's University

Research on the exerciser stereotype has demonstrated that people with a physical disability who present themselves as exercisers are evaluated more positively than their inactive counterparts (Arbour et al., 2007). A limitation of research in this field is the reliance on measures of explicit attitudes—attitudes which are consciously controlled and subject to social desirability. To address this research limitation, implicit attitude—attitudes which exist without conscious awareness—should be measured. This study evaluated the prevalence of negative implicit attitudes towards people with a physical disability and examined if these attitudes were influenced by the exerciser stereotype. One hundred able-bodied participants (82% female,  $M = 21.48$ ,  $SD = 3.01$  yrs) completed three paper-based implicit attitudes tests (IATs): a practice test, the Disability-Attitudes IAT, and the Disability-Activity IAT. The Disability-Attitudes IAT measured implicit attitudes towards people who were non-disabled relative to disabled. The Disability-Activity IAT measured attitudes towards people with a physical disability who were active relative to inactive. A total of 83.8% of participants had a negative Disability-Attitudes IAT score. These scores ( $M = -3.33$ ,  $SD = 3.07$ ) were significantly different than zero (the value associated with no bias),  $t(79) = -9.72$ ,  $p < 0.01$ ,  $d = 1.09$ , indicating negative attitudes towards people with a disability. However, scores on the Disability-Activity IAT score ( $M = 5.48$ ,  $SD = 2.57$ ) were positive and significantly different than zero (the value associated with no exerciser stereotype),  $t(79) = -19.09$ ,  $p < 0.01$ ,  $d = 2.13$ . The majority of participants (97.5%) exhibited positive attitudes towards people with a physical disability who were active. The study findings indicate that the exerciser stereotype exists implicitly and should be investigated as a means of undermining negative attitudes towards people with a physical disability.

### **Collective efficacy dispersion: A preliminary rugby lab study**

Dithurbide, Lori, Michigan State University; Philip Sullivan, Brock University; Deborah Feltz, Michigan State University; Graig Chow, UCLA

Past research has consistently found a positive and significant relationship between collective efficacy (CE) and performance in sport teams. However, when studying groups, it is often assumed that the group level construct, such as CE, is a shared belief amongst all

teammates. Previous studies have not considered the influence of dispersion of CE beliefs on team performance. For example, two different teams may have the same aggregated mean value of efficacy but the dispersion within the individual team members may be very different. The current study's purpose was to manipulate the dispersion of CE beliefs within teams and evaluate its effect on aggregated CE, and team performance. A total of 7 (5 male, 2 female) rugby scrum teams, each with 5 members, participated in the study. Each team performed a baseline performance against a scrum sled that measured the total force of the team's effort. CE was then manipulated to either a shared collective efficacy belief condition (3 teams) or a bimodal condition (4 teams) by providing bogus performance feedback to 2 natural subgroups within the scrum teams. Teams then regrouped to perform on the scrum sled where performance was measured by the force executed on the sled. Results indicated that the manipulation worked. Bimodal belief teams had more dispersion than shared belief teams ( $F = 7.936, p < .05$ ). Additionally, a non-significant effect for aggregated CE was found ( $F = 3.369, p > .05$ ) indicating that teams had similar CE means regardless of dispersion. However, no effect was found for team performance ( $F = .880, p > .05$ ). These results suggest that even when dispersion of CE beliefs occurs in sport teams, it may not significantly affect the strength of the relationship between CE beliefs and team performance. The results should be interpreted with caution considering the limited sample size. Future research should examine longer-term behavior and other team level processes, such as communication, cohesion, and satisfaction.

### **The Relationships Between Coach-Athletes Relationship and Performance and Satisfaction and The Mediating Effect of Team Cohesion.**

Dong-Fang, Jiech-der, Soochow University; Likang Chi, National Taiwan Normal University

The purpose of this study was to examine the mediating effect of team cohesion between coach-athletes relationships, performance and satisfaction. 3Cs model of coach-athlete relationship (Jowett, 2003) including closeness, commitment, complementarity were expected to predict the team cohesion and then predict athletes' performance and satisfaction (Jowett & Chaundy, 2004). Data was collected in the National Taiwan Games, 2009. Participants were 274 athletes (male = 112, female = 162) recruited from 10 different sports. The mean age was 22.69 5.60 years. Participants were asked to complete a questionnaire which assessed coach-athlete relationship, group cohesion, satisfaction, and performance. Structural Equation Modeling was used to analyze the hypothetical model. It is hypothesized that three factors of coach-athlete relationship: closeness, commitment, and complementarity can positively predict athletes' satisfaction and performance through team cohesion. The chi square value was 939.2(244),  $p < .05$ . and the fitness indexes of this model were acceptable: CFI = .99; NNFI = .98; RMSEA = .069; SRMR = .045. The data indicated that closeness and commitment can't predict team cohesion, only complementarity can predict significantly; and team cohesion can predict the satisfaction and performance, respectively. This results partially support that team cohesion can mediate the relationships between coach-athlete relationship and athlete's performance and satisfaction. Also, team cohesion can take regard as a powerful predictor to performance and satisfaction.

### **Pregnant Women's Exercise Motivation and Behavior: Preliminary Findings from a Randomized Physical Activity Intervention**

Downs, Danielle Symons, The Pennsylvania State University; Jennifer M. DiNallo, The Pennsylvania State University; Erica L. Rauff, The Pennsylvania State University; Jan

S. Ulbrecht, The Pennsylvania State University; Leann L. Birch, The Pennsylvania State University; Ian M. Paul, The Pennsylvania State University

**Background:** Physical activity (PA) offers health benefits to mothers and their offspring; however, little is known about how to intervene to effectively motivate pregnant women to be active. The study purpose was to deliver a PA intervention using 2 approaches: semi-intensive, structured exercise and minimum-contact, lifestyle PA. The structured group received face-to-face PA education, motivational support, and engaged in moderate PA on 2d/wk for 70 min/d with an instructor. The lifestyle group received PA education and motivational support every 3 weeks by mail/phone from an instructor, and were encouraged to engage in lifestyle PA on their own. These approaches were compared to a standard of care control group. We hypothesized the intervention participants would engage in more PA behaviors and have stronger motivational determinants than controls. **Method:** Women ( $n = 113$ ;  $M$  age = 31) were recruited by 15-18 wk gestation and randomized to one of the 3 groups until delivery. Measures of the participants' PA behaviors (Actigraph accelerometer, Leisure-Time Exercise Questionnaire [LTEQ]) and motivational determinants (TPB Attitude, Subjective Norm, Perceived Behavioral Control [PBC], Intention) were obtained at baseline (20-wk) and follow-up (32-wk). **Results:** No significant differences at baseline were found across the 3 groups for PA behaviors or the motivational determinants. As predicted at the 32-wk follow-up, RMANOVA revealed the structured group ( $M = 345$ ) had higher Actigraph mean counts/min and total LTEQ scores ( $M = 34$ ) than controls ( $M = 295$ ,  $M = 12$ , respectively;  $p < .05$ ). In contrast to the hypothesis, the lifestyle group did not outperform controls on either measure. Also as predicted, the structured group had higher scores for all of the TPB constructs than controls ( $p$ 's  $< .01$ ) and the Lifestyle group had higher Attitude, PBC, and Intention than controls ( $p$ 's  $< .01$ ). **Conclusion:** These preliminary findings suggest that a PA intervention, delivered in a structured approach, can positively impact pregnant women's PA behaviors and motivational determinants. NIDDK-07586702.

### **An Examination of Integrated Regulation versus Exercise Identity**

Duncan, Lindsay, The University of Western Ontario; Craig R Hall, The University of Western Ontario; Sarah Cobourn, The University of Western Ontario

Previous research has proposed that integrated regulation is a strong predictor of exercise behavior and it provides a potential target for interventions aimed at increasing exercise among individuals (Duncan et al., 2010). From a theoretical perspective, integrated regulation seems to be almost analogous to the construct of exercise identity, which also has been shown to be related to exercise behavior (Anderson et al., 1998). The objectives of this study were to; (1) determine the degree of similarity between integrated regulation and exercise identity, and (2) to determine if one construct provides a richer potential for intervention compared to the other. At baseline, university students ( $n = 250$ ) completed a demographic and current exercise behavior questionnaire, the Behavioral Regulations in Exercise Questionnaire (Version 2; Markland & Tobin, 2004) with the addition of 4 items to measure integration (Wilson et al., 2006), and the Exercise Identity Scale (Anderson et al., 1998). Exercise behavior was re-assessed at a four-week follow-up. Correlations revealed a very strong positive correlation between integration and exercise identity. Regression analyses were consistent with previous self-determination theory literature indicating that autonomous regulations were the strongest predictors of exercise behavior. However, when exercise identity was added to the regression analysis, it became the strongest predictor and intrinsic motivation was the only motivation variable that contributed to the prediction of

exercise behavior. These results highlight the similarity between integration and exercise identity. Furthermore, these findings suggest that identity may be a more important target variable than integrated regulation for interventions aimed at increasing exercise behavior.

### **Relationship between Dysfunctional Childhood Experiences and Successful Coping Skills in Elite Endurance Athletes**

Dunn, Paige, John F. Kennedy University

The purpose of this study was to examine the extent to which coping skills developed through dysfunctional childhood experience played a role in successful sport performances. The study looked at elite endurance athletes and participants included one professional female triathlete and one elite female triathlete. A descriptive phenomenological study was used to examine these athletes' coping skills and the development of these skills. Results showed that the athletes in this study have used coping skills perceived to be developed in their childhoods in successful sport performances. The athletes shared their ability to focus on appropriate elements to help them cope, manage pain and persevere in their sport performances. This study suggests that when these athletes use the coping skill of "tuning out"; they have control over their focus. They have the control necessary to shift their focus to an area that allows them the necessary performance state to endure and succeed in their athletic event. Both participants in this study used a narrow-external type of attentional focus during their athletic performances. This study serves to further the limited research on coping skills of athletes and provides additional information in the understanding of this area.

### **Moderators of Youth Exercise Intention and Behavior**

Ellis, Rebecca, Georgia State University; Maria Kosma, Louisiana State University; Danielle Symons Downs, Pennsylvania State University

The study tested moderators of the theory of planned behavior (TPB) based on geography, gender, race, and income among adolescents in an exercise context. Participants were 8th and 9th grade male and female students from Louisiana (LA;  $N = 448$ ,  $M$  age = 14.37 years) and Pennsylvania (PA;  $N = 681$ ,  $M$  age = 14.28 years). They completed measures of intention (INT), attitude, subjective norm (SN), perceived behavioral control (PBC), and exercise behavior (EXBEH). Multi-group path analyses were used to test the moderating effects of geography (LA vs. PA), gender, race (Blacks vs. Whites), and income (high vs. low) on the TPB construct relations. Based on two path analyses for geography, the unconstrained model had a better fit to the sample data than the constrained model ( $\Delta \chi^2 = 29.14$ ;  $p < .001$ ), and thus the moderating effects of geography on TPB were supported. The TPB model for PA explained more variance in EXBEH (46%) and the TPB model for LA (24%). The effects of PBC on INT (.55 vs .48) and EXBEH (.17 vs .10 [n/s]), and the effect of INT on EXBEH (.56 vs .42) were larger for PA than LA, respectively. The moderating effects for gender, race, and income were analyzed separately for each state due to the significant moderating effect of geography. Gender was a significant moderator of the TPB for only LA ( $\Delta \chi^2 = 25.18$ ;  $p < .001$ ) and not for PA ( $\Delta \chi^2 = 1.59$ ;  $p = .90$ ). In the LA sample, SN had the greatest effect on INT (.36) for boys, whereas for girls SN had the smallest effect on INT (.13). Similarly, PBC had the greatest effect on INT for girls (.58), whereas for boys PBC had a non-significant contribution to INT (.13). Race and income did not moderate the TPB relations within each state ( $p > .05$ ). All path coefficients were statistically significant, and the average model variances for race and income levels explained in INT and EXBEH were higher for the PA model than the LA model. Findings

support the moderating effect of geography on the TPB construct relations and indicate that gender moderates the TPB construct relations in LA.

**Effect of physical and psychological training program on psychological, neurological, and perceived wellness among Egyptian women above fifty years.**

Elwesiemy, Azza S., Faculty of Physical Education

Women differ from men in many different ways; one of these is hormonal differences that give women their specific feminine features. With progression of age, disturbance of hormonal secretion, gradual muscular and bony loss, and acquired obesity, women face a variety of health problems, movement difficulties, diminished coordination and failure to deal with personal pressures. They also find difficulty in proper dealing with information effectively and rapidly, in addition to slow reaction time, and lastly decrease in muscular power becomes evident. It is assumed that suffering from health and movement problems is apparently more evident among Egyptian women who do not practice any activity, their life-style with lack of culture of the importance of any healthy movement programs together with the increasing life pressures. During the last few years, many experts in the health field, insisted that health is not only that the body is free from diseases but it also means wellness, that is to say good body and physiological function, in addition to quality of life, which means satisfaction and happiness. Regarding explanation of health, we find that Egyptian women need help and direction towards following physical and psychological programs for (8) weeks, that can lead to improvement in quality of life and performance of duties with feeling of wellbeing. Aim of the study: Building physical and psychological program and identify its effects on dealing with personal pressures and on some neurological changes to improve fitness among Egyptian women over fifty years. Methodology: Experimental one group method. Sample: (9) working Egyptian women over fifty years. Instruments: personal stress inventory, scale for relaxation ability, reaction time device, hand grip dynamometer, wellness self-perception inventory. Results : there was a statistical significant difference between pre and post measuring regarding all the study variables at 0.05 level.

**Selection of the 'open' side - An eye-tracking study on the expertise-based influence of conscious and unconscious cues on the penalty situation in soccer**

Essig, Kai, Bielefeld University; Richard Siegers, Radboud University Nijmegen; Matthias Weigelt, Bielefeld University; Heiko Lex, Bielefeld University; Thomas Schack, Bielefeld University

This study investigates the influence of conscious and unconscious cues on the penalty situation in soccer. Soccer-experts and novices (each  $n = 21$ ) were shown static images of a goalkeeper displaced relatively to the center on the goal line (left vs. center vs. right) and their gaze positions were recorded. In the action task, participants had to react with a pedal press to the 'open' area of the goal. In the following perception task, they should estimate if the goalkeeper stood at the center or if he was displaced to the left or right by pressing the corresponding mouse button. Additionally, they rate the confidence in all their decisions from absolutely unsure to absolutely sure. Results of the perception task show that both groups could not consciously notice small displacements of the goalkeeper in the 'perception corridor' between  $-1.5\%$  to  $1.5\%$  from the center. In the action task, participants decided to kick the ball to the 'open' side, when the keeper was displaced. For the center position, shots were nearly equally directed to both sides. Thus, positions within the perception corridor can be recognized correctly, when an action is carried out. Experts were more confident in their

decisions than novices. Additionally, the confidence ratings for both groups are lower for displacements within the corridor. There was also an interaction effect of position  $\times$  group in the perception task,  $F(8,304) = 1.896$ ,  $p = .06$ . Experts gave lower confidence rates for positions at the edges of the corridor. This effect does not show up in the action task, where they were completely conscious about their decisions. The number of fixations increases initially with the distance from the center and drops from the edges of the perception corridor to the outer positions. Experts need more fixations at the positions with lower confidence ratings in order to confirm their decisions. Attention distributions show that in the perception task the focus is mainly directed on the goalkeeper. In the action task participants focus at the goalkeeper and the side they intend to shoot at.

### **Cognitive demands of moderately intense physical activity**

Etnier, Jennifer L., Jeffrey D. Labban, Bryan D Loy, Aaron T Piepmeier, Daniel M. Pendleton, Efferman Ezell, Kevin M. Fisher, Kelly K Dvorak, University of North Carolina at Greensboro

Studies using animal models have shown that animals (rodents and dogs) exposed to an environment that combines physical activity with cognitive engagement experience greater benefits in both measures of cerebral structure and behavioral measures of cognitive performance. Based upon this, researchers have expressed interest in testing the effects of interventions that combine physical and cognitive activity for the cognitive performance of older adults. Therefore, the purpose of this study was to assess the cognitive demands of various forms of moderately intense physical activity. Participants were asked to perform a 15-min exercise session on a treadmill at a perceived intensity level of 13-15 on the Borg Rating of Perceived Exertion Scale. During exercise, participants were randomly assigned to various exercise conditions: do nothing else (ALONE), watch a video with no sound (WATCH), listen to the dialogue from a video (LISTEN), watch and listen to a video (BOTH), or do BOTH and expect to answer questions about the video following its conclusion. The video was one of 5 different clips from Planet Earth. Participants performed all 5 exercise conditions on different days with the order of exercise conditions and the video clip determined in a random, counter-balanced order. Participants were also asked to perform a simple auditory reaction time (RT) task during the exercise. Based upon the principles of a dual-task paradigm, RT (msec) was used as the measure of the cognitive demands of the task with a slower RT indicative of a more demanding task. Preliminary results indicate that RT is slower ( $ES = 1.08$ ) during the BOTH condition ( $M = 326$ ) than during the other conditions ( $M = 301$ ). Considered in conjunction with the findings from the animal literature, this finding has implications for a chronic exercise intervention study with humans. Future research will be necessary to determine if participants who watch and listen to an educational television program while exercising at a moderate intensity level experience the greatest cognitive benefits over the long-term.

### **Using Social Cognitive Constructs to Predict Preoperative Physical Activity before Total Joint Replacement**

Fiala, Bonnie A, University of Victoria; Ryan E Rhodes, University of Victoria; Chris Blanchard, University of Ottawa; John Anderson, University of Victoria

Objective: The purpose of this study was to examine social cognitive constructs as predictors of preoperative physical activity (PPA) in a sample of individuals waiting for total joint replacement (TJR) surgery using the framework of Bandura's Social Cognitive Theory (SCT).

Methods: Participants ( $n = 78$ ) were individuals waiting for TJR at the two major urban centres on Vancouver Island, Canada who completed measures of the SCT (self-efficacy, outcome expectancy, self regulation, task efficacy & sociocultural factors of pain, physical function and neighborhood walking environment) framed for PPA. Results: Independent t-tests suggested no differences between type of surgery (hip versus knee), gender or age for PPA ( $p < .05$ ). Over half of the sample was considered inactive (55%) using a definition of physical activity as accumulating at least 30 minutes of exercise at a moderate or vigorous intensity at least 3 days per week in bouts of 10 minutes or more. Bivariate correlations relating to PPA were significant ( $p < .05$ ) between self regulation (SR) (.25), task efficacy for exercise (TEE) (.27) and pain (-.28). Hierarchical regression analysis revealed that SR (beta = .17) and TEE (beta = .20) explained 10% of the variance in PPA behavior, but were not significant predictors of PPA independently. The addition of pain to the regression analysis added 4% of the explained variance, and remained the only significant predictor ( $p < .05$ ) of PPA behavior. Conclusions: SCT showed modest capability in predicting PPA in this sample, suggesting further testing of theoretical models is warranted in this area. These findings highlight the influence of pain on physical activity before TJR surgery, and support the importance of considering individual factors such as pain when designing targeted interventions to increase activity in this population.

### **Emotional reactions to being unable to exercise: Identity and attributions predict guilt and shame**

Flora, Parminder K, University of Saskatchewan; Shaelyn M Strachan, University of Ottawa; Kevin S Spink, University of Saskatchewan; Lawrence R Brawley, University of Saskatchewan

Research based in Identity Theory (IT) has reported that exercise identity (EXID) is related to negative affect when behaviour is inconsistent with EXID, with stronger EXID individuals having stronger negative emotions than those with weaker EXID. Further, Weiner's (1985) Attribution-Emotion Model (AEM) suggests that an individual's future behaviour and emotions may be linked to how individuals attempt to explain important outcomes (e.g., failure to exercise). IT and AEM may complement one another to help in our understanding of the relationship between individuals' exercise identity, their perception of causes of failure and subsequent emotional reactions. Accordingly, we examined whether EXID, Cause of inconsistent behaviour (i.e., personal vs situational), and causal attributions would predict negative emotions. We were specifically interested in whether attributions would contribute to the explained variance in emotions after controlling for the contribution of EXID. Participants varying in identity strength ( $n = 224$ ) were randomized to either a personally ( $p$  C) or situationally caused (SC) challenge. Once randomized, they read a relevant, believable scenario about a PC or SC no-exercise context and completed measures for EXID, attributions, and emotions. We used a hierarchical multiple regression model to predict the negative emotions of shame and guilt. The theory-based order of entry was EXID (block 1), Cause of inconsistency (block 2), and attributions (locus of causality and personal controllability dimensions; block 3). Shame was predicted by EXID,  $R^2_{adj} = .05$ ,  $p < .001$  and attributions significantly improved the prediction,  $R^2 \text{ Delta} = .11$ ,  $p < .001$ . Similarly, EXID predicted guilt,  $R^2_{adj} = .06$ ,  $p < .001$  and attributions provided significant improvement,  $R^2 \text{ Delta} = .08$ ,  $p < .001$ . Cause did not contribute significantly to either model. Results were as hypothesized and supported premises for IT and AEM. To our knowledge, this is the first demonstration of an EXID, attribution and emotion relationship about failure to exercise. Funded by SSHRC Grant No. 410-2007-0218.

### **Enjoyment and the Distraction Hypothesis: Reading for Pleasure versus School on Affective Responses to Exercise**

Foster, Rachel, East Carolina University; Thomas D. Raedeke, East Carolina University; Kristina Karvinen, East Carolina University; David Loy, East Carolina University; Nicholas P. Murray, East Carolina University

Considerable research has shown that acute exercise is associated with improved affect. In addition to stimulus properties of exercise itself (e.g., intensity), social-environmental factors also impact affective responses. Based on the distraction hypothesis, exercise settings that provide a “time out” from life stress (Barhke & Morgan, 1978) may result in more positive affective responses than those that provide less of a distraction. It is plausible that enjoyable experiences may provide a stronger distraction than exercise that is less enjoyable. Therefore, this study was designed to compare reading for pleasure versus school (potentially a weaker distractor) on affective state responses, enjoyment, and the extent to which exercise provided a distraction. Thirty-six active college students (15 males, 21 females) completed two moderate intensity exercise sessions, one per reading condition. Basic affect including valence and activation (Hardy & Rejeski, 1989; Svebak & Murgatroyd, 1985) were assessed pre, during and post exercise. The Exercise Induced Feeling Inventory (Gauvin & Rejeski, 1993) was completed pre/post exercise. Enjoyment (Kendzierski & DeCarlo, 1991; Raedeke 2007) and the degree to which exercise provided a distraction were measured post exercise. Participants reported greater enjoyment and distraction from life stress when reading for pleasure versus school ( $d > 1.0$ ). Repeated measures ANOVA revealed that pleasure versus school reading resulted in more positive affective valence ( $p = .0006$ ). School reading resulted in participants feeling slightly worse during exercise compared to baseline ( $d = -.16$ ) with the pleasure reading group showing more positive feeling states post versus pre exercise ( $d = .68$  for pleasure versus  $.16$  for school). Pleasure reading was associated with greater increases in engagement than school reading ( $p = .04$ ). For the remaining affective states, both conditions resulted in similar improvements. These findings lend further support that affective responses to exercise are influenced by social-environmental factors.

### **A little bit goes a long way: The effects of a wheelchair sport session on social cognitive theory constructs and leisure time physical activity among people with physical disabilities**

Foulon, Brianne L, McMaster University; Kathleen A Martin Ginis, McMaster University; Cortney Benedict, Ontario Wheelchair Sports Association, Bridging the Gap; Amy E Latimer, Queen’s University

Regular participation in leisure time physical activity (LTPA) among people with physical disabilities has numerous benefits (Wolfe et al., 2008), but this population is one of the most sedentary segments of society (Statistics Canada, 2001). To date, no published studies have examined the effects of an acute physical activity intervention among people with disabilities. In an able-bodied sample, a single physical activity experience has been shown to improve LTPA cognitions and behaviour (McAuley, Bane & Mihalko, 1995; Treasure & Newbery, 1998). The purpose of this pilot study was to examine the impact of an acute wheelchair sport session on social cognitive theory constructs (SCT; Bandura, 1986) and LTPA. Eight individuals ( $M$  age = 41.75 years) with either a spinal cord injury, multiple sclerosis, cerebral palsy or amputation, participated in a one-day wheelchair tennis clinic. SCT constructs and LTPA were measured immediately before and after the session, as well as four weeks later. Paired samples t-tests showed that self efficacy for moderate-intensity



aerobic self-efficacy significantly increased immediately following the session,  $t(7) = -2.67$ ,  $p = 0.03$ . Although not statistically significant, calculation of Cohen's  $d$  (1992) indicated a small increase in heavy-intensity aerobic self-efficacy ( $d = 0.31$ ), and a medium-sized increase in tennis self-efficacy ( $d = 0.35$ ) and barrier self-efficacy ( $d = 0.62$ ). Four-weeks after the session, there was a medium-sized increase in tennis self-efficacy ( $d = 0.40$ ) and a large-sized increase in barrier self-efficacy ( $d = 1.04$ ). LTPA levels did not change. The acute wheelchair sport session was successful in increasing key social cognitions, including task and barrier self-efficacy. Although LTPA did not increase in this small sample, findings of this pilot study are promising, as increases in these key cognitions have been associated with increases in physical activity participation in other populations (McAuley, Bane & Mihalko, 1995; Treasure & Newbery, 1998).

### **Antecedents of Moral Disengagement in Sport**

Gaines, Stacey A, Texas A&M University-Kingsville; Alan L Smith, Purdue University

Researchers have sought to understand factors that undermine moral reasoning and behavior in sport (see Weiss, Smith, & Stuntz, 2008). Recent efforts have specifically targeted moral disengagement (Boardley & Kavussanu, 2007; Lucidi et al., 2008), the suspension of moral standards in an effort to reduce the self-censure typically experienced when violating these standards (Bandura, 1991). The aim of this study was to extend the extant knowledge base by exploring: (a) proposed antecedents of moral disengagement in sport and, (b) moral disengagement as a mediator of the link of these antecedents with cheating and aggressive behaviors in sport. Four individual difference variables (sport empathy, moral awareness, ego goal orientation, personal sport importance) and one situational variable (perceived teammate behavior) that are conceptually linked with moral functioning were examined as independent and combined predictors of moral disengagement. High-school basketball and soccer players ( $n = 407$ ; 48% female) completed psychometrically sound measures of these variables, as well as moral disengagement and cheating and aggressive behavior. Multiple regression analyses were conducted, showing sport empathy and moral awareness to negatively and independently predict moral disengagement. Ego goal orientation and perceived teammate behavior positively and independently predicted moral disengagement. Additionally, sport empathy and ego orientation moderated the relationship of perceived teammate behavior with moral disengagement. Perceived teammate behavior was associated more strongly with moral disengagement when scores on these variables were greater. Moral disengagement positively predicted athletes' self-reported engagement in cheating and aggressive behaviors and partially mediated the relationship of sport empathy, moral awareness, ego orientation, and perceived teammate behavior with these outcome variables. This study extends the moral disengagement knowledge base by identifying individual and situational factors that may influence the use of moral disengagement.

### **Trait Body Image Predictors of Body-Related Social Comparisons in University-Aged Women**

Gammage, Kimberley L, Brock University; Heather Varga, Brock University; Larkin Lamarche, University of Toronto

Social comparisons (SC) occur when one thinks about the self in relation to others in order to assess one's adequacy and social status (Festinger, 1954). While evidence suggests that negative SC are more harmful to body image, simply the process of making SC can have a negative impact (van den Berg et al., 2007). Further, there may be differences in SC tenden-

cies depending on exercise status. For instance, Varga and Gammage (2009) found that non/infrequent exercisers generally made more negative body-related SC than exercisers. The present study examined the relationship between trait body image and the frequency and direction of body-related SC made by non/infrequent exercisers and exercisers. University-aged women ( $n = 70$  non/infrequent exercisers;  $n = 82$  exercisers) completed demographic information and trait body image measures (social physique anxiety [SPA], body dissatisfaction, body esteem, appearance evaluation and orientation [or importance], and fitness evaluation and orientation). They also indicated the general direction ( $p$  ositive or negative) and frequency of their body-related SC. For non/infrequent exercisers, appearance orientation was the only significant predictor of the frequency of SC ( $F(9, 57) = 5.62, p < .001, R^2_{adj} = .387$ ). Trait body image measures accounted for significant variance in the direction of SC ( $F(9, 57) = 13.43, p < .001, R^2_{adj} = .68$ ), with SPA and body esteem significant predictors. For exercisers, trait body image (specifically SPA and appearance orientation) predicted the frequency of body-related SC ( $F(9, 71) = 8.67, p < .001, R^2_{adj} = .463$ ). Trait body image also predicted the direction of body-related SC for exercisers ( $F(9, 70) = 14.65, p < .001, R^2_{adj} = .609$ ), with body dissatisfaction, appearance orientation, and fitness orientation significant predictors. The results indicated that certain trait body image measures may be good predictors of one's body comparison tendencies, although the body image dimensions which predict these SC may differ based on exercise status.

### **Parental perceptions of the effects of exercise on behavior in children and adolescents with AD/HD**

Gapin, Jennifer, Barry University; Jennifer L. Etnier, University of North Carolina Greensboro

Anecdotally, parents often report that children with AD/HD who are physically active on a regular basis experience positive changes in cognitive and behavioral symptoms of their disorder. Recently, there has been an increase in claims made in the popular media that physical activity could help manage AD/HD symptoms; yet surprisingly there is a lack of empirical evidence to support these claims. Therefore, the purpose of this study was to scientifically document this anecdotal relationship to provide preliminary evidence for the benefits of regular physical activity in reducing AD/HD symptoms. **METHOD:** Parents ( $n = 68$ ) of children diagnosed with AD/HD ( $M$  age = 10.82) completed an internet survey assessing their perceptions of how physical activity influences their child's AD/HD symptoms. Parents were asked to indicate if participation in physically active by their child resulted in a difference in AD/HD symptoms broadly and then specifically for symptoms of inattention, hyperactivity, and impulsivity. If a difference was reported, participants were asked if the difference was positive or negative and to describe their perceptions in detail. **RESULTS:** Responses to survey questions revealed that the majority of parents (82%) reported that regular physical activity resulted in positive effects on their child's AD/HD symptoms. Additionally, the greatest benefits were reported for symptoms of inattention and hyperactivity. Responses to open-ended questions supported the quantitative results, and specific details of these responses will be discussed in this presentation. **CONCLUSION:** This is the first study to provide empirical evidence documenting parents' perceptions of how physical activity positively influences AD/HD symptomatology and suggests that physical activity can be a viable strategy for reducing symptom severity. These results also show that physical activity may have greater benefits for specific symptoms of the disorder, providing potentially important directions for the development of physical activity interventions for children and adolescents with AD/HD.

### Characteristics of Sport Spectators in Taiwan

Gau, Li-Shiue, Asia University, Taiwan; Matthew T. Gailliot, University of Albany

This study attempts to investigate the characteristics of sport spectators compared to non-spectators of sports. Data analyzed in this paper were collected in the fifth cycle's survey of the research project 2007 "Taiwan Social Change Survey (TSCS)," conducted by the Institute of Sociology, Academia Sinica and sponsored by the National Science Council in Taiwan. The TSCS is the largest nationwide social survey in Taiwan. A total of 2,147 completed questionnaires were obtained for the Leisure Time module. The results showed that 778 people reported not having watched any sports on TV and that 1637 people reported having never attended sporting events in person. A cross-table was used to obtain two groups: 442 people attended live sports and also watched sports on TV, named sport-spectator group (SSG); 710 people neither attended live sports nor watched sports on TV, named non-sport-spectator group (NSSG). For demographic characteristics, the SSG was comprised of more men and fewer women than was the NSSG (pearson chi-square = 164.31,  $p < .001$ ). The SSG had higher education (13.39 years) than did the NSSG (10.33 years) ( $F = 153.84, p < .001$ ). The average age of the SSG was younger (36.29 years old) than was the NSSG (50.82 years old) ( $F = 211.19, p < .001$ ). The SSG considered themselves as being of higher social status than did the NSSG. The SSG felt happier and healthier in their life than did the NSSG. For personality, compared to the NSSG, the SSG scored higher on measures of extraversion, being relaxed, and being imaginative and scored lower on conscientiousness. Compared to the SSG, the NSSG scored higher on measures of conservatism and neuroticism, and lower on measures of talkativeness and trusting others. For AIO (Activities, Interests, Opinions) of lifestyle, SSG are more actively participating in different types of leisure activities and are more willing to take risk and go to an unfamiliar place for vacation. The study provides useful information for international sport managers for how to further expand sport markets to Taiwan.

### Global Trends of Research Performance of Sports

Gau, Li-Shiue, Asia University, Taiwan; De-Chen Yu, Asia University, Taiwan; Yuh-Shan Ho, Asia University, Taiwan

This study attempted to evaluate the sport research for the past 16 years and identify mainstream issues. Data were based on the online version of Social Science Citation Index (SSCI) from 1993 to 2008. The SSCI was searched under the keywords "sport" and "sports" as a part of the title, abstract, or keywords to compile a bibliography of all papers related to sports research. During the 16-year period, a total of 10,691 publications were retrieved. Among them, article ( $n = 7,655; 72%$ ) as the most-frequently used document type and therefore retained for further analysis. In the last 16 years, the annual number of articles devoted to sport research increased more than four-fold, i.e., from 219 in 1993 to 934 in 2008. The average article length fluctuated slightly, with an overall average length of 13.5 pages. The average number of authors per article rose from 2.1 in 1993 to 2.9 in 2008. The average number of cited references increased stably from 29 references per article to 40. Based on a cubic model fitting the yearly cumulative publications during 1993-2008, it can be predicted that, in 2016, the number of research articles on the topic of sports will be approximately twice of the number of publications in 2008. Synthetically analyzing source title keywords, author keywords and keyword plus, it can be concluded that physical education, athlete performance and sports participation seemed the mainstream issues of sport research in the sixteen-year study period. The words adolescents, youth,

children, adolescent, and athletes frequently appeared, which indicated that the emphasis of sport research was placed on these subject groups. Meanwhile, it was noticed that the popular modes of sports in research might be Soccer, Football, and Basketball. Moreover, in addition to a general word, Sport psychology, more specific or definite author keywords related to sport psychology also appeared: motivation, stress, anxiety, and self-esteem. This new bibliometric method can help researchers realize the panorama of sport research, and establish the further research direction.

### **Comparing the Motives for Watching Sports in Person and on TV**

Gau, Li-Shiue, Asia University, Taiwan; Shih-Yao Lai, Asia University, Taiwan

This study attempted to compare the motives for attending games in stadium and motives for watching sports on TV. It was hypothesized that motives for watching sports in person are stronger than those for watching sports on TV due to the fact that attending games in stadium would take transportation cost and need to buy a ticket. Another hypothesis is that a major motive for people who attend games in person is more likely to be the self-esteem motive than for people who watch sports on TV. That is, the self-esteem motive has more power to drive people to attend games in person than the entertainment and sociability motives because attendees can support their teams more closely in stadium. A questionnaire was utilized, including: 1. Measures of entertainment, sociability and self-esteem motives (7-point Likert scales), 2. The major ONE motive that has the strongest influence on watching sports. In 2008 Olympic baseball qualifying tournament, 162 participants were recruited at Taichung Intercontinental Baseball Stadium when attending one of the tournament games in person, called the stadium group (STG). Additionally, 237 respondents were recruited at a university campus to answer the questionnaire based on their experiences in watching the tournament on TV, called the TV group (TVG). The sample was consisted of 202 females (51.1%). The majority of participants had at least a college education ( $n = 353$ , 89%) and were between 18 and 25 years old ( $n = 238$ , 65%) with a mean age of 25.70 years ( $SD = 7.10$ ). The reliabilities of the three subscales of motives were between 0.83 and 0.86. An analysis of variance showed that the STG had higher level of motivation (entertainment = 5.68, sociability = 5.30, self-esteem = 5.16) than did the TVG (4.49, 4.03, 4.40) ( $p < .05$ ). The first hypothesis is supported. Further, a higher percentage of people from the STG (43%) than that from the TVG (24%) chose self-esteem as the major motive for watching sports. The Chi Square analysis showed that the comparison was significant ( $p < .001$ ). The second hypothesis is supported.

### **The development of a golf specific self-efficacy measure.**

Gnagy, Erik O, University of Texas; John Bartholomew, University of Texas at Austin

Objective: To design and validate a questionnaire measuring self-efficacy in regards to performing golf skills related to one's overall golf performance. Self-efficacy's relationship with performance is regarded as, "the most influential psychological variable impacting sport performance" (Bond, et al., 2001). Defined as an individual's judgment of their capability to successfully execute a given task within a specific context, self-efficacy has been shown to be strongly correlated with athletic performance (McAuley & Gill, 1983). Bandura suggests that efficacy beliefs influence "whether people think erratically or strategically, optimistically or pessimistically" (Bandura, 2006; p. 309). Thus, high efficacious individuals pursue challenges, set higher goals, put forth greater effort, and persist in the face of adversity (Feltz & Lirgg, 2001). Method: Participants completed a 35-item questionnaire, which was analyzed using Principle Components. Each factor was then analyzed for internal consistency

through Cronbach's Alpha. Predictive validity was tested by correlating average 18 hole score with each of the four derived factors. Procedure: A sample of 100 golfers of varying ability levels were recruited for participation in the study. Results: The factor analysis identified 5 factors, however items loading on the 5th factor cross loaded with the other factors and therefore was removed. Using a criterion level of .5, fifteen items were grouped into 4 factors. The 4 factors were: long approach shots, shots under 100 yards, driving accuracy, and putting skills. The respective internal consistencies were: LA = .95, U100 = .86, DA = .93, and PS = .85. All four factors analyzed were negatively related to average 18 hole score: U100  $r = -.67$   $p < .01$ , LA  $r = -.76$   $p < .01$ , DA  $r = -.58$   $p < .01$  and PS  $r = -.5$   $p < .01$ . Conclusions: The present findings are a positive first step towards validating the golf specific self-efficacy questionnaire. Further research is necessary to run a confirmatory factor analysis, strengthening the validity of the questionnaire.

### **Does Inspiration Increase Situational Motivation in Male Team Athletes? An Exploratory Study**

Gonzalez, Stephen P, University of Utah; Jon N Metzler, Army Center for Enhanced Performance, Fort Hood; Maria Newton, University of Utah

Inspiration is a transcendent evoked sense of energy from an external source that implies motivation (Thrash & Elliot; 2003, 2004). Coaches use tactics such as pep talks and movie clips to both inspire and motivate their players. Little is known regarding the efficacy of these practices. Framed within Self Determination Theory (Deci & Ryan, 1985; Vallerand 1997) this study explored the impact of a simulated pep talk on inspiration and situational autonomous motivation. The study employed a two group pre-test post-test experimental design. 151 African American (64.9%) and White (31.1%) male collegiate football players ( $M = 19.61$  years,  $SD = 1.24$ ) from two NCAA Division I universities in the Southeastern United States participated. Participants completed the Inspiration Scale (Thrash & Elliot, 2003), Situational Motivation Scale (Guay, Vallerand, & Blanchard, 2000), Sport Motivation Scale (Pelletier et al., 1995), and Need for Relatedness Scale (Richer & Vallerand, 1998) and were then randomly assigned to one of two experimental conditions. The treatment group watched a movie clip of a football coach giving a half-time speech and the control group watched a movie clip of the same football coach giving game instructions. After the video all participants completed the IS and SIMS. A two-way repeated measures ANOVA revealed a significant group by time interaction,  $F(1,74) = 31.71$ ,  $p < .001$ , on inspiration. Inspiration increased more for the football players in the treatment condition ( $M$  Delta = .51) than those in the control condition ( $M$  Delta = -.72). Situational motivation did not change in either group [ $F(1,74) = 1.81$ ,  $p = .18$ ,  $f = .11$ ]. Multiple regression analysis revealed, after controlling for relatedness and contextual motivation, that change in inspiration was not predictive of change in situational motivation (Delta  $R^2 = .007$ ,  $p = .79$ ). The results support coaching speculation that inspiration can be manipulated through the use of tactics like pep talks; however, the inspirational effects of these tactics on motivation are unclear.

### **Exploring the Construct Validity of the Transtheoretical Model to Structure Physical Activity Interventions for Individuals with Serious Mental Illness**

Gorczyński, Paul, University of Toronto; Guy Faulkner, University of Toronto; Steven G Greening, University of Western Ontario; Tony Cohn, University of Toronto, Centre for Addiction and Mental Health

**Objective:** Physical activity and weight management intervention research involving individuals with serious mental illness (SMI) are often not explicitly based on any theoretical framework. This study examined the construct validity of the Transtheoretical Model (TTM) in individuals with SMI to guide future physical activity interventions. **Methods:** Fifty-four individuals completed surveys that asked about their current stage of change for physical activity, self-efficacy, and perceived advantages and disadvantages of being more physically active. **Results:** The majority of individuals reported being in the preparation stage of the TTM. Participants indicated they were most confident about scheduling physical activity and least confident about being physically active in poor weather. As individuals approached the action and maintenance stages, self-efficacy and perceived benefits of physical activity increased significantly. Although perceived disadvantages decreased with each successive stage of the TTM, this change was not significant. **Conclusions:** Findings of this study support the TTM's application in this population as the core constructs of self-efficacy, perceived benefits of and barriers to physical activity differed across stages and changes were in the direction predicted by theory. These results highlight the potential utility of the TTM in structuring physical activity interventions for this population.

### **An integrated self-efficacy and basic psychological need satisfaction in physical activity scale for children: Factor structure and composition**

Gray, Casey, The University of Western Ontario; Harry Prapavessis, the University of Western Ontario; Nerissa Campbell, the University of Western Ontario; Daniela Rivas, the University of Western Ontario; Erin McGowan, University of Alberta; Justine Wilson, the University of Western Ontario

The purpose of the present study was to examine the factor structure and composition of an integrated tool to measure children's self-efficacy and basic psychological need satisfaction in physical activity contexts. Male ( $n = 48$ ) and female ( $n = 42$ ) school aged children (11-14 years) completed questionnaires assessing their perceptions of task and barrier self-efficacy, as well as satisfaction of autonomy, competence, and relatedness needs. Two Principal Components Analyses ( $p$  CA) with direct oblim rotation were conducted to examine self-efficacy and basic psychological needs satisfaction factors. The first PCA produced a 2 factor solution accounting for 70.77% of the variance in self-efficacy (item loadings range from .656 to .869 for the 5 barrier-efficacy items, and .822 to .950 for the 9 task-efficacy items). The second PCA produced a 3 factor solution accounting for 73.25% of the total variance in basic psychological needs (item loadings ranged from .818 to .922 for the 5 competence items, .529 to .898 for the 4 autonomy items and .627 to .950 for the 5 relatedness items). The correlation matrices revealed small to medium relationships among basic psychological needs ( $r$ s = .184 to .362) and self-efficacy ( $r = .53$ ) variables. Reliability analyses showed Cronbach's alphas ranging from .738 to .957 for the five variables. Taken together these data provide initial psychometric evidence for the integrated self-efficacy and basic psychological needs questionnaires. These scales should be employed in future research with children in physical activity contexts to provide further evidence construct validation for these integrated scales.

### **Examining the Relationship between Athletes' Achievement Motives and Ability to Employ Imagery**

Gregg, Melanie J, The University of Winnipeg; Jenny O, California State University, East Bay; Craig R Hall, the University of Western Ontario

Athletes employ imagery that services the achievement of their goals; some imagery content is more related to task and ego achievement goals than others. In addition, the effective use of imagery is moderated by imagery ability. The aim of the present study was to determine the relationship between goal orientations and imagery ability, as image quality may be cognitively regulated by motivational states and it is important to assess this relationship. 272 male and female athletes, representing nine sports, participated in the study. Cognitive imagery ability was assessed by the Vividness of Movement Imagery Questionnaire-2. The Motivational Imagery Ability Measure for Sport was used to assess motivational imagery ability. Goal orientations were assessed with the Perceptions of Success Questionnaire. A two-step cluster analysis identified four distinct task and ego orientation clusters. Following identification and validation of the various clusters, two separate multivariate analyses of covariance (Bonferroni-adjusted  $p = .025$ ) were conducted to assess differences in cognitive imagery ability and motivational imagery ability for the clusters, with gender and sport type (i.e., team and individual) entered as covariates. For cognitive imagery ability gender was a significant covariate (Bonferroni-adjusted  $p = .025$ ), and when gender was controlled for clusters did not differ on cognitive imagery ability ( $p = .04$ ). Regarding motivational imagery ability, sport type was a significant covariate; however, even with it controlled for, cluster membership demonstrated a significant multivariate effect ( $p = .0001$ ). Univariate analysis indicated that the four clusters differed on each of the four motivational imagery subscales ( $p = .0001$  for each). It was concluded that goal orientations have an important relationship with motivational imagery ability but this same relationship is not evident with cognitive imagery ability.

### **The relationship between the quiet eye period and occipital lobe activity during the act of golf putting**

Guadagnoli, Mark A., UNLV; Michael A. Gaetz, University of the Fraser Valley; Chris Bertram, University of the Fraser Valley; Kristina Lindquist, PFI; Valeria Martinez, UNLV; Danika Dickson, University of the Fraser Valley

Neuroscience is now suggesting that the notion of the eyes being the window to the soul may be truer than once thought. More specifically, the concept of the eyes as an index of performance has been investigated in a paradigm known as 'quiet eye'. The paradigm, pioneered by Joan Vickers and others, suggests that eye movement immediately prior to performance, or lack thereof, is "a potential predictor of elite athlete performance." In the currently study we investigated the relationship between the quiet eye period and occipital lobe activity during the act of golf putting. Eight individuals participated in the study. The data revealed significant results between all three potential correlations [(quiet eye to putting accuracy  $r = .789$ ), (quiet eye to occipital lobe activity  $r = -.897$ ), (occipital lobe activity to accuracy  $r = -.735$ ). We interpret these results to suggest that the quiet eye effect is related to both upstream ( $n$  eurollogical) and downstream ( $p$  erformance) effects.

### **The relationship between the physical self-description in bodybuilding members and intensity level**

Guillen, Felix, University of Las Palmas de Gran Canaria; Rosa Lopez, University of Las Palmas de Gran Canaria

The overall purpose of this study was to examine the physical self-description of the members of a bodybuilding center. It was also the purpose to explore their physical self-description, attending to the characteristics of the exercises they do. Participants were 206 bodybuilding

members (76 females and 130 males) and ranged in age from 16 to 35 years old ( $M = 25$ ;  $SD = 6$ ). The Physical Self-Description Questionnaire (PSDQ; Marsh, & Sutherland, 1994) was used in its Spanish version (Gracia, Marcó, Fernández, & Trujano, 1998) and demographic information was also collected. The results show the existence of positive correlations between the number of times a week the participants practice exercise, the length of each session and the years they have been practicing and one of the two dimensions, specifically the physical fitness self-description. And there's also a positive correlation between the above mentioned variables and all the subdimensions that constitute this first dimension (coordination, physical activity, sports condition, strength, flexibility and endurance). As for the subdimensions belonging to the second dimension, physical self-description, there's a highly positive correlation between the variables presented and health and self-esteem and a highly negative one between them and body fat. There is also a highly positive correlation between the number of times a week the participants practice exercise, the length of each session and the years they have been practicing and the subdimensions of health and self-esteem. No differences were found between male and female participants. The results are discussed in terms of their implications theoretical and practical utility.

### **Unconscious priming in sequential movement perception**

Güldenpenning, Iris, Bielefeld University; Dirk Koester, Bielefeld University; Wilfried Kunde, Dortmund University; Thomas Schack, Bielefeld University

Perceptual superiority is a fundamental component of expertise in different domains such as chess or sport. At present, it is unclear whether these perceptual skills are necessary to process information unconsciously. Is it possible to bias expert behaviour without awareness? In a recent priming study it was found that expertise is an important prerequisite of unconscious processing of chess scenarios. However, to accentuate the debate about the cognitive prerequisites of unconscious processing we decided to do a further study in another domain, in motor expertise. Therefore we applied the subliminal priming paradigm with stimuli of the high jump movement. Sixteen novices and sixteen experts had to categorise photographic pictures of the high jump movement, i.e. whether they belong to the approach or the flight phase. Each target picture was preceded by a briefly presented and masked prime picture. The prime pictures were not consciously perceivable. In a second experiment, prime pictures were mirrored at the vertical axis. Experts as well as novices showed the priming effect which means faster response times if prime and target are of the same category (e.g., flight) and slower response times if prime and target are of different categories. The priming effect was not modulated by changing the visual properties (i.e. mirroring the primes). These results indicate that expertise is not an essential prerequisite for unconscious information processing in a categorisation task with pictures of a complex movement. Moreover, the priming effect appears to reflect a processing stage beyond sensory processing. Further research might focus on the relevant features of a movement posture (e.g. kinematic features), which are relevant for unconscious categorisation.

### **Gender variations in physical activity and well-being in individuals diagnosed with osteoporosis**

Gunnell, Katie E., The University of British Columbia; Diane E. Mack, Brock University; Philip M. Wilson, Brock University; Peter R. E. Crocker, The University of British Columbia

Health-enhancing physical activity (HEPA) is associated with psychological well-being in older adults (Chodzko-Zajko, Schwingel, & Park, 2009). However, the relationship is



complex and may vary by gender and type of HEPA (e.g., gardening or walking; Asztalos et al., 2009). This investigation a) examined gender differences in self-reported HEPA in a sample of individuals with osteoporosis and b) determined gender-specific variations in the association between type of HEPA and markers of well-being. Male ( $n = 34$ ;  $M$  age = 63.91 years;  $SD = 13.63$  years) and female ( $n = 217$ ;  $M$  age = 68.43 years;  $SD = 11.22$  years) participants completed questionnaires assessing HEPA and global markers of well-being on a single occasion. Estimates of effect size for type of HEPA demonstrated small-to-moderately strong ( $d$ 's = 0.02 to 0.72) differences by gender with significant differences noted for walking as a commuting activity, household activities and leisure- time gardening ( $p < .01$ ). In general, HEPA was positively associated with Positive Affect (PA) and Subjective Vitality (SVS) and negatively associated with Negative Affect (NA;  $r$ 's = -.14 to 0.44). However, more occupational HEPA ( $r = 0.40$ ,  $p < .01$ ) among males and more commuting activity ( $r = 0.23$ ,  $p < .001$ ) among females were associated with higher NA. Males differed from females when examining the overall magnitude of association between type of HEPA and well-being. The correlation between NA and occupational HEPA was significantly larger ( $p < .05$ ) in males. However, the association between NA and commuting activities was significantly higher in females ( $p < .05$ ). Finally, the associations between PA and SVS and leisure- time biking were significantly higher for males than females ( $p < .05$ ). Overall, this study indicates that males and females with osteoporosis engage in different types of HEPA, and that the nature of HEPA can impact well-being across gender. Consequently, intervention programs that seek to increase HEPA participation and well-being in individuals with osteoporosis may wish to consider gender and type of HEPA.

### **Psychological effects of synchronous music on Tai Chi exercise**

Guo, Linxuan, Hong Kong Baptist University

The present study examined the impact of selected music on psychological indices during Tai Chi exercise. Participants ( $n = 42$ , mean age = 20.3 years,  $SD = 0.9$ ) were exposed to different exercise conditions of both synchronous music and no music control. The selected music included exercise music which was widely used for Tai Chi practice, Chinese classical music and adapted pop music. Dependant measures included motivational qualities of music and exercise-induced feeling states. A one-way repeated ANOVA measures was used to analyze motivational qualities of the selected music. Paired-sampled t-tests were used to evaluate the difference of the exercise-induced feeling states between the exercise conditions. In addition, a semi-structured interview was conducted with 11 participants. An inductive content analysis of the interview data was undertaken for further insight into the preference to synchronous music and the effect of music to Tai Chi participation. Results indicated that exercise music had significantly higher motivational qualities than other selected music ( $p < .05$ ). For exercise-induced feeling states, revitalization and positive engagement were significantly higher in music condition than no music control ( $p < .05$ ). Physical exhaustion was less in music condition. Partly consistent with the previous research and conceptual framework, the findings indicated that music tempo was stressed mostly with reference to the current qualitative study, but faster music was not regarded to stimulate motivation in Tai Chi, largely different from the findings in repetitive exercise which was the focus in previous studies. Meanwhile, cultural implication of music was found to be another important consideration; whereas it was not added into the updated theoretical work as a factor pertaining to motivational quality of music. It is encouraged to make adaptation for Tai Chi music by adding modern element but not to change Tai Chi's essence, which may be helpful in the promotion of Tai Chi and change of the age-stereotyped impression.

### **Exploratory Analysis of Motivational Climate in Army Reserve Officer Training Corps Leader's Training Course**

Haile, Sheryl L., College of the Ozarks

Established as a central factor in goal approach behavior and outcomes for sport and exercise venues (e.g., Duda, 2001; Papaioannou, Marsh, and Theoridoike, 2004; Treasure, 2001), perceived motivational climate (PMC; Newton & Duda, 1999) remains a relatively untapped construct in military research. With physical fitness as a cornerstone of soldier preparation (Department of the Army, 1992) and performance as the standard of training efficacy, Achievement Goal Theory (AGT; Nicholls, 1984; 1989) presents as an appropriate model for exploring the motivational variables affecting training outcomes. Using a multi-level analysis model similar to Papaioannou et al. (2004), this study utilized modified sport and exercise assessments to examine the relationship of PMC and training outcomes for Reserve Officer Training Corps (ROTC) cadets participating in the Leader's Training Course (LTC). Analysis results indicated that achievement goal orientations were not correlated with one another. Task orientation was found to be significantly correlated with outcome variables, providing a significant contribution at the individual level. Hierarchical Linear Modeling (HLM) indicated perceived task-involving climate to be a significant contributor to variable outcomes, and a more positive predictor than perceived ego-involving climate. Support was found for a compatible person-environment fit for interactions of task orientation and task-involving climate, whereas incompatible orientation and climate interactions had a significant negative effect. Platoon-level effects were negligible for most areas, with the exception of orientation and climate interaction where support was found at both the individual and platoon-level, evidencing a true group-level effect. Implications for these findings will be discussed.

### **Deceleration in Preparatory Heart Rate, Anxiety, and Balance Beam Performance**

Hale, Bruce D, Pennsylvania State University- Berks; Britney N Niles, Penn State University - Berks

Lacey's (1967) 'intake-rejection hypothesis' predicted that an external focus of attention during sport task performance leads to heart rate deceleration. Several studies (Landers et al., 1994; Radlo et al., 2004)) showed that a prior heart rate decrease was associated with better performance in aiming sports. Wulf et al. (2001) found that an external focus was better than an internal focus in a postural lab task, but Guillot et al. (2004) suggested that an internal focus is better on stable balance beam performance. Cottyn and colleagues' (2002, 2006, 2008) studies on balance beam performance showed that there was a significantly lower heart rate at the end of the preparatory period before a routine and a significant decrease in heart rate before any fall. The purpose of this study was to examine the effect of attentional focus on heart rate, anxiety intensity, direction and frequency, and performance on the balance beam. Thirteen Division 3 female gymnasts completed the Immediate Anxiety Measurement Scale (IAMS; Thomas et al., 2008) before participating in both an eyes-open (internal) and eyes-closed (external) condition while performing a full turn on the balance beam during practice. Heart rate was measured during the preparation period, on initiation of the skill, and after termination of the skill. A  $2 \times 3$  (attentional focus  $\times$  trials) within-subjects repeated measures ANOVA produced a significant interaction indicating that heart rate was significantly lower in the closed eyes than the open eyes condition in the preparatory period. Another one-way repeated measures ANOVA was significant suggesting that preparatory heart rate significantly declined in 'fall' performances. Paired *t*-tests with

Bonferroni corrections were calculated on the 9 IAMS subscales in both conditions, and Cognitive and Somatic Anxiety Intensity were significantly higher in eyes-closed condition, while Self-Confidence Intensity, Direction, and Frequency were higher in the eyes-open condition. Open-eyes Cognitive Anxiety Intensity was correlated with heart rate measures.

### **The relative age effect and level of competition in Canadian minor hockey**

Hancock, David J, University of Ottawa; Brad W Young, University of Ottawa; Diane M Ste-Marie, University of Ottawa

The relative age effect (RAE) occurs when individuals are placed into annual age cohorts for competition. Specifically, individuals born early in the cohort, who possess nearly a one-year age difference over individuals born late in the cohort, are more represented on elite teams than their younger counterparts. Barnsley and Thompson (1988) were among the first to identify the RAE in sport amongst Canadian youth hockey players, noting the RAE existed for players aged 11 to 18, but not for those younger than 11. Further, a RAE was evident for players on top tier teams, but not for players on lower level teams. Results were limited in that the authors examined RAE in one city and did not provide detailed descriptions regarding the competition level for each division. Specifically, it would be beneficial to know the selection process for players on the top, middle, and lower level teams. Thus, the purpose of this investigation was to provide a more recent examination of the RAE and competition level in Canadian minor hockey with a broader sample. Concurrently, we examined whether coach selection processes contribute to RAEs. If coach selection were involved, we would expect to see a strong RAE for competitive teams and a weak RAE for non-competitive (i.e., no coach selection) teams. Participants were 231,295 Ontario players from Atom (9-10 years), Peewee (11-12 years), Bantam (13-14 years), and Midget (15-17 years) divisions. Birthdates were organized into quartiles based on the Hockey Canada selection year (Q1 = January to March; Q2 = April to June; etc.). Chi-square analysis indicated a significant RAE ( $p < 0.001$ ) within each division. Furthermore, there was a significant RAE ( $p < 0.001$ ) for the competition level within each division. The highest levels of hockey had the most players born in the first two quartiles (e.g., AAA, up to 73%) whereas the lowest levels of hockey had the most players born in the last two quartiles (e.g., House League, up to 53%). Discussion revolves around the implications that coach selection may have on the RAE.

### **Relationship between Physique Anxiety and Body Fat Percentage**

Helbig, Casi R, Texas Lutheran University; Ruth Brown, Texas Lutheran University; Noah L Dean, Texas Lutheran University

This study investigated the relationship between physique anxiety and body fat percentage. Participants were 31 undergraduate students at Texas Lutheran University. The Social Physique Anxiety Scale (Hart et al., 1989) was administered to each subject. The assessment consisted of 12 questions, asking them to rate themselves on a scale of 1 to 5, from "not at all characteristic" to "extremely characteristic" of themselves. Based on the Social Physique Anxiety scores, the following three categories were created: 1) more anxiety 2) average anxiety and 3) less anxiety. Next, skin fold measurements were taken at three different sites with skin fold calipers. The sites for males were the chest, abdomen, and thigh. For females, skin folds were taken from the triceps, suprailiac, and the thigh. Each site was measured three times and an average was taken from the three measurements. The sum of the three sites was then compared to a body composition chart according to age and gender in order to get the

body fat percentage. The five body composition categories for percent body fat (Jackson & Pollack, 1980) were: (1) excellent (2) good (3) average (4) fair and (5) poor. The mean social physique anxiety score (SPAS) score was 20.3 for males and 33.9 for females. For all participants, 19% were categorized “less anxious”, 58% were of “average anxiety”, and 22% were “more anxious”. Average body fat levels were 9.9% for males and 21.6% for females. For all subjects, 61% fall in the excellent category, 36% were “good”, 3% were “average” and no subjects fell under the fair or poor category. The research question was tested using Pearson correlation of physique anxiety to body fat percentage. The hypothesis predicted that there would be a direct relationship between the two variables. This hypothesis was supported ( $r = .766$ ) ( $p < .05$ ). While research has showed misperceptions in body image, these findings support that levels of physique anxiety are directly related to percentage of body fat. While high levels of anxiety can be detrimental, some anxiety can motivate change.

### **Competitive State Anxiety: A Construct in Search of a New Measurement Model**

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Current competitive state anxiety assessment tools, such as the Competitive State Anxiety Instrument-2 (CSAI-2; Martens et al., 1990), have been used frequently by sport researchers; but have been criticized on conceptual and psychometric grounds (Cerin, 2003; Lane et al., 1999). Consequently, understanding the nature of competitive state anxiety, including its antecedents and consequences, is limited. Is the problem with the underlying conceptual model of the CSAI-2, or with the specific measurement model upon which the instrument is based? In an effort to develop a better tool for assessing competitive state anxiety, discrete emotion theory (Pekrun et al., 2002), the transactional model of stress, coping, and emotion (Lazarus, 1991), and empirical literature (e.g., Hardy et al., 2009; Martens et al., 1990; Smith et al., 2006) were integrated to cast anxiety within a larger conceptual framework. A new multidimensional assessment model was developed to differentiate between a challenge appraisal emotion (i.e., hope) and a threat appraisal emotion (i.e., anxiety). Each emotion was hypothesized to have at least three cognitive (i.e., worry/belief, motivation and focus/concentration) and three somatic (i.e., bodily tension, autonomic arousal and affect) components. Symptoms were selected that loaded highly on hope and minimally on anxiety and vice versa. Likewise, symptoms were chosen that loaded highly on only a single cognitive or somatic dimension. A mixed research design, involving both qualitative and quantitative procedures, was implemented. Three pilot studies with adult sport performers provided preliminary support for our revised approach to assessing competitive state anxiety. Specifically, our results revealed that though threat (i.e., anxiety) and challenge (i.e., hope) anticipatory emotions share select symptoms, positive and negative emotional states could be distinguished through unique structure systems. The findings of this research have both theoretical and measurement implications.

### **Validity and reliability of the Behavioral Regulation in Sport Questionnaire (BRSQ) with youth athletes.**

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Grounded in Self Determination Theory (Deci & Ryan, 1985), the Behavioral Regulation in Sport Questionnaire (Lonsdale, Hodge & Rose, 2008) measures 6 motivation regulations (Intrinsic Motivation (IM), Integrated Regulation (IG), Identified Regulation (ID), Introjected Regulation (IJ), Extrinsic Regulation (ER), and Amotivation (AM)) assumed to be relevant to sport participants. The purpose of the current study was to examine the validity and reliability of a 24 item version of the BRSQ (with IM measured as a uni-dimensional concept; Deci & Ryan, 1985) within a youth population. Participants were male ( $n = 431$ ) and female ( $n = 152$ ) athletes ( $M$  age = 15.4,  $SD = 1.23$ ) from a range of team and individual sports. Confirmatory factor analysis revealed a poor model fit to the hypothesized factor structure ( $\chi^2(237) = 902.09$ ,  $RMSEA = .07$ ,  $SRMR = .07$ ,  $CFI = .91$ ,  $TLI = .89$ ). Modification indices suggested the removal of two items, one from the IG and the IJ subscales. A re-specified model showed improvement ( $\chi^2(191) = 557.37$ ,  $RMSEA = .06$ ,  $SRMR = .06$ ,  $CFI = .95$ ,  $TLI = .94$ ) and was adopted for subsequent analyses. Internal reliability was found to be acceptable for all 6 subscales with Cronbach alphas from .74 to .86. Convergent validity was assessed using a subsample of 402 participants who completed the general self subscale of the Self-Description Questionnaire II (Marsh, 1990). As hypothesized (Deci & Ryan, 2000), bivariate correlations showed a small but significant positive association between self-worth and IM ( $r = .13$ ,  $p = .01$ ) and small negative associations with ER ( $r = -.15$ ,  $p < .01$ ) and AM ( $r = -.14$ ,  $p < .01$ ). Finally, 39 participants completed the BRSQ on 2 separate occasions 4 months apart to assess test-retest reliability. Interclass correlations revealed moderate reliabilities with lower test-retest reliability for the AM subscales (IM = .60, IG = .65, ID = .73, IJ = .66, ER = .59, Am = .41). In conclusion, this research offers some support for the psychometric properties of a 22 item BRSQ in the case of youth sport participants.

### **The Developmental History of Athletes Questionnaire (DHAQ): Considerations when collecting athlete training histories**

Hopwood, Melissa, Victoria University; Clare MacMahon, Victoria University; Joseph Baker, York University; Damian Farrow, Australian Institute of Sport

Investigations of training histories of elite athletes provide valuable information about the practice requirements and psychosocial conditions associated with expert sport performance. Past research in this area has involved either interviews with small samples of elite athletes, parents, and/or coaches, or the administration of basic questionnaires requiring retrospective recall of time spent in practice during each year of sport involvement. The Developmental History of Athletes Questionnaire (DHAQ) extends the current literature by allowing for the collection of detailed developmental histories from a larger sample of participants than has been investigated in the past. Validation procedures for the DHAQ have revealed some notable observations pertaining to athlete training histories. Fifteen Australian national level athletes completed the DHAQ on two occasions, and participated in a semi-structured interview. Thirteen parents and nine coaches participated in a similar interview to substantiate athlete data. Intraclass correlations and percent agreement statistics were calculated for total hours of sport involvement between the two occasions of the DHAQ ( $ICC = .90$ ,  $p < .01$ ; percent agreement = 84.18%), between the initial completion of the DHAQ and the athlete interview ( $ICC = .86$ ,  $p < .01$ ; percent agreement = 81.71%), and between the initial completion of the DHAQ and the parent interview ( $ICC = .72$ ,  $p < .01$ ; percent agreement = 75.26%). These results suggest the DHAQ is a reasonably reliable instrument for the collection of historical athlete training data. Furthermore, several issues were identified that have implications for both the validity and interpretation of previous research in this area,

as well as how such information should be collected in the future. These issues include: a) accurately determining time spent in competition and supplementary practice activities such as physical conditioning, b) acknowledging that training commitments vary throughout the year, and c) verifying the accuracy of information recalled across the career-span.

### **Measurement Development & Validation: Physical Self-Concept Scale for Older Adults (PSCS-O)**

Hsu, Ya-wen Eva, Graduate Institute of Physical Education, National Taiwan Sport University; Jing-hong Frank Lu, Graduate Institute of Physical Education, National Taiwan Sport University; Feng-chun Nell Tsai, Graduate Institute of Physical Education, National Taiwan Sport University

Although research had already demonstrated solid relationship among physical activity, physical self-concept and global self-esteem, little attention had been paid to the underlying dimensions of physical self-concept of elderly. The purpose of the present study was to develop and validate a measurement of physical self-concept in older adults. Firstly, we conducted a qualitative study, including semi-structured interviews ( $n = 5$ ) and a focus group panel discussion ( $n = 8$ ), and eight dimensions with two higher-order categories were identified. Secondly, study 2 established an initial instrument through 3 phases. In phase 1, an initial item pool of 40 items was generated from findings of study 1 and previous relevant literatures. In phase 2, content validity was assessed through three experts. In phase 3, exploratory factor analysis and item analysis were conducted using 181 older adults to clarify the underlying dimensions and to trim the number of items. An initial version of Physical Self-Concept Scale for Older Adults (PSCS-O) containing 18 items and 6 dimensions was then produced. Finally, in study 3 ( $n = 232$ ), the factorial stability of PSCS-O was provided through confirmatory factor analysis, indicating that a model of 18-item with second-order had better fitness-of-indices values. Furthermore, the construct validity was demonstrated through the examination of relationship between PSCS-O and the Chinese Aging Well Profile (CAWP). PSCS-O demonstrated adequate convergent-divergent validity; besides, independent living function, the new concept in PSCS-O, was the most salient predictor to older adults' subject well-being. To conclude, the results of this research demonstrated that this new measurement, PSCS-O, has preliminary sound psychometric properties. Given that physical self-concept is essential to older adults' positive identity and global self-esteem, future validity testing are needed to provide more convincing evidence for the reliability and construct validity.

### **The relationship between negative self-talk and alpha power at the left temporal region of the brain**

Hung, Tsung-Min, National Taiwan Normal University

The understanding of the optimal mental state is critical to performance enhancement. EEG studies on this topic found that increased alpha power at the left temporal region of the brain was associated with superior performance in closed motor skills such as shooting, archery, and golf putting. Why does increased alpha power at the left temporal region of the brain affect performance? The left temporal region of the brain has been associated with verbal-analytical function of the cognitive process. An increase of alpha power at this region could be implicative of a verbal-analytical function inhibition, such as reduction in a verbal function such as self-talk. This line of explanation is logical and plausible. However, a direct test of

the association between alpha power at the left temporal region of the brain and self-talk was until now, nonexistent. Thus, the purpose of this study was to examine how negative self-talk and instructional self-talk affect alpha power at the left temporal region of the brain. We hypothesized that both types of self-talk attenuate alpha power at the left temporal region. Twenty-four male college students from a police academy, each with at least six months of training in 10-meter air pistol shooting, participated in the study. A within subject design was employed. Every participant performed thirty shots on each of the three conditions (i.e., negative self-talk, instructional self-talk, and control) in a counter-balanced order. Alpha power at the left temporal region three seconds prior to trigger pull were subjected to a  $3 \times 3$  (condition  $\times$  epoch) ANOVA with repeated measures on both factors. The EEG result of this study is consistent with past studies. T3 alpha increased while shooters approached trigger pull for all conditions but shooting performance did not vary among conditions, nor did the manipulation of self-talk affect alpha power at the left temporal region of the brain.

### **Successful and Unsuccessful Performance Differences in EEG Activity during Golf Putting**

Hung, Chiao-Ling, National Taiwan Normal University; Jihh-Kuan Huang, National Taiwan Normal University; Tsung-Min Hung, National Taiwan Normal University

The purpose of this study was to examine whether successful and unsuccessful putting performance are differentiable from electroencephalogram (EEG) activity. To answer this question, a preliminary investigation was conducted. Two skilled golfers were recruited in this study. The successful and unsuccessful putts were selected from each golfer while the participants performed 100 putts at a golf green simulator. EEG data were epoched 1 second consecutively for 2 seconds prior to the point of golf putt. EEG was assessed for three frequency bands, (i.e., low-alpha, 8-10 Hz; high-alpha, 10-13; and low-beta, 13-20). Examination of data from the two subjects showed that, low-alpha power decreased before successful putts, but increased before unsuccessful putts. With respect to high alpha, although unsuccessful putts have greater high-alpha power than the successful, successful putts increased power when approaching to the putting while unsuccessful putts decreased. Additionally, both performances were associated with increased beta power in the left compared with right hemisphere, but successful putts exhibited increased power in the left hemisphere and decreased power in the right hemisphere relative to unsuccessful, except in the occipital area. Low-alpha power has been related to general arousal. The increased low-alpha power during the unsuccessful putts may imply a state of excessive arousal that may impair putting performance. Furthermore, high-alpha and low-beta power have been related to task-specific attentional processes. Increasing attention before putts result in successful performance while decreasing attention cause performance failure. In conclusion, the preliminary finding from the present investigation indicated that successful and unsuccessful putting performances are differentiable from EEG activity. This preliminary finding is informative for the design of future study.

### **Relational consequences associated with coach-athlete Big Five similarity: Do opposites really attract?**

Jackson, Ben, University of Western Australia; J. Robert Grove, University of Western Australia; Daniel F. Gucciardi, University of Queensland; James A. Dimmock, University of Western Australia

Personality research in sport has diminished in recent years, principally due to a lack of explanatory power regarding personal achievement and participation. However, despite conceptual and methodological advancements, researchers have overlooked how personality traits may underpin interpersonal processes in sport. The primary purpose of this study was to explore the role of coach-athlete Big Five similarity in predicting indices of relationship functioning. Ninety-one regional-level, individual-sport athletes ( $M$  age = 20.76,  $SD$  = 3.55) and their coaches ( $M$  age = 37.33,  $SD$  = 10.17) provided data relating to their own Big Five traits, as well as their relationship commitment and relatedness (i.e., trust, closeness). Accounting for demographic variables (e.g., experience, relationship length), actor-partner interdependence models (APIMs) revealed that greater similarity between coaches and athletes in terms of their extraversion and openness to experience predicted enhanced commitment ( $b = -.57, p < .001$ ;  $b = -.45, p < .05$ , respectively) and relatedness ( $b = -.58, p < .001$ ;  $b = -.50, p < .05$ , respectively) for interactants. Alongside similarity effects, APIMs also provided insight into how individuals' personality traits directly predicted outcomes for themselves (actor effects) and their partners (partner effects). Several positive actor effects emerged for commitment and relatedness (i.e., agreeableness, extraversion). Partner effects were also apparent, for example, dyad members reported greater commitment ( $b = .44, p < .01$ ) and relatedness ( $b = .40, p < .01$ ) when their partner was highly conscientious. Overall, these findings indicate that dyad members' personality traits, both in isolation (i.e., actor, partner effects) and relative to one another (i.e., similarity), may represent important constructs in shaping effective dyadic processes. Future research using the Big Five model is encouraged in order to better understand how personality factors contribute to relationship dynamics across sport, exercise, and health contexts.

### **“It’s not me, it’s you”: Big Five personality traits and relationship commitment in athlete dyads**

Jackson, Ben, University of Western Australia; J. Robert Grove, University of Western Australia; Daniel F. Gucciardi, University of Queensland; James A. Dimmock, University of Western Australia

Researchers within romantic and familial settings have devoted considerable attention to exploring how personality factors may promote harmonious dyadic interactions. Nonetheless, little is known regarding the role of personality constructs upon relationship functioning in athletic domains. The extant literature outside sport indicates that relational outcomes may be shaped not only by individuals' own traits, but also by their perceptions of each other's personality. In this study, both members of 86 regional-level athlete-athlete partnerships ( $M$  age = 22.78,  $SD$  = 4.24) reported perceptions of their own and their partners' Big Five traits, along with relationship commitment. Actor-partner interdependence models were utilized to explore how athletes' perceptions of their own and their partner's traits independently predicted outcomes for either themselves (i.e., actor effects) or their partners (i.e., partner effects), whilst accounting for key demographic variables. Actor effects revealed that athletes reported greater commitment to their partnership when they perceived themselves to be highly agreeable ( $b = .27, p < .05$ ), conscientious ( $b = .25, p < .05$ ), or open to experience ( $b = .21, p < .05$ ). Moreover, when they rated their partners favorably on these same dimensions, this predicted increased personal commitment alongside the effects of their own personality. With respect to partner effects, when athletes reported being highly agreeable ( $b = .23, p < .05$ ) and/or conscientious ( $b = .26, p < .05$ ), this was associated with greater commitment for their partners. Also, for dyad members who rated their partner high



on openness to experience, this predicted greater commitment for the partner ( $b = .27, p < .01$ ). These findings contribute to the growing literature on interpersonal perceptions and relationship dynamics in sport. Specifically, in addition to providing evidence that one's own traits may shape relational perceptions, this study revealed that the beliefs individuals form regarding one another's personality may also foster commitment in athletic partnerships.

**Relational efficacy in undergraduate sports science classes: Outcomes associated with students' self-efficacy, other-efficacy, and RISE beliefs**

Jackson, Ben, University of Western Australia; Lauren K. Banting, University of Western Australia; J. Robert Grove, University of Western Australia; Mark R. Beauchamp, University of British Columbia

Within interdependent settings individuals develop a network of efficacy cognitions that extend beyond their confidence in their own capabilities and encompass perceptions about those with whom they interact. Specifically, in addition to self-efficacy beliefs, people also evaluate the capabilities of significant others (other-efficacy) as well as making inferences regarding significant others' confidence in them (relation-inferred self-efficacy, RISE). Research in coach-athlete contexts has documented a number of adaptive outcomes associated with these 'relational' efficacy beliefs. Outside of sport, effective relationships between teachers and students are theorized to be central to academic and personal development; however the utility of Lent and Lopez's (2002) tripartite model, that incorporates these relational efficacy beliefs, in educational settings is presently unclear. In this study, 371 undergraduate sports science students ( $M$  age = 19.38 years,  $SD = 1.88$ ) were recruited from physical activity classes (e.g., soccer, tennis), and were asked to rate (a) their confidence in their own ability to carry out the various tasks required of them in class (self-efficacy), (b) their confidence in their teacher's instructional abilities (other-efficacy), and (c) their estimation of their teacher's confidence in their in-class capabilities (RISE). Hierarchical regression analyses were conducted, with self-efficacy, other-efficacy, and RISE entered sequentially as predictors of students' perceptions of in-class effort and enjoyment. Each of the tripartite efficacy constructs explained unique variance in effort scores, adj.  $R^2 = .25, F(3, 365) = 40.62, p < .001$ . Moreover, a high degree of confidence in oneself (i.e., self-efficacy) and one's teacher (i.e., other-efficacy) predicted greater class enjoyment, adj.  $R^2 = .30, F(2, 366) = 81.10, p < .001$ . These findings indicate that, alongside self-efficacy perceptions, relational efficacy constructs may play an important role in fostering desirable outcomes within sports science classes.

**Validity of a measure of cohesion for youth sport: The Youth Sport Environment Questionnaire**

Jewitt, Eryn, Wilfrid Laurier University; Mark Eys, Wilfrid Laurier University; Todd Loughhead, University of Windsor; Mark Bruner, Queens University

Cohesion plays an important role in sport and is a crucial factor in the success of groups (Carron et al., 2005). Recently, Eys and colleagues (2009) developed the Youth Sport Environment Questionnaire (YSEQ) as a tool to measure cohesion in youth sport groups. The purpose of the present study was to examine the predictive and construct validity of the YSEQ. Specifically, predictive validity was assessed by comparing perceptions of cohesion by sport type (individual vs. team sport athletes), as well as team tenure (first year vs. veteran group members). With respect to construct validity, the relationship between cohesion and

perceived motivational climate was assessed. Participants included 687 athletes ( $M$  age = 15.34  $\pm$  1.23 years) who completed two inventories; the YSEQ (task and social cohesion) and the Motivational Climate Scale for Youth Sports (mastery and ego involving climate; Smith et al., 2008). A 2 (individual vs. team sport involvement)  $\times$  2 (first year vs. veteran group members) factorial MANOVA demonstrated main effects for both sport type, Wilks's lambda = .99,  $F(2,682) = 4.35$ ,  $p < .05$ , and team tenure, Wilks's lambda = .99,  $F(2,682) = 3.99$ ,  $p < .05$ . At a univariate level, no differences for task cohesion were found with respect to sport type or tenure. However, team sport athletes ( $M = 6.10 \pm 1.78$ ) perceived greater social cohesion than individual sport athletes ( $M = 5.69 \pm 1.98$ ),  $F(1,683) = 6.85$ ,  $p < .01$ . In addition, veteran athletes ( $M = 6.00 \pm 1.86$ ) perceived greater social cohesion than first year athletes ( $M = 5.72 \pm 1.93$ ),  $F(1,683) = 3.58$ ,  $p = .05$ . Finally, perceptions of a mastery motivational climate were positively related to both task ( $r = .45$ ,  $p < .001$ ) and social cohesion ( $r = .21$ ,  $p < .001$ ). In contrast, perceptions of an ego climate were negatively related to task cohesion ( $r = -.20$ ,  $p < .001$ ). The results provide support for the validity of the YSEQ and highlight areas of future research.

### **Effects of an Exercise Intervention on Depression, Fatigue and Exercise Behavior Change of Chronic Kidney Disease Patients**

Kao, Yu-Hsiu, National Taipei College of Nursing; Pei-Ying Chen, Taipei Veterans General Hospital; Yi-Ching Huang, National Taipei College of Nursing; Shih-Chiung Lai, National Taipei College of Nursing

This study explored the effect of an exercise program on depression, fatigue and exercise behavior in chronic kidney disease (CKD) patients. A quasi-experimental approach selected 94 samples diagnosed CKD without taking dialysis treatment from a nephrology outpatient clinic of a medical center in northern Taiwan. Samples were divided at random into experimental ( $n = 45$ ) and control ( $n = 49$ ) groups. Experimental group subjects agreed to join a 3-month intervention of exercise program. A group exercise program was prescribed to the experimental group one week from acceptance, and telephone guidance followed for individual samples in the second and third months after acceptance. The effect of exercise program was measured in the fourth month. Both groups completed the pre-test and post-test forms of the questionnaire of depression, fatigue, and past 3-month regular exercise. Data was analyzed using analysis of covariance (ANCOVA). Findings indicated that the difference in depression (9.56  $\pm$  5.83 to 8.89  $\pm$  5.40), fatigue (51.78  $\pm$  9.40 to 49.29  $\pm$  8.76) and weekly exercise amount over the past 3-month (11.19  $\pm$  11.66 METs to 13.04  $\pm$  11.13 METs) of the experimental group is statistically significant before and after intervention, while the difference in the control group is insignificant. Therefore, exercise program can effectively reduce depression and fatigue and increase the amount of weekly exercise in CKD patients.

### **Comparison of different aiming time on shooting performance and EEG in skilled pistol shooters**

Kao, Shih Chun, National Taiwan Normal University; Tsung-Min Hung, National Taiwan Normal University

The purpose of this study was to examine the shooting performance and EEG activity of different aiming times (AT). Twenty-four skilled pistol shooters were requested to perform 30 shots which were subsequently classified into three aiming durations categories based

on individual AT. Specifically, short AT (ST) were trials of AT shorter than 1 *SD* ( $SD = 2.63$  seconds) while long AT (LT) were those longer than 1 *SD*. Those within 1 *SD* from the mean were the median AT (MT). After the classification of aiming periods, we deleted the trials with AT shorter than 2 seconds and rejected data from participants with less than 3 shots were retained. As a result, 19 participants whose average AT was 8.89 seconds were used for analysis. In this study, EEG was assessed at four bands, (theta, 6-8Hz; low alpha, 8-10; high alpha, 10-12; and low beta, 14-20), using sites Fz, T3, C3, Cz, C4, T4, Oz. EEG data were epoched 0.5 seconds consecutively for 2 seconds prior to the trigger pull and four  $3 \times 4 \times 7$  (aiming time  $\times$  epoch  $\times$  electrode) ANOVAs with repeated measures were employed. The results showed that the shooting scores with MT were significantly better than that of LT and ST. EEG beta of Oz was significantly lower in ST compared to MT and LT, and the difference between MT and LT approach significance (.069). Furthermore, beta of Cz showed similar result of Oz, but at C3 LT has higher power than ST. Since the beta activity at Oz and Cz could be related to the specific visual process and motor control of aiming, the higher and lower beta power in LT and ST probably represented the insufficient or over-involvement of visual processes and motor control which led to poor performance. This result is consistent with past findings, which suggest that superior shooting performance is associated with optimal specific brain activation.

### **Stress reactivity, health behaviors and compliance to medical treatment in breast cancer survivors.**

Karvinen, Kristina H, East Carolina University; Nicholas Murray, East Carolina University; Hyder Arastu, Brody School of Medicine at East Carolina University; Gloria Frelix, Brody School of Medicine at East Carolina University; Ron Allison, Brody School of Medicine at East Carolina University

Approximately 194,000 new cases of breast cancer are expected in the United States in 2009. While the stress of cancer and its treatments may have implications on quality of life (Knobf, 2007), evidence suggests that stress may also have adverse effects on the autonomic, endocrine and immune systems (Haas & Schauenstein, 1997), which in turn may affect disease course. In order to explain relationships between stress, disease course and its mediators, Andersen et al. (1994) proposed a Biobehavioral Model of cancer stress and disease course. This model posits that stress has a direct effect on quality of life, immune function, compliance to treatments and health behaviors. Reviews of observational and experimental studies in cancer survivors provide some support and rationale for this model (Andersen et al., 1994; Andersen, 2002); however, the majority of studies have only explored specific relationships within the framework rather than testing the causal pathways of three or more variables. Moreover, no known studies to date have utilized objective measures of stress response (e.g., salivary cortisol, heart rate variability) in relation to quality of life, compliance or health behaviors in breast cancer survivors. For the present study, we examined the relationships of stress, compliance to medical appointments and health behaviors in twenty-three breast cancer survivors. Utilizing the Trier Social Stress Test (TSST), the participants gave a speech in front of a simulated audience and completed a math subtraction task. Results revealed participants with a history of non-compliance had a higher increase in Heart Rate Variability ( $p < .001$ ) as well as a significantly increase cortisol levels ( $p < .05$ ) following the TSST than participants without a history of non-compliance. In addition, health behaviors differences were found ( $p < .05$ ) in high stress response participants as compared to low stress response participants. Findings are discussed in terms of the Biobehavioral model.

## Effects of Moral Disengagement and 2x2 Achievement Goals on Unsportsmanlike Behavior

Kaye, Miranda P, Ithaca College

This study examined the effects of achievement goals and moral disengagement on unsportsmanlike behaviors. Athletes ( $n$  female = 91;  $n$  male = 103;  $M$  age( $SD$ ) = 20.39(1.52)) completed a questionnaire assessing these variables. Findings indicated that unsportsmanlike behavior was significantly related to moral disengagement ( $r = .24$ ), performance-approach (PAp,  $r = .33$ ) mastery-approach (MAp  $r = -.20$ ) and performance-avoidance goals (PAv;  $r = .20$ , all  $p < .01$ ). A series of regression analyses further indicated that PAp goals predicted unsportsmanlike behavior (beta = .19,  $p < .05$ ) above and beyond moral disengagement (Delta  $R^2 = .06$ ,  $p < .01$ ). Examination of each of the categories of unsportsmanlike behavior revealed unique associations with moral disengagement and achievement goals. With the exception of abetting behavior which was best predicted only by moral disengagement (beta = .41,  $p < .01$ ; Delta  $R^2 = .02$ ,  $p > .05$ ), achievement goals predicted each of the categories of unsportsmanlike behavior above and beyond the influence of moral disengagement alone. Specifically, PAp goals predicted hypercompetitive (beta = .39,  $p < .01$ ) and intimidating behavior (beta = .18,  $p < .05$ ) beyond the influence of moral disengagement (Delta  $R^2 = .39$ ,  $p < .01$ ; beta = .57,  $p < .01$ ; Delta  $R^2 = .04$ ,  $p < .05$  respectively). Approach-oriented goals (PAp beta = .34,  $p < .01$ ; MAp beta = -.17,  $p < .05$ ) predicted antisocial behavior above the effect of moral disengagement (Delta  $R^2 = .12$ ,  $p < .01$ ). Avoidance-oriented goals (PAv beta = .21,  $p < .05$ ; mastery-avoidance (MAv) beta = .20,  $p < .05$ ) predicted disrespectful behavior above the influence of moral disengagement (Delta  $R^2 = .09$ ,  $p < .01$ ). MAp goals predicted acquiescent and overly deferential behavior beyond the effect of moral disengagement. And, MAv goals (beta = -.27,  $p < .01$ ) predicted melodramatic behavior beyond the effect of moral disengagement (Delta  $R^2 = .08$ ,  $p < .05$ ). Together these findings indicate, that while all associated with moral disengagement, 2 x 2 achievement goals may further our understanding of athletes engagement in different types of unsportsmanlike behavior.

## Interpersonal Unsportsmanlike Behavior: A Multidimensional Scaling Analysis

Kaye, Miranda P, Ithaca College

Occurrences of unsportsmanlike behavior have been examined as a variety of separate types of behavior (e.g., cheating, faking an injury, trying to injure opponents, gamesmanship, etc.). The application of Interpersonal Theory (Kiesler, 1983; Leary, 1957; Wiggins, 1982) provides a unifying theoretical framework to organize these various types of behavior which may aid in the development of our understanding of unsportsmanlike behavior. This study identifies and provides preliminary evidence of the interpersonal nature of unsportsmanlike behavior. Participants ( $n = 272$ ;  $M$  age = 20.62,  $SD = 1.25$ ) with current or recent sport experience completed questionnaires eliciting similarity ratings of eight categories of interpersonal unsportsmanlike behaviors. Multidimensional scaling analysis revealed category placement around two factors, one representing the interpersonal dimension of dominance and one representing the interpersonal dimension of affiliation. The eight categories of unsportsmanlike behavior began to fit the expected circular pattern around these dimensions (S-Stress = .26; Tucker's Coefficient of Congruence = .95). These findings provide initial support for the interpersonal nature of unsportsmanlike behavior.

### **Transformational Teaching in Elementary School Physical Education Settings: Implications for Student Motivation and Adaptive Attitudes.**

Keith, Sharon E., The University of British Columbia; Mark R. Beauchamp, The University of British Columbia

The overall purpose of this study was to examine the prospective relationships between students' perceptions of their teachers' behaviors, as conceptualized by transformational teaching (Morton, Keith, & Beauchamp, in press), and student self-determined motivation and attitudes within physical education contexts. 533 elementary school students (aged 11-13) from 23 classes participated in this prospective observational study. Students completed an initial battery of measures mid-way through the school year that corresponded to their perceptions of their teacher's use of transformational teaching, as well as student psychological need satisfaction, self-determined motivation, and adaptive attitudes (interest/value and perceived usefulness of physical education). Two months later students completed the same measures once more. Results indicated that transformational teaching was a positive predictor of student self-determined motivation ( $R^2 = .20$ ). The relationship between transformational teaching and student self-determined motivation was also found to be partially mediated by psychological need satisfaction. Finally, transformational teaching was able to account for significant variance in students' reports of interest/value ( $R^2 = .25$ ) and perceived usefulness ( $R^2 = .16$ ) of physical education. The findings of this study add to a growing body of literature which suggests that transformational teaching contributes to student engagement in physical education.

### **Self-Definition in Novice and Expert Tennis Players**

Kendzierski, Deborah, Villanova University; Diane E. Whaley, University of Virginia

Perceived ability and commitment contribute to physical activity self-definition (PASD) as theorized (Kendzierski & Morganstein, 2009), with perceived commitment contributing most for runners and cyclists. The extent to which people consider themselves similar to their prototype of one who does the activity adds to predictability of PASD beyond that provided by perceived commitment and ability for both novice and expert distance runners (Kendzierski, Jackson, & Kerr, 2009); perceived commitment (PC) contributes most for novices and self-prototype match (SPM) most for experts. In these studies, perceived ability (PA) only made a small contribution to self-definition, possibly because fitness and distance running and noncompetitive cycling require simple skills so ability may not be salient. This study involved tennis, which requires complex skills. It examined (a) whether SPM adds to the predictability of PASD when PC and PA are controlled, and (b) the relative contributions of PA, PC, and SPM to PASD for novices and experts. Tennis players (96 novices, 127 experts;  $M = 44.05$  years,  $SD = 9.22$ ; 58.3% women, 41.7% male, were recruited from clubs, public courts, and classes. Players with NTRP ratings of 3.5 or lower were considered novices; those with ratings of 4.0 and higher were considered experts. The groups had similar PC scores but experts had higher PA, SPM, and PASD scores; group variances did not differ. Hierarchical regression analyses revealed that for both groups the addition of SPM significantly improved the predictability of tennis player PASD beyond that provided by PA and PC ( $F(1, 92) = 20.80, p < .001$  for novices,  $F(1, 123) = 28.72, p < .001$  for experts). For novices, SPM and PC made similarly moderate contributions (Betas = .40 and .38) and PA made an unexpectedly small but significant contribution (Beta = .18). The pattern was similar for experts (Betas = .44 and .42) but PA made a surprisingly

nonsignificant contribution ( $Beta = .04$ ). Theoretical and applied implications for physical activity self-definition are noted.

### **Psychosocial Determinants of Physical Activity and the Stages of Change Among Diverse Older Adults**

Kim, Taeung, Louisiana State University; Maria Kosma, Louisiana State University

Although the benefits of physical activity among older adults are well-documented, only few people over 65 years are regularly active (i.e., 22%). Therefore, the purpose was to examine the relations among the transtheoretical model (TTM) constructs, the stages of change (SOC), and physical activity among ethnically and economically diverse older adults using a modified SOC scale. This was a one-year, cross-sectional study, and data collection took place in 11 community settings in a Southeastern state. Standardized, self-report scales were used to assess the TTM constructs and physical activity among 176 older adults (Mean age = 72.07, women = 123, Whites = 94, Blacks = 78). The distribution of participants across the SOC was as follows: precontemplation = 24, contemplation = 22, preparation = 22, and action = 106. Based on the MANOVA, the TTM constructs overall significantly differed across the SOC in the expected direction. Self-efficacy and the processes of change increased across the SOC. Individuals in action had the lowest number of perceived cons compared with precontemplators, contemplators, and preparators. Based on the ANOVA, people in action exhibited higher physical activity scores (Mean = 145.96 MET-hrs/day) than those in precontemplation (Mean = 92.06 MET-hrs/day) and contemplation (Mean = 80.76 MET-hrs/day). Based on the direct discriminant function analysis, the most important predictors of the SOC were self-efficacy ( $r = .71$ ), the behavioral processes of change ( $r = .62$ ), perceived cons ( $r = -.61$ ), and the cognitive process of change ( $r = .44$ ). The overall classification accuracy was acceptable (63.8%). The most accurately classified SOC were action (95.3%), precontemplation (25%), contemplation (18.2%), and preparation (0.0%). Health promoters can use the improved SOC scale to implement stage-matched physical activity motivational programs by using such TTM-based strategies as increased successful activity experiences, goal setting, and information about exercise barriers and ways to overcome them.

### **Sport Participation and Possibilities for Positive Development Among Children From Low-Income Families**

Kingsley, Bethan C, University of Alberta; Nicholas L Holt, University of Alberta; Lisa N Tink, University of Alberta

Sport participation has been associated with numerous positive developmental outcomes. However, there is little evidence examining the role of sport in the lives of children from low-income families. Hence, the purpose of this study was to examine the benefits and challenges children from low-income families experienced through being provided with opportunities to participate in youth sport. In order to access this 'hard-to-reach' group the authors partnered with a non-profit organization that provided funding to low-income families to pay children's sport registration fees. Families who had received funding from the organization in the previous 12 months were recruited via a mail-out. A total of nine low-income families (9 parents, 10 children) participated in individual semi-structured interviews, during which they were asked about how being provided with sport opportunities influenced the children's lives. Data were transcribed verbatim and subjected to a content analysis procedure. Analysis

revealed four themes (1) Participants valued sport participation. (2) Making friends with ‘different types’ of children and building relationships with other adults (e.g., coaches) were the main developmental benefits associated with sport. (3) Despite the fact families received funding, they still faced financial and logistical barriers that impeded their children’s continued participation in sport. However, these families were prepared to make financial sacrifices in other areas to help facilitate their children’s participation. (4) Parents and children wanted to have more involvement, sustained participation, and opportunities to engage in a variety of different programs to maximize the developmental benefits children could accrue through sport. In conclusion, the findings of this study suggest that the social benefits of sport are particularly important to low-income families. However, these families required additional funding and opportunities to ensure their children’s sustained participation to optimize possibilities for positive development through sport.

### **Occupation Correlates of Adults’ Participation in Physical Activity: A Systematic Review**

Kirk, Megan A., University of Victoria; Ryan E. Rhodes, University of Victoria

Background: Occupational factors may be critical determinants of low physical activity (PA) participation. The purpose of this review is to unite and appraise the existing research examining occupation correlates of adults’ participation in PA to establish direction for future research. Methods: Eligible studies were from English peer-reviewed journals. A total of 58 studies passed the inclusion criteria. Major findings were summarized based on common subtopics of occupation category and PA, occupational PA and leisure-time PA, work hours and PA, occupation and total PA, and occupation, parenthood and marital status. Results: Included articles were published between 1984 and 2009, with sample sizes ranging from 171 to 203 120. Occupation factors correlated with PA, but the findings varied based on the measures used. Blue-collar occupations were found to have the lowest PA during leisure-time compared to white-collar and professional workers. High occupational PA had a positive association with leisure-time PA. Work hours were negatively associated with leisure-time PA, though the effect was small. Some preliminary evidence found psychosocial work demands (e.g., job strain) to negatively influence PA levels, but further research is needed to confirm the findings. Conclusions: Evidence supports the premise that those employed in occupations demanding long work hours and low occupational PA are at risk of inactivity. Existing research has focused on cross-sectional data and study-created self-report measures. Future researchers are encouraged to conduct longitudinal objective evaluations of total daily PA across several domains (e.g., home, work, leisure) and consider the influence of several occupation characteristics on PA to better understand the overall contribution of occupation on PA status. Intervention efforts should focus on making time for regular PA within the workplace (e.g., walking meetings, active fit breaks).

### **The Relationship between Copying Strategies and Mental Toughness among Soccer Players**

Kuo, Tzu-Hui, National Taiwan Sport University; Yu-Kai Chang, National Taiwan Sport University; Shih-Hsien Yen, National Taiwan Sport University; Mu-Cheng Chin, National Taiwan Sport University

Mental toughness has recently been recognized as a crucial psychological characteristic in successful athletic performance. Similar to mental toughness, athletes with better sport-specific psychological copying strategies have been linked to delivering more desirable

performances. Given that these psychological characteristics are important for athletes, the purpose of this paper is to investigate the mental toughness and copying strategies status among soccer players of different demographic variables. In addition, relative to this study, the relationships between subcomponents of mental toughness and copying strategies were explored. 254 soccer players in Taiwan were requested to complete the Trait Mental Toughness Inventory of Sport (TMTIS) and the Athletic Coping Skills Inventory-28 (ACSI-28) for assessing mental toughness and copying strategies, separately. The independent t-test and one-way ANOVA were computed for the differences of mental toughness and copying strategies based upon athletic variables, and the Pearson Product Moment Correction was computed between mental toughness and copying strategies statuses. The results indicated that players with higher achievement levels have significantly higher scores in all mental toughness subcomponents (positive effort, anti-pressure, and endurance) and subcomponents of copying strategies. In addition, excepting freedom from worry, copying strategies subcomponents have significant moderate positive correlations on positive effort and anti-pressure; however, copying strategies subcomponents only have low positive correlation to endurance. Practical implications of these findings and the future direction of research for mental toughness and copying strategies are discussed.

### **The Relationship between Body Image Investment, Dietary Restraint, and Exercise Dependence in University-Aged Men**

Lamarche, Larkin, University of Toronto; Kimberley L Gammage, Brock University

Body image investment is the importance placed on the body. Although some level of investment can be healthy (motivational salience), unhealthy investment occurs when people derive their sense of self from their physical appearance (self-evaluative salience). Diet and exercise are among some ways to achieve the ideal body. Although diet and exercise can lead to healthy outcomes, they can also be potentially health-damaging. More specifically, cognitive dietary restraint and exercise dependence may be two potentially harmful variables related to body image investment. The purpose of this study was to examine the relationship between DR, exercise dependence, and body image investment. University men and women ( $n = 204$ ) completed a series of questionnaires measuring DR (3-Factor Eating Questionnaire), exercise behaviour (Exercise Dependence Questionnaire), and body image investment (Appearance Schemas Inventory-Revised). Three separate regressions were conducted to predict motivational salience, self-evaluative salience, and total investment score from DR and exercise dependence, controlling for BMI. In each case, the overall regression was significant (motivational salience:  $F(3,188) = 12.17, p < .001, R^2_{adj} = .15$ ; self-evaluative salience:  $F(3,188) = 13.91, p < .001, R^2_{adj} = .17$ ; total investment score:  $F(3,188) = 17.04, p < .001, R^2_{adj} = .20$ ). Further, DR was a significant predictor of motivational salience, self-evaluative salience, and total investment score. Exercise dependence did not significantly predict body image investment. These results indicate that DR is related to body image investment, whether it is considered healthy or unhealthy. Future research should examine other variables (i.e., body image evaluation, eating disorder symptoms, and personality traits) that may clarify differences between healthy and unhealthy body image investment.

### **Does verbal persuasion lead to changes in perceived and actual balance performance?**

Lamarche, Larkin, University of Toronto; Kimberley L Gammage, Brock University; Kinga Eliaz, Brock University; Allan L Adkin, Brock University



This study was designed to manipulate balance efficacy using positive or negative verbal persuasion in order to investigate its influence on perceived and actual balance performance in healthy young adults. Participants ( $n = 52$ ) performed a timed 8-m tandem walk task with their eyes closed and were then randomized to either a high balance efficacy group (provided with feedback that performance was within the top 20% for their age and gender), low balance efficacy group (provided with feedback that performance was within the bottom 20% for their age and gender) or control group (no feedback), regardless of actual performance. Following the performance feedback, participants completed the same task. Prior to each task, participants rated their balance efficacy. Following each task, participants rated the level of their conscious monitoring of balance (state-specific modification of the Movement Specific Reinvestment Scale). Time taken to complete the task was recorded to provide an estimate of actual performance. The results showed a significant group (high, low, control) by feedback (pre, post) interaction for balance efficacy, conscious monitoring of balance, and time taken to complete the task ( $p < 0.05$ ). Following the performance feedback, balance efficacy increased for the high group, decreased for the low group but did not change for the control group. Conscious monitoring of balance increased for the low group but did not change for the high or control group while the time taken to complete the task decreased for the high and low group but did not change for the control group following the performance feedback. These results suggest that verbal persuasion may differentially modify performance on this specific balance task through changes in balance efficacy (achieved through “positive” verbal persuasion) or changes in conscious control of balance (achieved through “negative” verbal persuasion). This study was supported by a grant from NSERC and SSHRC.

### **Is there an optimal approach to constructing physical activity messages? A systematic review and recommendations**

Latimer, Amy E, Queen’s University; Lawrence R. Brawley, University of Saskatchewan; Rebecca L. Bassett, McMaster University

Physical activity guidelines offer a prescription about how much activity to do to obtain benefits. To motivate people to act, guidelines need messages that convey why and how to achieve the recommended activity level. This systematic review evaluated the effectiveness of three approaches for constructing physical activity messages for healthy adults: tailoring to suit individual characteristics of message recipients, framing in terms of gains versus losses, and targeting to affect change in self-efficacy. We searched the MEDLINE, PsycINFO, EMBASE and CINAHL databases up to July 2008. Relevant reference lists were also searched. Only intervention trials, field experiments, and laboratory-based studies with comparison groups were included. We evaluated the study quality using established criteria (van Tulder et al., 1997) and used a descriptive approach to analyze emerging patterns in research findings. Twenty-two studies were identified. Methodological quality of these studies ranged from 1–7 on a 9-point scale. Twelve studies evaluated message tailoring. In 10 of these, tailored messages resulted in greater physical activity than a control message. Six studies evaluated framed messages. Five of these demonstrated that gain- framed messages lead to stronger intentions to be active compared to a control message. Moreover, a gain-frame advantage was evident in three of the four studies that assessed physical activity. Four studies evaluated self- efficacy change messages. Two studies that used an experimental design provide a clear indication that individuals’ efficacy beliefs can be affected by messages that incorporate types of information known to be determinants of self-efficacy. Overall, the limited evidence could not support definitive recommendations for optimal message content. Instead,

promising practices for constructing physical activity messages are offered and areas for further investigation are suggested.

### **Achievement Goal Profiles and Observational Learning Use: An Exploratory Investigation**

Law, Barbi, Nipissing University; Jennifer Cumming, University of Birmingham; Craig Hall, The University of Western Ontario

Research has supported the positive relationship between mastery-focused achievement goal orientation and athletes' use of psychological skills, such as imagery, goal setting, and self-talk (e.g., Cumming et al., 2002; Harwood et al., 2004). The purpose of this study was to examine the relationships among athletes' achievement goal orientations, perceptions of competence about their sport ability and ability to learn new skills, as well as their use of observational learning. A heterogeneous sample of athletes ( $n = 404$ ;  $M$  age = 20.43 years,  $SD = 1.61$ ) completed the Achievement Goal Questionnaire for Sport (Conroy et al., 2003), Functions of Observational Learning Questionnaire (Cumming et al., 2005), Perceived Ability subscale of the Intrinsic Motivation Inventory (McAuley et al., 1989), items assessing perceived ability to learn new skills, and a demographic questionnaire. A two-step cluster analysis, using agglomerative hierarchical clustering, produced three achievement goal profiles: High Achievement Motivation, High Approach Motivation, and High Avoidance Motivation. Additional multivariate and univariate analyses supported this three-cluster solution and suggested that achievement goal profiles are associated with distinct patterns of observational learning use and perceived abilities. Specifically, athletes who are higher in mastery and approach orientations compete at a higher level ( $p < .01$ ), employ more of the skill ( $F(2, 401) = 4.02, p < .05, \eta^2 = .02$ ) and performance ( $F(2, 401) = 5.51, p < .05, \eta^2 = .03$ ) functions of observational learning, and possess higher perceptions of their abilities to perform in sport ( $F(2, 401) = 11.78, p < .05, \eta^2 = .06$ ) and to learn new skills ( $F(2, 401) = 15.69, p < .05, \eta^2 = .07$ ). This suggests that observational learning may be one of several self-regulatory strategies used by athletes with more adaptive goal profiles and more positive self-beliefs. Findings will be discussed in terms of theoretical and practical implications for the study of self-regulatory strategies in sport.

### **A cross-cultural examination of the validity of the Revised Physical Self-Perception Profile**

Ling-Wen, Huang, National Taiwan College of Physical Education; Chu-Min Liao, National Taiwan Sport University; Hsiu-Tin Wu, National Taiwan Sport University

It has been suggested in the literature that physical self-perceptions play an important role in individual's motivational processes in sport. The Physical Self-Perception Profile (PSPP) developed by Fox and Corbin (1989) has been one of the widely used measurements of physical self-perceptions in sport and exercise domains. However, the alternative response format of PSPP has been found to be confusing for youth and young adults. Recently, a revised PSPP was developed by Kalmet and Fouladi (2008) using a 4 point Likert-type scale instead of the alternative response format and found to be psychometrically sound. The purpose of this study was to examine whether the revised PSPP was suitable for adults from Taiwan, in which the culture is different from that of the North America. The items of each subscale of revised PSPP (sports competence, physical condition, body attractiveness, physical strength, and physical self-worth) were translated into Chinese, following

a proper back-translation process. Content and logical validities were examined by sport psychologists. The Chinese-version scale was administered to participants ( $n = 244$ , 150 male, 93 female, 1 did not report) aged from 15 to 43 ( $M = 24.91$ ,  $SD = 5.23$ ). Confirmatory factor analysis showed that the data fit the five-factor structure of the revised PSPP ( $\chi^2/df=2.52$ ,  $RMSEA = 0.08$ ,  $NFI = 0.93$ ,  $NNFI = 0.95$ ,  $CFI = 0.96$ ). Cronbach's alpha of the five subscales ranged from .67 to .82. It seems that the revised PSPP is suitable for Taiwanese, but more studies are warrant.

### **Exploring the life skills for Taiwanese Athletes**

Liou, Chee, Overseas Chinese University; Chu-Min Liao, National Taiwan Sport University

Literature has suggested that the development of psychological skills may not only improve the athlete's performance but also enhance personal growth. In other words, psychological skills can be seen as life skills to help athletes cope with personal problems during lifetime. However, until now, there is no research to investigate the life skills of athletes in Taiwan. The purpose of this study was designed to explore the life skills for Taiwanese athletes. Three former elite athletes were interviewed in this study (1 female in Heptathlon, 1 female in Volleyball, and 1 male in Tennis). It was found that there are two categories of life skills for Taiwanese athletes: personal and interpersonal life skills. There are 9 personal life skills: coping, distraction, preparation, goal setting, self-talk, emotional management, personal control, persistence, and patience. However, it is surprising that this study only found one interpersonal life skill (social skill). Although there were just three retired athletes participated in this study, it was the first step for exploring the life skills for Taiwanese athletes.

### **Frontal theta, alpha, and beta comparison of executed and rejected shots in pistol shooting**

Liu, Chien, National Taiwan Normal University; Tsung-Min Tsung Hung, National Taiwan Normal University

For this study, electroencephalographic (EEG) recording changes during the pre-shot period with elite shooters were investigated. The frontal midline theta represents attention, concentration, and arousal of the subject. Only expert shooters showed a steady increase of theta power during the last three seconds prior to the shot at the medial frontal cortex. Past research has also indicated that there is an overall increase in EEG alpha power in expert shooters compared to novices, with alpha and beta power progressively increasing during the aiming period in rejected shots for elite shooters. This study attempted to examine the attentional processes related to the pre-shot period. We recruited twenty-four elite pistol shooters to perform thirty shots and choosing six members whose rejection trail was over and above six shots. EEG from the frontal region (i.e., F7, F3, Fz, F4, and F8) was assessed and theta (4-7 Hz), alpha (8-12 Hz), and beta (14-20) frequency bands were derived between the executed and rejected shots. EEG data were epoched per second for three consecutive seconds prior to execution or rejection.  $2 \times 3 \times 5$  (trial type  $\times$  epoch  $\times$  electrode) ANOVAs with repeated measures were employed. Results for executed compared with rejected shots revealed an increased process in frontal beta power. Additionally, for executed shots the alpha power first decreased but then reversed in epoch two. The theta power's result was contrary to the alpha power. These results were generally consistent with the past research, which has showed increasing alpha and beta power.

## A Study of Comparison of Acute Emotion and Physiological Signals Before and After Exercise

Liu, Suyen, National Chung Cheng University

Research on acute emotion after acute exercise has attracted much attention in recent years. Exercise not only improves people's fitness but also can affect people's emotion and well-being. Do people's emotions and physiological signals change after running on a treadmill? Will their emotion and mood improve after exercise? The above questions are worth to investigating. Purposes: 1. Compare the changes of emotion before and after exercise. 2. Compare the differences of physiological signals (heart rate variability, HRV & Respiratory rang variability, RCV) before, during, and after exercise in the four types of emotion (happiness, depression, anxiety, and sadness). 3. The correlation among acute emotion, emotion before exercise, physiological signals, and the physical activity level. Methods: 18 participants were recruited and ran on the treadmill for 30 minutes at 70% of maximum heart rate. The Profiles of Mood Scale and the self-reported pleasure, arousal and dominance (*p* AD) of emotion were measured. Physiological signals were collected from BioPac150. Self-reported PAD of emotion and POMS were measured before and after exercise to compare the mood changes. The physiological signals of the participants were monitored throughout the entire exercise to compare the differences before, during, and after exercise at 4 types of emotion contexts. One-Way ANOVA, two-way ANOVA and Pearson's correlation were used to analyze the data. Results: 1. Exercise can reduce the negative emotion immediately and promote positive mood. 2. There were interaction between emotion and exercise stage on physiological signals. Higher HRV and RCV were found in the anxiety than other emotion and during the exercise than resting. 3. There was no correlation between the acute emotion and the physical activity level.

## Achievement goals and self-determination constructs: Predicting self-reported stage of exercise behavior

Lochbaum, Marc, Texas Tech University; Leslie Podlog, Texas Tech University; Kyle Litchfield, Texas Tech University

The purpose of the present study was to examine whether different motivations to exercise would enable prediction of stage of exercise behavior change, among participants self-classified in the preparation, action or maintenance stage of exercise. Exercise motivations were assessed using appropriate measures of the 2 × 2 achievement goals and the self-determination continuum. These questionnaires were administered to 206 female (*M* age = 25.21) and 213 male (*M* age = 30.59) participants from university and community settings who identified themselves in either the preparation (19.6%), action (29.8%), or maintenance (50.6%) stage of exercise. Sex differences were found in the performance approach goal, overall intrinsic motivation, and identified regulation (Wilks's lambda = .89,  $F(13, 401) = 3.50, p < .000$ ); thus, backwards binary logistic regressions were conducted separately for females and males. For the preparation/action dichotomy, intrinsic motivation ( $B = .19$ ) and amotivation ( $B = -.52$ ) were predictors for females, while only intrinsic motivation ( $B = .10$ ) was for males, accurately classifying 76% and 59% of the participants respectively. For the female action/maintenance dichotomy, the mastery-approach goal ( $B = .85$ ) and intrinsic motivation ( $B = -.20$ ) remained in the final binary logistic regression and accurately classified 67% of the participants. Finally, for the male action/maintenance dichotomy, the mastery-approach ( $B = .62$ ), mastery-avoidance ( $B = -.25$ ) and performance-avoidance

( $B = -.22$ ) goals as well as extrinsic motivation ( $B = .60$ ) remained in the final regression model, accurately classifying 71% of the participants. Results highlight the importance of recognizing gender differences in developing interventions for moving nonexercisers from the preparation to action stage as well as from the action to maintenance stage. Findings also reveal the importance of the mastery approach goal for both males and females desiring to move from the action to maintenance stage of exercise.

**Advancing the exercising personality in an adult sample: A look into mechanisms of change**

Lochbaum, Marc, Texas Tech University; Kyle Litchfield, Texas Tech University; Ryan Rhodes, University of Victoria; Leslie Podlog, Texas Tech University

The purpose of this investigation was to further the exercising personality literature by exploring mechanisms responsible for exercise stage transitions. Achievement goals and perceived ability are viable mechanisms based on past research with personality traits and self-reported exercise (Lochbaum et al., 2007, 2009). Adults (females = 182; males = 137) ranging from 18 to 68 years of age ( $M$  age 32) completed measures of personality,  $2 \times 2$  achievement goals, perceived physical ability and stage of exercise based on the transtheoretical model. The following stages were represented: maintenance ( $n = 153$ ), action ( $n = 60$ ), preparation ( $n = 51$ ), contemplation ( $n = 30$ ) and pre-contemplation ( $n = 25$ ). MANOVA results revealed main effects ( $p < .01$ ) for sex and exercise stage. Follow-up tests for sex revealed differences ( $p < .05$ ) in agreeableness (females > males), neuroticism (females > males) and perceived physical ability (males > females). For personality, follow-up tests revealed differences ( $p < .05$ ) in agreeableness and neuroticism, with post hoc tests demonstrating results consistent with the exercising personality literature. Bivariate correlations indicated relationships ( $p < .05$ ) amongst the exercising personality variables and the potential achievement goal/perceived ability mechanisms. Binary logistic regressions were conducted with the mechanisms as the predictors of the four possible neighboring stage dichotomies. Results revealed perceived physical ability as a predictor ( $p < .05$ ) of both the action/maintenance ( $B = .86$ ) and preparation/action ( $B = .42$ ) dichotomies. The mastery-approach ( $B = .34$ ) and performance-avoidance ( $B = -.42$ ) goals were predictors ( $p < .05$ ) of the contemplation/preparation dichotomy. No mechanism emerged as a significant predictor of the pre-contemplation/contemplation dichotomy. The reported results add depth to the exercising personality literature by stimulating mechanistic explanations and interventions.

**A Theory-based Intervention Designed to Increase Chronic Low Back Pain Patients' Adherence to Physiotherapists' Recommendations: A Pilot Study**

Lonsdale, Chris, University College Dublin; Aileen Murray, University College Dublin; Megan Tennant Humphreys, University College Dublin; Suzanne McDonough, University of Ulster; Geoffrey Williams, University of Rochester; Deirdre Hurley, University College Dublin

The purpose of this pilot study was to test the feasibility and conduct a power analysis related to a self-determination theory-based communication skills training program designed to increase physiotherapists' psychological needs supportive behavior when treating patients with chronic low back pain (CLBP). Primary outcomes were self-reported physical activity (PA), adherence to prescribed home-based exercises, and back pain-related measures (pain, disability, and satisfaction). Secondary outcomes included psychological needs support, autonomous motivation, and competence. Control ( $n = 4$ ) and intervention ( $n = 3$ ) group

physiotherapists received one hour of training in evidence-based treatment for CLBP, including PA promotion advice and home-based exercises. Intervention group physiotherapists also received six hours of autonomy-support training, utilizing the '5A' health behavior change model. Patients ( $n = 28$ , mean age = 46.60 years) completed questionnaires at Week 1 and Week 4 following their initial visit. Compared with the control group, intervention group participants reported more PA ( $d = .26$  in Week 1,  $d = .50$  in Week 4), greater adherence to prescribed home-based exercise ( $d = .40$  in Week 1,  $d = .15$  in Week 4) and larger improvements in satisfaction with level of back pain ( $d = .41$ ). However, decreases in pain levels were similar across the groups and improvements in functional outcomes were less for the intervention group than the control group ( $d = .25$ ). Compared with control group participants, the intervention group reported similar or higher levels of autonomy support ( $d = .24$  in Week 1, no difference in Week 4), autonomous motivation (no difference in Week 1,  $d = .21$  in Week 4), and perceived competence ( $d = .32$  in Week 1,  $d = .46$  in Week 4). A focus group interview indicated that intervention group physiotherapists valued the training and believed it had provided them with useful skills. Findings provided preliminary evidence supporting the feasibility of this intervention. More in-depth study into the effectiveness of this training is warranted.

### **Motivational climate, self-determination motivation, and psychological well-being in Mexican young athletes.**

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Drawing from the frameworks of Achievement Goal Theory (Ames, 1992; Dweck, 1999; Nicholls, 1989) and the Self-Determination Theory (Decy Ryan, 1985; 2000) the present study tested the following sequential relationship model of motivational processes and indicators of optimal psychological functioning in the case of Mexican athletes: Motivational Climate - Self-determined motivation - Psychological Well-being (Subjective Vitality and Self-esteem). The mediational role of self-determined motivation was also studied. Six hundred fifty-one Mexican young athletes (330 female and 321 male,  $M$  age = 13.99  $SD = 1.88$ ) completed a multi-section questionnaire tapping the targeted variables. Structural Equation Modeling (SEM) analysis revealed that task-involving climate positively predicted self-determined motivation ( $\beta = .30$ ,  $p < .01$ ), however ego-involving climate negatively predicted self-determined motivation ( $\beta = -.31$ ,  $p < .01$ ). In turn, the self-determined motivation positively predicted psychological well-being indicators, that is, Subjective Vitality ( $\beta = .22$ ,  $p < .01$ ) and Self-esteem ( $\beta = .59$ ,  $p < .01$ ). In addition, the results (Delta  $\chi^2(4) = 29.19$ ,  $p > .05$ ) of the mediation analysis (Holmbeck, 1997) showed that the self-determined motivation totally mediated the path between Task-involving climate and Self-esteem, and partially mediated the path between Task-involving climate and Subjective Vitality. The results are discussed in terms of their theoretical and practical utility.

### **Examining the Relationship Between Athlete Leadership Behaviors and Cohesion in Team Sports**

Loughead, Todd M, University of Windsor; Diana J Vincer, University of Windsor

Athlete leadership has been defined as an athlete occupying a formal or informal role within a team who influences a group of team members to achieve a common goal (Loughead et

al., 2006). To date, research has shown that the number of athlete leaders on a sport team is related to greater athlete satisfaction (Eys et al., 2007) and higher perceptions of cohesion (Hardy et al., 2008). While research has shown these positive associations, a limitation to this body of knowledge has been the focus on the number of athlete leaders. Consequently, very little is known concerning the types of athlete leader behaviors and its relationship to group-related constructs such as cohesion. Therefore, the purpose of the present study was to examine the relationship between athlete leadership behaviors and perceptions of cohesion. Athletes from a variety of team sports ( $n = 315$ ) completed the Group Environment Questionnaire (Carron et al., 1985), which assessed cohesion and the Leadership Scale for Sports (Chelladurai & Saleh, 1980), which assessed athlete leadership behaviors. The results showed that the leadership dimension of Social Support, and Training and Instruction were related to the cohesion dimensions of ATG-T (beta = .16,  $p < .05$ ; beta = .15,  $p < .05$ , respectively), ATG-S (beta = .31,  $p < .05$ ; beta = .27,  $p < .05$ , respectively), GI-T (beta = .19,  $p < .05$ ; beta = .32,  $p < .05$ , respectively), and GI-S (beta = .36,  $p < .05$ ; beta = .25,  $p < .05$ , respectively). Furthermore, the leadership dimension of Democratic Behavior was positively related to ATG-T (beta = .18,  $p < .05$ ). Lastly, the leadership dimension of Autocratic Behavior was negatively related to the cohesion dimensions of ATG-S (beta = -.13,  $p < .05$ ), GI-T (beta = -.19,  $p < .05$ ), and GI-S (beta = -.21,  $p < .05$ ). Findings from the present study provide initial support that it is important to foster the development of athlete leader behaviors in order to influence the team environment.

### **The effect of high skill level in cricket batting on the relative age effect**

Low, Jeffrey, Liverpool John Moores University; Paul R. Ford, Liverpool John Moores University; A. Mark Williams, Liverpool John Moores University

Athletes born relatively early within their peer age group are more likely to be selected onto sports teams compared to those born later in the selection year. The overrepresentation of relatively older athletes in youth and adult sport has been termed the relative age effect (RAE). The RAE has been shown in many professional sports (for reviews, see Musch & Grondin, 2001; Wattie et al., 2008). However, researchers have recently provided evidence to suggest that relatively younger athletes are not as disadvantaged as first thought. Relatively younger athletes are more likely to receive higher salaries in professional soccer (Ashworth & Heyndels, 2007), to be chosen in the earlier rounds of NHL drafts (Baker & Logan, 2007), and are as likely to receive Most Valuable Player (MVP) awards (Ford et al., 2008) compared to their relatively older counterparts. Athletes that receive higher salaries, are early draft picks, or are selected for MVP awards may be perceived as the more skilled performers in their sport. We believe these studies show that very high levels of skill in a sport render an athlete's relative age irrelevant. To test this assumption, we examined the birthdates of English professional cricket batsmen ( $n = 826$ ). Birthdates were categorised into quartiles based on the relevant selection date. There was a significant overrepresentation of batsmen born in the first quartile,  $X^2 = 10.94$ ,  $p = .01$ ; (Q1 = 29%, Q2 = 22%, Q3 = 27%, Q4 = 23%). We subsequently used their batting score averages between 1990 and 2009 as a measure of batting skill to create two groups using a third split: high-scoring ( $n = 275$ ) and low-scoring ( $n = 275$ ). We removed the other participants from the analysis. Birthdates of high-scoring batsmen were higher in the first quartile,  $X^2 = 10.28$ ,  $p = .02$ ; (Q1 = 33%, Q2 = 21%, Q3 = 25%, Q4 = 21%), whereas low-scoring batsman's were not ( $X^2 = 2.54$ ,  $p = .47$ ; (Q1 = 27%, Q2 = 22%, Q3 = 26%, Q4 = 24%). Findings contradict previous research (e.g., Ford et al., 2008) suggesting that high levels of skill mask the effect of an athlete's relative age.

### **I'm Stressed! How Does That Make Me Feel About Exercise?**

Lutz, Rafer, Baylor University; Matthew Stults-Kolehmainen, Northern Illinois University; John B. Bartholomew, University of Texas at Austin

There is documented support for inverse relationships between stress perceptions/events and physical activity engagement. Yet, physical activity is a commonly reported coping strategy and we might expect some individuals to increase/maintain exercise during stressful periods. Based on the Transtheoretical Model, previous research suggests that individuals in the Maintenance Stage engage in more exercise as stress increases, whereas those at all other stages reduce exercise as stress increases. The present investigation seeks to uncover the potential effects of stress on psychological variables associated with exercise engagement, and whether stage of change moderates such effects as with behavioral outcomes. In a prospective design, we recruited 95 female university students to complete a 6-week evaluation of stress events/intensity and exercise outcomes. Participants completed a leisure-time physical activity log each day and a stress events and stress intensity scale each week (Weekly Stress Inventory: Brantley, et al., 1997). Included in the activity log were questions related to self-efficacy for next week's exercise, and enjoyment and satisfaction with last week's exercise. Results of HLM revealed that there was no main effect of stress events on enjoyment or satisfaction ( $p > 0.1$ ), and the main effect of stress events on self-efficacy was marginal ( $\beta = -0.017$ ,  $se = 0.009$ ,  $t(85) = -1.890$ ,  $p = 0.062$ ). Considering stress intensity, in contrast, there was a main effect on satisfaction ( $\beta = -0.008$ ,  $se = 0.003$ ,  $t(85) = -2.922$ ,  $p = 0.005$ ) and self-efficacy ( $\beta = -0.005$ ,  $se = 0.002$ ,  $t(85) = -1.987$ ,  $p = 0.050$ ), but no effect for enjoyment ( $p > 0.1$ ). Considering this set of psychological correlates of exercise participation there were more apparent associations with stress intensity as compared to stress events. Stage of change did not appear to moderate the effect of stress on these variables as was previously demonstrated with self-reports of exercise participation.

### **Predictors of Sources of Self-Confidence in Collegiate Athletes**

Machida, Moe, Michigan State University; Robin S Vealey, Miami University; Rose Marie Ward, Miami University

Vealey et al. (1998) identified nine sources of sport-confidence that predict the strength of one's confidence beliefs in competitive sport context. These can be categorized into controllable (mastery and physical/mental preparation) and uncontrollable sources (demonstration of ability, physical self-presentation, social support, coaches' leadership, vicarious experience, environmental comfort, and situational favorableness). The purpose of the present study was to examine antecedents of these nine sources of confidence. Based on the past studies suggesting their links with confidence, achievement goal orientation and perfectionism were selected as personal, and coach induced perceived motivational climate and perceived coaches' interpersonal behaviors were chosen as social predictors of sources of confidence. Participants were 206 college athletes, and following seven measures were utilized: (a) Demographic questionnaire, (c) Sources of Sport-Confidence Questionnaire (Vealey et al., 1998), (d) Sport-Multidimensional Perfectionism Scale-2 (Gotwals & Dunn, 2009), (e) Task and Ego Orientation in Sport Questionnaire (Duda, et al., 1991) (f) Perceived Motivational Climate in Sport Questionnaire-2 (Newton, et al., 2000), and (g) Interpersonal Behavior Scale (Pelletier, et al., 2007). Structural equation modeling and multiple regressions were used to analyze the data. The results indicated that personal factors were stronger predictors of athletes' selection of sources of confidence than social factors.



Adaptive dimension of perfectionism (e.g. personal standard) positively predicted controllable sources, while maladaptive dimensions (e.g. perceived coach pressure) of perfectionism positively predicted uncontrollable sources of confidence. Task-goal orientation was the positive predictor and ego-goal orientation was the negative predictor of both categories of sources. The only social factor that emerged as a significant predictor of selection of sources was task-involving motivational climate, which positively predicted both controllable and uncontrollable sources.

**The relationship between social physique anxiety and exercise behavior: Does the fulfillment of basic psychological needs matter?**

Mack, Diane E, Brock University; Philip M Wilson, Brock University; Benjamin D Sylvester, Brock University; Paige Gregson, Brock University; Susanna Cheung, Brock University; Samuel Rimmer, Brock University

Social physique anxiety (SPA) stems in part from the prospect or presence of negative interpersonal evaluation involving one's physique (Hart, Leary, & Rejeski, 1989). Meta-analytic evidence has indicated that SPA is inconsistently related to exercise behavior (Mack, Wilson, Waddell, & Gasparotto, 2008). This finding has led to speculation that SPA may influence exercise behavior indirectly, as opposed to directly, through other mechanisms (Martin Ginis & Mack, in press). The purpose of this study was to examine whether perceived psychological need satisfaction experienced from participation in exercise mediates the SPA - exercise behavior relationship. A convenience sample of undergraduate students ( $n = 266$ ;  $n$  female = 171) completed the Social Physique Anxiety Scale (Martin, Rejeski, Leary, McAuley, & Bane, 1997), the Godin Leisure-Time Exercise Questionnaire (Godin & Shepard, 1985), and the Psychological Need Satisfaction in Exercise Scale (Wilson, Rogers, Rodgers, & Wild, 2006). A weak negative relationship was noted between SPA and exercise behavior ( $r = -0.11$ ; 95% C =  $-0.23$  to  $0.01$ ). Using Preacher and Hayes (2008) multiple mediation approach, the fulfillment of the three psychological needs (i.e., autonomy, competence, and relatedness) mediated the SPA - exercise behavior relationship (point estimate =  $-1.99$ ; Bias Corrected and Accelerated Confidence Interval =  $-3.25$  to  $-0.84$ ), with perceived competence and relatedness serving as unique mediators in this sample. Overall, results suggest that people who feel that their bodies are negatively appraised within exercise contexts are less likely to sustain their behavior if they feel incompetent or socially disconnected from others. Consideration of other mediators (e.g., behavior regulation) to explain the SPA - exercise behavior relationship is warranted.

**Understanding Usage of Exercise Videogame Bikes Using the Theory of Planned Behaviour among Parents with Young Children in the Home-Setting: A Pilot Study**

Mark, Rachel S., University of Victoria; Ryan E. Rhodes, University of Victoria; Naomi Casiro, University of Victoria; Anna-Marie de Zwager, University of Victoria

Parents are at risk for low physical activity (PA). Exercise videogame bikes (EV) have physiological and psychological benefits; however, trials have been limited to college-aged males in the lab. This study compared EV to traditional stationary bikes (C) in the home among parents with a 6-week single-blinded RCT design. Parents (self-reported as physically inactive) were randomized to EV ( $n = 16$ ) or C ( $n = 20$ ). Individuals had a trial with the bike and then completed questionnaires of expectancies for use using the theory of planned behavior (time 1; T1). Usage was tracked through self-report logs. After the trial

(time 2; T2), questionnaires were completed by EV and C as well as a qualitative process evaluation with EV. Meeting of PA guidelines was assessed through self-reported PA at T1 and T2. Although not significant, a small effect for usage in favor of EV was found ( $d = .17$ ). 26% of EV and 32% of C met PA guidelines at T1, and 69% of EV and 25% of C did at T2 ( $h = .91$  at T2). RM-ANOVA for affective attitude had a significant group effect,  $F(1, 34) = 13.92, p = .00, \eta^2 = .29$ . Post hoc showed EV had higher scores than C at T1 ( $T(39) = 3.28, p = .00, d = 1.61$ ) and T2 ( $T(34) = 2.96, p = .01, d = 1.74$ ). A significant time effect was also yielded ( $F(1, 34) = 34.66, p = .00, \eta^2 = .51$ ) with post hoc showing declines for EV ( $T(15) = 5.31, p = .00, d = 1.51$ ) and C ( $T(19) = 3.79, p = .00, d = 1.21$ ). Perceived behavioral control had a significant time effect ( $F(1, 34) = 12.34, p = .00, \eta^2 = .27$ ) with significant declines for EV only ( $T(15) = 4.05, p = .00, d = 2.31$ ). The time effect for intention was significant ( $F(1, 34) = 36.28, p = .00, \eta^2 = .52$ ) with declines for EV ( $T(15) = 4.28, p = .00, d = 2.29$ ) and C ( $T(19) = 4.09, p = .00, d = 1.69$ ). Qualitative follow-up suggested that participants enjoyed using the bike but experienced barriers (e.g., time, fatigue, and lack of game variety). Usage differences were not significant between groups but PA guideline results suggest that EV may help augment other PA initiatives. The strong affective component of EV is also highlighted. It is suggested that future studies be conducted with larger scale trials and longer durations.

### **The importance of self-regulation for physical activity participation: A test of Social Cognitive Theory**

Martin Ginis, Kathleen A., McMaster University; Amy E Latimer, Queen's University; Rebecca L Bassett, McMaster University; Kelly P Arbour-Nicotopoulos, University of Toronto; Dalton Wolfe, University of Western Ontario

Social Cognitive Theory (SCT; Bandura, 1986, 1997) is one of the most prominent theoretical frameworks used to guide studies of leisure-time physical activity (LTPA). However, surprisingly few LTPA studies have applied and tested SCT in its entirety (Rovniak et al., 2002). No published studies have applied the full SCT to study LTPA among people with disabilities. Thus, the purpose of this study was to examine the utility of SCT for predicting LTPA in people with spinal cord injury (SCI). Participants were 196 men and 64 women with SCI ( $M$  age = 44  $\pm$  13 yrs). During a telephone interview, they completed measures of social support for LTPA, exercise task self-efficacy (moderate and heavy intensity), self-regulation efficacy (goal-setting, barrier, and scheduling), outcome expectations (instrumental and affective), and self-regulation (goal intentions and planning). One month later, they were administered measures of LTPA. Latent variable structural equation modeling was used to examine the fit of a model in which the SCT constructs were depicted as predictors of LTPA. The model fit the data reasonably well ( $\chi^2(55) = 152.09, p < .001, CFI = .89, IFI = .90, RMSEA = .11$ ) and explained 39% of the variance in LTPA. This value is somewhat less than the variance in LTPA explained among able-bodied people (55%; Rovniak et al.). The latent variable of self-regulation was the only significant, direct predictor of LTPA ( $\beta = .72, p < .001$ ). Self-regulation was predicted ( $p < .001$ ) by the latent variables outcome expectancies ( $\beta = .36$ ) and self-regulation efficacy ( $\beta = .71$ ), but not task self-efficacy. Contrary to Bandura's theorizing, social support did not predict either type of self-efficacy. Taken together, these results suggest that SCT is useful for predicting and explaining LTPA in people with a disability. The results also highlight the importance of developing exercise self-regulation skills—such as goal-setting and action planning—in this population. Research supported by a SSHRC Community-University Research Alliance Grant.

### **Self-regulated learning in sport: A review**

McCardle, Lindsay, University of Victoria

Self-regulated learning (SRL) has been defined as the motivational, cognitive, and behavioural processes that students deliberately and effortfully engage in the pursuit of goal achievement (Zimmerman, 1989). Generally, research on SRL has consistently shown correlations between aspects of SRL and academic achievement (Perry, Dowler, & Phillips, 2008). Despite the relevance of SRL models for researching learning in sports contexts (c.f., Zimmerman, 2000; Schunk & Ertmer, 2008), no systematic review of SRL research in sport contexts exists. Thus, the purpose of this paper is to systematically review the research about SRL in. Eligibility criteria included: (a) focus on self-regulated learning, and (b) investigation of learning or performance of a sport skill. Searches were limited to publication dates from 1990 to 2009 in four major databases (*p* sycINFO, SPORTDiscus, MedLine, Web of Science). Eighteen of 113 articles met the inclusion criteria. Preliminary findings indicated that (a) athletes engage in SRL, and (b) that SRL and performance are correlated. Measurement of SRL included self-report measures of specific processes of SRL, microanalysis, think aloud protocol, observation and interviews, and general self-report measures of SRL. Zimmerman's (1989, 2000) social cognitive model of SRL was mostly frequently utilized, with other articles employing Bandura's (1986) social cognitive theory, Zimmerman's (2004) sequential model of SRL development, Kirschenbaum's (1984) 5-stage theory of self-regulation, or no particular theoretical framework. Targets for future research are discussed.

### **The Difference is More than Floating: Breast Cancer Survivors' Decisions to Join Dragon Boat Teams and Support Groups**

McDonough, Meghan H, Department of Health and Kinesiology, Purdue University; Jaclyn M Poliseo, Purdue University; Sarah Ullrich-French, Washington State University; Catherine M Sabiston, McGill University

Breast cancer survivors are commonly faced with stressors that can extend for years after treatment and have an ongoing impact on quality of life (Hadd et al., in press; de Ridder et al., 1998; Vivar & McQueen, 2005). Physical activity programs for breast cancer survivors have a positive impact on well-being (Courneya et al., 2002). One mechanism for attaining benefits from group activities is social support. Dragon boat teams provide an opportunity for gaining support from other survivors (McDonough et al., 2008; Sabiston et al., 2007). Breast cancer support groups also offer opportunities for support with other breast cancer survivors. Little is known, however, about women's perceptions of support available from dragon boat teams and support groups and how women make decisions about participating in either type of group. The purpose of this study was to explore breast cancer survivors' decisions to join a dragon boating team and their comparison of that decision to their decision to join or not join a breast cancer support group. 17 female novice members of a dragon boat team for breast cancer survivors were interviewed. Interview transcripts were analyzed using content analysis. Reasons for not joining or continuing with a support group included a perceived negative focus on cancer, and not feeling a primary need for support. Reasons why women felt dragon boat was a better fit for them included the physical activity focus de-emphasizing cancer, taking action and moving forward, community involvement, and getting a combination of physical, emotional, and social benefits. The opportunity to connect with other survivors was seen as similar in both types of groups. Support groups were perceived as better for disseminating information, facilitating social interactions quickly, and

may be a better fit for some people or at different stages of survivorship. There are multiple reasons why breast cancer survivors are drawn to or avoid participating in survivor groups, and different types of groups may fill different needs and reach different people.

### **Can verbal persuasion improve performance under pressure?**

McKay, Brad, University of Nevada, Las Vegas; Gabriele Wulf, University of Nevada, Las Vegas

Increasing self-efficacy has improved the performance of individuals on a variety of skills and tasks, and in various situations. The present study manipulated self-efficacy beliefs in the ability to perform well in a high-pressure situation. Unskilled participants were randomly assigned to one of two groups: a control group or a high self-efficacy group. Participants were asked to throw twenty baseballs at a target, fill out two questionnaires and a manipulation check, and then throw twenty more baseballs in a high-pressure situation. Self-efficacy was manipulated by informing the participants in the experimental condition that their questionnaire results suggested that they were likely to excel in a high-pressure situation. Pressure was manipulated by offering a secret prize to participants who were able to improve their performance by 15% or more on the second block of throws. Further, participants were told that they had been paired with another participant in the study and that both participants had to improve by 15% to win the prize. They were then told that their partner in the study had already finished and had successfully improved on the second block. Finally, participants were also told they were being videotaped and that their movement patterns were going to be analyzed by the experimenter. Results indicated that participants in the high self-efficacy condition reported higher self-efficacy beliefs and performed better on the high-pressure trials, relative to controls. Self-efficacy was found to significantly predict high-pressure performance as well, indicating that self-efficacy partially mediated the effect of the intervention on high-pressure performance. The implications of manipulating situation-based self-efficacy for the performance of motor skills will be discussed in relation to previous studies that manipulated skill-specific self-efficacy. Also, the potential downside to increasing self-efficacy through an intervention that implies an entity-like conception of ability will also be discussed.

### **The effect of mindfulness training on performance in closed-skill sports: The power of mild acceptance**

Meeûs, Mathieu SP, Catholic University Leuven; Filip Boen, Catholic University Leuven, Belgium; Bert De Cuyper, Catholic University Leuven

The purpose of this experiment was to examine the effect of mindfulness training on performance in closed-skill sports, during which athletes have much time to reflect in between their physical activities. One experimental group was composed by 27 participants, who followed an eight-week course in mindfulness. It was compared with a control group of 36 participants who did not follow any training in mindfulness. In the pretest (i.e., just before the start of the mindfulness course) and in the posttest (i.e., after the end of the course, eight weeks later), participants completed three motor tests: a darts test, a golf putting test, and a sinusoid test. Repeated measures ANOVA's showed that the experimental group improved significantly more on the golf putting test than the control group. A similar result was found for the number of errors made on the sinusoid test. The order in which the tests were performed (i.e., first golf putting test or darts test) also had an impact. The experimental

who first performed the darts test and then the golf putting test improved significantly more in the number of errors, compared to the other groups. No significant group effects were found in the darts test, neither in the extent of errors on the sinusoid test. It is concluded that mindfulness might have a positive effect on specific motor skills in closed-skill sports. Further research is needed to corroborate these preliminary findings.

### **The effects of video feedback on coaches' behaviour and the coach-athlete relationship.**

Meeûs, Mathieu SP, Catholic University Leuven; Sidónio Serpa, Technical University Lisbon; Bert De Cuyper, Catholic University Leuven

The purpose of this experiment was to study the impact of video feedback on the coaches' nonverbal behaviour, and its relation with their athletes' anxiety and perception of the coaches' behaviour and emotions. One experimental group was composed by 45 athletes and four coaches, and one control group by 58 athletes and five coaches. The tools were one adapted Coaching Behaviour Assessment System (CBAS), one adapted Coaching Behaviour Questionnaire (CBQ), and the Competitive State Anxiety Inventory-2 (CSAI-2). The participants responded to the questionnaires twice having seven weeks in between. The coaches' behaviour in competition during halftime breaks and timeouts was video recorded. Each coach received a frequency table with the answers of his team in the first series of responses, compared with his own answers. The coaches also saw a video of their behaviour during their interventions in competition. Repeated measures ANOVA's showed that athletes of the experimental group became significantly less anxious and that they perceived their coaches significantly more positively than athletes of the control group. The self-perception of coaches of the experimental group improved significantly more, compared to the self-perception of coaches of the control group. One-way ANOVA's showed that goalkeepers in both conditions were significantly more anxious in the pre-test. In both conditions, goalkeepers perceived their coaches less positively than the field athletes in both pre- and post-test. It is concluded that an intervention using video feedback might have positive effects on the anxiety level and coach perception among athletes, and on the self-perception of coaches. It is also concluded that goalkeepers perceived their coach less positively and were more anxious compared to field athletes. Further research is needed to corroborate these findings.

### **Implicit vs. Explicit Motives and Aspects of Athletes' Practice**

Mempel, Gordon, Humboldt-University Berlin; Mirko Wegner, Humboldt-University Berlin; Hanno Strang, Humboldt-University Berlin

On the basis of the information-processing model of implicit and explicit motivation (Schultheiss, 2007), two studies were carried out in a multitheme (achievement & affiliation) and multimethod (indirect & direct) design. It was assumed that indirect motivational measures (implicit motives) better predict practice behavior over time while direct motivational measures (explicit motives) are associated with preferences for the social organization of practice. In Study 1, international tennis players ( $n = 32$ ) filled out a questionnaire on their number of practice hours per week. In Study 2, additionally, German karatekas ( $n = 32$ ) answered questions on their preference for individual or group settings in practice. In Study 1, the indirect motive measure (achievement) predicts the number of practice hours. In Study 2, again, the indirect motive measure is associated with the number of practice hours; here, the theme is affiliation. Furthermore, karatekas' preference for individual and group practice were linked to their direct motive measure of achievement and affiliation, respectively.

The results underline assumptions that implicit motives are rather associated with repeated behavior like practice work loads per week while explicit motives better predict decision making and preferences in social settings.

### **Fear of negative evaluation is an antecedent to choking under pressure**

Mesagno, Christopher, University of Ballarat; Christopher M. Janelle, University of Florida

Choking under pressure (i.e., choking) is defined as a critical deterioration in the execution of habitual processes as a result of an elevation in anxiety under perceived pressure, leading to substandard performance. Explanatory choking models have been proposed, but existing models fail to acknowledge antecedents to performance decreases and ignore covert mechanisms that precipitate the initial anxiety increase. The purpose of the current study was to examine one aspect of a proposed self-presentation model of choking using a fear of negative evaluation (FNE) questionnaire as a predictor of choking. Initially, 138 experienced basketball players ( $M$  age = 25.50,  $SD$  = 8.94) were screened to participate based on answers to the Brief Fear of Negative Evaluation-II (BFNE-II; Carleton et al., 2006) questionnaire. Of these, 17 high FNE and 17 low FNE players were selected for participation in the experimental stage. Participants performed 150 total basketball shots in three separate phases (familiarization, low-pressure, and high-pressure), whereby increased pressure was induced with an audience, monetary performance incentive, and a video camera. Analysis of scores on the Revised Competitive State Anxiety Inventory-2 (Cox et al., 2003) revealed significant differences between groups as a function of the pressure manipulation. During the high-pressure phase, state anxiety increased considerably for the high FNE group, whereas only minimal increases were exhibited for the low FNE group. Significant group differences were also noticed in performance as a function of the pressure manipulation. Specifically, the low FNE group maintained performance and the high FNE group decreased performance during the high pressure phase. Results support the proposition that FNE is a likely predictor of choking, and researchers are encouraged to consider self-presentation as a relevant supplement to current choking models.

### **Clothing-based and proxy body image (BI) predictors of disordered eating risk among collegiate track and field athletes**

Monsma, Eva V, University of South Carolina; Toni M McGehee, University of South Carolina

In order to better understand the etiology of disordered eating in the context of track and field the purpose of this study was to consider the role of athletes' BI from a variety of perspectives, BI distortion and SPA as predictors of the EAT-26 and its subscales. Participants ( $n$  = 282) completed the Stunkard silhouette scale measuring perceived and ideal BI in uniform (U) and daily clothing (DC). Similarly, athletes' BI perceptions were assessed from the perspective of their friend, parents and coach (i.e., Proxy BI). The Social Physique Anxiety Scale (SPAS) was also administered and height and weight was self-reported. Along with BMI, BI Distortion (BMI-perceived BI) was calculated. The interaction of the repeated measures 6 (event type)  $\times$  11 (BMI and BI variables) MANOVA indicated BI Dissatisfaction (perceived-ideal) and BI Distortion were greater among non-lean field events than participants in all other events who reported significantly lower Proxy BI from the perspective of friends and parents but not coaches Wilks's Lambda = .50,  $F(50) = 3.9$ ,  $p < .001$ ,  $\eta^2 = .13$ . After controlling for BMI and event type (4%), stepwise regression analysis indicated

SPA (46%), DC Dissatisfaction (6%) and U Distortion (1%) explained 55.6% of EAT-26 variance. Considering EAT-26 subscales separately indicated these variables explained 60% of Dieting variance. SPA (34%) and DC Discrepancy (2%) explained 37.9% of Bulimia variance, while these variables and Proxy BI-parent (2%) explained 15.7% of Oral Control variance. Along with SPA, clothing type and proxy BI particularly from parents and friends are implicated as sources of disordered eating risk and should be considered further.

### **Establishing the Content Validity of the Transformational Parenting Questionnaire (TPQ): A Think-Aloud Investigation**

Morton, Katie L, University of British Columbia; Mark R Beauchamp, University of British Columbia

Parenting is a critical social determinant of the health-related behaviors of adolescents. It has been argued that extending transformational leadership theory (Bass & Riggio, 2006) to the parenting domain represents an opportunity to understand how parents influence adolescent health-enhancing and health-compromising behaviors. One likely reason for the paucity of studies in this area relates to the fact that at present there is no reliable and valid measure of transformational parenting. In the present study, we utilized a 2-phase approach in order to develop a measure of transformational parenting for use with adolescents and parents (of adolescents) that exhibits strong content validity. In the first phase, a comprehensive battery of items was generated from an extensive literature review of both the parenting and transformational leadership literatures (cf. Clark & Watson, 1995). In the second phase, we utilized three focus groups with parents (of adolescents) and four focus groups with adolescents, whereby participants completed the initial measure of transformational parenting and then discussed within groups, the instructions, response format and each item in turn. A 'retrospective think-aloud' protocol (Willis, 1994) was used in order to understand how members of the target population interpreted and responded to items. Qualitative content analysis was used to analyze the data and results identified a series of issues related to item wording, interpretation, and the response format that required attention. The results of the retrospective think-aloud protocol facilitated the development of a preliminary measure of transformational parenting that is developmentally appropriate and exhibits strong content validity. In sum, the qualitative measurement development techniques utilized in this study hold much promise in the sport and exercise psychology domain for establishing the content validity and user-friendliness of questionnaires.

### **Psychophysiological Indices of Competition: A Self-Determination Theory Examination**

Murray, Nicholas, East Carolina University; Scott Rigby, I; Rich Ryan, University of Rochester; Danielle Zebroski, East Carolina University; David Esposito, East Carolina University

Video games have continued to grow in popularity and in addition technological advancement can now generate a simulation of an alternate world that is believable as real by the user. Due to the complexity and the required skill, video games offer a unique opportunity in a controlled setting to evaluate competition, self-efficacy, learning, control, as well as decision-making skills. The purpose of this study is to examine psychophysiology of competition within the Self-Determination theory framework utilizing fighting genre video games. Sixteen participants were recruited in known pairs in which their electroencephalogram (EEG), heart rate variability, electrodermal response, performance as well as a set of paper and pencil measures were examined for two participants during competitive game play. Results

demonstrated significant differences ( $p < .05$ ) in aggression, performance, competence as well as psychophysiological measures. In addition, mediating factors included motivation, competence, EEG asymmetry and arousal response. The findings are discussed in terms of Self-Determination theory.

### **Successful Dissemination of Fun 5: A Physical Activity and Nutrition Program**

Nigg, Claudio R, University of Hawaii; Karly Geller, University of Hawaii; Paula Adams, Kahoomiki; Michele Hamada, University of Hawaii; Richard Chung, Hawaii Medical Service Association

Physical activity (PA) and fruit and vegetable consumption (FVC) are health behaviors contributing to the reduced risk of chronic diseases including cardiovascular and metabolic disease, obesity, and reduced symptoms of anxiety and depression. Unfortunately, most children are not meeting PA and FVC recommendations. Therefore, this project examined the reach, effectiveness, adoption, implementation, and maintenance of an evidence-based physical activity and nutrition curriculum disseminated to after-school programs across the state of Hawaii. The program components included nutrition, physical activity, and sustainability, which were adapted to after-school settings and disseminated across four years (2004-2008). The Reach, Effectiveness, Adoption, Implementation, and Maintenance (RE-AIM) framework was used to evaluate dissemination quality and measured through direct observations, surveys, and interviews. Results are presented descriptively. At the beginning of dissemination (2004-2005), the Fun 5 program was implemented in 38% of after-school sites in Hawaii reaching 8,548 students, and now is in 90% reaching 22,609 students (2008-2009). Despite dramatic increases in program reach each year, implementation and adoption remained consistently effective and students' physical activity levels during program activities peaked in the final year. Further, evaluations demonstrated strong potential for long-term program sustainability. The Fun 5 program demonstrated strong promise for long-term maintenance with potential for a public health impact among Hawaii after-school students. Future emphasis on wide-spread program dissemination is encouraged, bridging research and community efforts to improve our children's health and impact public health. Funded by the Hawaii Medical Service Association, an Independent Licensee of the Blue Cross and Blue Shield Association.

### **Physical Activity, Inactivity, and Nutrition Behavior among Children: Investigating Compensation and Transfer Effects**

Nigg, Claudio R, University of Hawaii; Judith Vaeth, University of Karlsruhe

We compared the influence of physical activity (PA), inactivity, and nutrition behavior on each other in children to determine if there are compensation or transfer effects via cross-sectional and longitudinal investigations. 13 Hawaii afterschool sites took part,  $n = 137$ ; 73% of baseline (T1) sample; 57% female, Grade 4 = 37%, Grade 5 = 37%, and Grade 6 = 26%. At T1 small correlations (all  $p$ 's  $> .05$ ) were found between: strenuous PA and fruits,  $r = .26$ ; mild PA and inactivity,  $r = .18$ ; mild PA and fruits,  $r = .23$ ; and mild PA and vegetables,  $r = .25$ . Medium correlations were found between: strenuous and mild PA,  $r = .37$ ; moderate and mild PA,  $r = .42$ ; moderate PA and fruits,  $r = .37$ ; vegetables and strenuous PA,  $r = .34$  and moderate PA,  $r = .38$ . Large relationships were found between: strenuous and moderate PA,  $r = .56$ ; and fruits and vegetables,  $r = .62$ . Regressions showed no significant ( $p > .05$ ) relationship of T2 strenuous PA and of T2 mild PA with all T1 predictors. Although T2



strenuous PA was marginally ( $p < .10$ ) significant with T1 strenuous PA and T1 moderate PA. T2 mild PA is also marginally ( $p < .10$ ) significant with T1 moderate PA and T1 mild PA. There was a significant ( $p < .05$ ) relationship between T2 moderate PA and T1 strenuous PA ( $B = .298$ ) and marginally with T1 mild PA ( $B = .168$ ). A significant negative relationship was also found between T2 moderate PA and T1 vegetables ( $B = -11.346$ ). For T2 fruits there is a significant negative relationship with T1 vegetables ( $B = -.235$ ). T2 vegetables and inactivity significantly predicted with itself at T1. This shows: (1) no compensation effects; (2) inactivity does not seem to be related to PA or nutrition; but (3) important transfer effects between different PA intensities, between nutrition behaviors, and between strenuous PA and fruits and vegetables. This supports growing evidence that multiple-behavior interventions have the potential for much greater impact on health than single-behavior interventions. Funded by the Hawaii Medical Service Association, an Independent Licensee of the Blue Cross and Blue Shield Association.

### **An Examination of Baseball Batting Technique Changes Following Multiple-Speed Imagery Intervention**

O, Jenny, California State University, East Bay; Craig R. Hall, The University of Western Ontario

In an extensive qualitative examination of the reasons why athletes choose to image at specific speeds (i.e., slow motion, real-time, and fast motion; O & Hall, 2010) athletes reported that slow motion images of complete sport movements were most often combined or concluded with real-time speed images. This latter finding may hold significant implications for imagery researchers examining voluntary image speed manipulation; to increase ecological validity, designs should attempt to approximate athletes' natural image speed use structure (i.e., combining real-time speed with other speeds). The present study examined whether changes in baseball batting technique were evident following a six-week, multiple image-speed intervention. Three multiple speed imagery interventions were employed in a single-subject design: (1) slow motion combined with real-time imagery practice (SM RT); (2) real-time combined with fast motion imagery practice (RT FM); and (3) combined slow motion, real-time, and fast-motion imagery practice (SM RT FM). Visual analysis (e.g., Martin & Pear, 1996), well as employment of the  $d1$  statistic (Busk & Serlin, 1992) indicated that positive and meaningful changes to baseball batting technique were observed following the intervention. Results of the current study suggest that the use of slow- and/or fast-motion image speeds may not be detrimental to performance if they are paired with real-time speed images, and, if they are assigned specific and appropriate functions.

### **Perceptions of formal and informal athlete leader effectiveness in youth sport**

Paradis, Kyle F, University of Windsor; Todd M Loughhead, University of Windsor

One source of leadership that has garnered some recent research attention has been the leadership provided amongst teammates or athlete leadership. Loughhead et al. (2006) defined athlete leadership as an athlete occupying a formal or informal role within a team who influences team members to achieve a common goal. To date, athlete leadership has been shown to be related to athlete satisfaction (Eys et al., 2007) and communication (Hardy et al., 2008). One variable that has yet to be examined is athlete leadership effectiveness. In organizational settings, research has shown a number of studies have related leader behavior to leader effectiveness (Hogan & Kaiser, 2005). Thus, it may be important to identify which athlete leader behaviors are related to leadership effectiveness in the sport context.

Therefore, the purpose of this study was to examine the relationship between athlete leadership behaviors and perceptions of leadership effectiveness. The participants were 150 athletes ( $n = 89$  females,  $n = 61$  males) from competitive youth soccer with a mean age of 14.80 ( $SD = 1.09$ ). Each athlete completed two measures of athlete leadership behavior: the Leadership Scale for Sports (LSS; Chelladurai & Saleh, 1980) and the transformational leadership dimensions of the Multifactor Leadership Questionnaire (MLQ; Bass & Avolio, 1995). As well, they completed the MLQ's leadership effectiveness scale. Results revealed for formal athlete leaders were perceived most effective when displaying the leader behaviors of training and instruction ( $\beta = .24, p < .05$ ), positive feedback ( $\beta = .20, p < .05$ ), charisma ( $\beta = .25, p < .05$ ), and individual consideration ( $\beta = .25, p < .05$ ). Informal athlete leaders were deemed most effective when displaying the leadership behaviors of training and instruction ( $\beta = .20, p < .05$ ), democratic behaviour ( $\beta = .18, p < .05$ ), and individual consideration ( $\beta = .23, p < .05$ ). Results are discussed in terms of their implications concerning the leadership behaviors required to be an effective athlete leader.

### **Do Older Adults Need Past Experience with Exercise to Have Exercise Self-Efficacy?**

Parise, Carol, Sutter Institute for Medical Research; Nick Galli, University of Utah; Ira B Tager, University of California, Berkeley

**Background:** Declines in physical functioning associated with aging make it important that older adults maintain regular physical activity (PA). Exercise self-efficacy (ESE) is one's belief in the ability to do exercise and has been shown to be the strongest predictor of exercise adoption and adherence. The goal of this study was to determine if past PA influenced current ESE in adults 55 and older. **Methods:** Subjects were participants of a longitudinal study of physical performance of older adults in Sonoma, CA who underwent a home interview between Jan. 2000 to Dec. 2001. Participants were stratified into regular (RE), sometimes (SE), and never (NE) exercisers based on mean MET expenditures per week. ESE was measured by asking the percent confidence in their ability to walk, run, and climb stairs for increasing distances without stopping. Past PA was measured by asking about participation in 22 PAs between ages 15-19, 20-39, and 40-54, and documentation of playing on a sports team in high school or college. ANOVA was used to compare differences between means. Multiple regression was used to investigate the association of current and past PA with ESE. Analyses were conducted separately for men and women and adjusted for age and perceived healthview. **Results:** ESE data were obtained on 620 females and 442 males. Male ( $F_{2,430} = 23.08; P < 0.001$ ) and female RE ( $F_{2,605} = 19.03; P < 0.001$ ) had higher ESE than the SE and NE. After adjustment for age and healthview, current exercise was associated with a 3% increase in the variance of ESE for females and a 4% increase for males. Team participation and PA at ages 15-19 and 20-39 were not associated with ESE. PA between ages 40-54 accounted for <2% of the adjusted variance of ESE in both men and women ( $p < 0.05$ ). **Discussion:** Older, RE with high ESE were no more likely than NE to have experience with PA when they were younger. It appears that ESE is a transient characteristic and must be consistently reinforced. Healthy, sedentary older adults who did not exercise in the past may be able to acquire ESE, increasing the likelihood of participation in regular exercise.

### **Examining the Effects of an 18-Week Cardiovascular Exercise Program on Body Image in Overweight and Obese Women**

Pearson, Erin S, The University of Western Ontario; Craig R. Hall, The University of Western Ontario

Negative body image has been identified as a consequence and predictor of overweight and obesity; effectuating improvements in this construct has been recommended as a treatment goal for these conditions. Exercise has been identified as a practical and very accessible means to ameliorate negative body image. However, ambiguity exists as to whether improvements in physical status resulting from exercise are indicative of improvements in this construct. The purpose of the present study was to examine body image in relation to changes in body composition and cardiovascular fitness over the course of an 18-week exercise program for overweight and obese female non-exercisers ( $n = 37$ ; age = 35.3 7.3; body mass index = 30.2 5.4kg/m<sup>2</sup>). Participants completed the Multidimensional Body-Self Relations Questionnaire at baseline, 6, 12, and 18 weeks as a measure of evaluative, cognitive, and behavioural dimensions pertaining to body appearance, health, and physical functioning. Body composition was assessed using Dual-Energy X-Ray Absorptiometry at these same time-points and a sub-maximal fitness test was administered pre and post-intervention. Repeated measures ANOVAs revealed no significant changes to cardiovascular fitness. However, significant improvements in six out of eight body image variables and measures of body composition (e.g. decreases in fat/fat-free mass, weight, and waist circumference) were observed over the course of the program. Yet, despite these positive changes, analyses revealed limited correlational significance between changes in body composition and improvements in body image. The relationships between body image, body composition, and cardiovascular fitness are discussed in relation to interventions targeting overweight through exercise.

#### **Are social networks associated with exercise habits in coronary heart disease patients?**

Pelaez, Sandra, Concordia University; Kim L. Lavoie, Université de Quebec a Montreal; Andre Arsenault, Montreal Heart Institute; Simon L. Bacon, Concordia University

Background and goal: Exercise (EX) is a crucial component of prevention and recovery from Coronary Heart Disease (CHD). However, CHD patients generally fail to initiate or adhere to EX programs. The availability of social networks (SN) has been associated with both EX adherence and reduced CHD. The aim of this study was to investigate the role of SN, defined as the number and kind of people lived with, as a predictor of EX in CHD patients over a 2 year period. Method: 365 cardiac outpatients (115 women, 250 men;  $M$  age = 62.79;  $SD = 8.55$ ) referred for an exercise stress test at a tertiary care cardiac center were followed for 2 years. Patients' sociodemographic, anthropometric, and EX habits (using the 12 month PAR questionnaire) were assessed at baseline, 1 year, and 2 years. Results: After controlling for age, sex, peak exercise METS, and employment status, there was a significant relationship between living with a parent and exercise habits over the 2 years ( $F = 8.52$ ,  $p = .004$ ), and a trend for those living with children ( $F = 3.43$ ;  $p = .065$ ). The analyses indicates that patients who lived with a parent were more active than those who did not live with a parent, whereas those individuals who lived with a child tended to have lower levels of EX. There were no other significant relationships between SN and EX, including living with a partner ( $F = 0.35$ ;  $p = .553$ ). Discussion: Previous studies examining SN and EX have mostly focused on the role of partners or spouses. This epidemiological longitudinal study indicates that partners do not appear to play a significant role in the EX habits of the CHD patients we studied, though living with a parent and a child do. Results suggest that interventions to promote EX habits in CHD patients should consider targeting the whole family and not just partners or spouses. Future research is needed to investigate the mechanisms underlying the present relationships.

## Gender Identity and Motivation to Participate in Preventive Exercise Programs

Pfeffer, Ines, University of Leipzig

Gender differences in exercise and sport participation are well documented. Less men participate in preventive exercise programs than women but often choose sport activities with a higher risk for injuries, like team sports. Men emphasize more than women performance enhancement and competition, while women exercise more often to enhance well-being and physical attractiveness. These gender differences in motivation may be explained by gender identity. The Theory of Planned Behaviour (TPB) provides a framework to study motivation for physical activity and proposes that behavior can best be predicted from a person's intention, and intention is a function of attitudes, subjective norms and perceived behavioral control. Two announcements of muscular endurance training were developed: (A) health oriented vs. (B) performance oriented. Is there an interaction Condition  $\times$  Gender or Condition  $\times$  Gender Identity regarding TPB constructs?  $N = 312$  participants were allocated randomly to condition A or B. After reading the announcement participants were asked to fill in a standardised questionnaire measuring gender identity with the PAQ (masculinity/femininity) and TPB constructs related to the announced exercise program. In a 2 (condition)  $\times$  2 (gender) MANOVA with the TPB constructs as dependent variables no significant interaction Condition  $\times$  Gender was found. Using gender identity as independent factor a 2 (cond)  $\times$  2 (masc high/low)  $\times$  2 (fem high/low) was conducted. A significant interaction Cond  $\times$  Masc was found. As expected, participants who score low on masc refer higher subjective norms for condition A than B and people scoring high on masc perceive higher subjective norms for condition B than A. We also found a significant interaction Cond  $\times$  Masc  $\times$  Fem. The female-typed persons perceive higher subjective norms for cond A than B whereas the androgynous, male-typed and undifferentiated persons refer higher subjective norms for cond B than A. The results show that gender identity is more important to explain differences in TPB constructs than gender. Future studies should include behavioral measures.

## The Physical Activity Recall Assessment for People with Spinal Cord Injury - Short Version: Validity and Reliability.

Phang, Sen Hoong, McMaster University; Kathleen A. Martin Ginis, McMaster University; Amy E. Latimer, Queen's University; Kelly Arbour-Nicitopoulos, The University of Toronto

The Physical Activity Recall Assessment for People with Spinal Cord Injury (PARA-SCI; Martin Ginis et al., 2005) is a semi-structured interview that uses a 3-day recall format to determine the number of minutes/day an individual participates in Activities of Daily Living (ADL) and Leisure-Time Physical Activity (LTPA) at mild, moderate and heavy intensities. Although reliable and valid, the PARA-SCI can be cumbersome to administer in studies where only a measure of LTPA is needed. The PARA-SCI-Short Version (SV) was created to measure the amount of LTPA performed in the past week. The purpose of this study was to determine the concurrent validity and test-retest reliability of the PARA-SCI-SV. It was hypothesized that: (a) the amount of mild, moderate and heavy LTPA reported on the PARA-SCI-SV would be positively correlated with amounts reported on the PARA-SCI, and (b) the PARA-SCI-SV would demonstrate acceptable test-retest reliability over a 1-week period. Participants were 103 men (74%) and women living with SCI ( $M$  age = 48.1  $\pm$  12.7). Validity was determined by calculating the correlation between LTPA reported on the PARA-SCI and PARA-SCI-SV. Test-retest reliability was determined by administering the PARA-SCI-SV at two time points, separated by 1-week. Spearman's rank order correlations

showed significant ( $p < .05$ ) correlations between the LTPA scores from the PARA-SCI and PARA-SCI-SV at all intensities ( $\rho = .27 - .54$ ). PARA-SCI-SV showed significant ( $p < .05$ ) intraclass correlation coefficients ( $ICC = .62 - .93$ ) for all intensities of LTPA. These results suggest that the PARA-SCI-SV is a valid and reliable measure of LTPA for people living with SCI. This new measure requires significantly less time to administer and can be used for studies with research questions pertaining to LTPA only.

### **Does motor or visual experience enhance the detection of deceptive movements in soccer?**

Pizzera, Alexandra, Psychological Institute; Markus Raab, German Sport University Cologne

Judging deceptive behavior of players correctly in order to make the right decisions as to whether to call a foul, represents one of the high demands sport officials have to face during competitions. The present study examines if own bodily information (visuo and motor experience) serves as a source to enhance decision making in perceptual tasks involving deceptive movements. Twenty-six participants were assigned to a motor ( $n = 8$ ) or visual group ( $n = 7$ ), in which they were asked to train faking fouls in soccer ( $n = 8$ ) or watch the training over a 4-week intervention period with eight training sessions altogether, or a control group ( $n = 11$ ). Accuracy and reaction time in four videotests, with the task to categorize videoclips into the four categories no foul, foul, foul and yellow card, foul and red card, served as measures for the decision-making performance. Results of a  $4 \times 3$  (Videotest  $\times$  Group) repeated-measures ANOVA reveal that all groups enhance their reaction time significantly ( $F(3, 23) = 5.71; p < .01; \eta^2 = .20$ ), but not their accuracy. For reaction time and accuracy there is no Group and interaction effect, though the visual group shows to be about 300 ms faster than the control and 170 ms faster than the motor group. A more detailed analysis focusing on those categories of the videotest that the experimental groups trained, reveals that all groups enhance their reaction time ( $F(3, 23) = 8.67; p < .01; \eta^2 = .27$ ) and accuracy ( $F(3, 23) = 6.39; p < .01; \eta^2 = .22$ ) significantly. Again, the visual group is about 340 ms faster than the control and about 130 ms faster than the motor group, though there is no Group and no interaction effect. Sport associations could use these results in their referee education program by including observational training of one-on-one-situations to enhance accurate judgments of these situations on the field. Thus, perceptual performance of soccer referees concerning deceptive movements can be trained by visuo-motor training and serve as an additional factor to enhance the decision-making performance of referees.

### **The Relationship between Self-Presentational Concerns and Pre-Game Emotions Among Adolescent Football Players**

Podlog, Leslie W., Texas Tech University; Marc Lochbaum, Texas Tech University

Self-presentational concerns have been shown to predict a range of sport and exercise related cognitions, emotions and behaviors (Hausenblas, Brewer & Van Raalte, 2004). Self-presentation research in sport is however, largely cross-sectional in nature and hence subject to limitations associated with this study design. The purpose of this investigation was to prospectively examine the relationship among self-presentational concerns and pre-game emotions/mental states among middle and high school aged football players. In addressing this purpose, football players ( $n = 113$ ; mean age = 15.57) completed a measure of self-presentational concerns (SPSQ, McGowan, Prapavessis & Wesch, 2009) a week prior to the measurement of the selected pre-game emotions and mental states (i.e., attentiveness, self-assurance, serenity and fear). Results indicated that concerns about appearing

athletically untalented were negatively associated with attentiveness ( $r = -.47, p < .01$ ) and self-assurance ( $r = -.39, p < .01$ ), while concerns over physical appearance were associated with reduced attentiveness ( $r = -.20, p < .05$ ). Mental composure inadequacies were also negatively associated with attentiveness ( $r = -.39, p < .01$ ) and self-assurance ( $r = -.25, p < .01$ ). Regression analyses revealed that concerns about appearing athletically untalented negatively contributed to the significant prediction of pre-game attentiveness,  $\beta = -.474, p < .001$ , and self-assurance  $\beta = -.378, p < .001$ . These findings highlight the importance of reducing self-presentational concerns in promoting positive pre-game emotions and mental states that are likely to impact the quality of athletes' competitive play and experience.

### **Coping Effectiveness in Collegiate Athletes**

Poliseo, Jaclyn M, Purdue University; Meghan H McDonough, Purdue University

Framed within Lazarus' (1999) cognitive-motivational-relational theory, this study attempted to understand the process of coping effectiveness in sport. Congruent with Lazarus' theory is the goodness-of-fit model (Folkman, 1991, 1992), where effective coping can be attained by having correspondence between control appraisals and coping function. A compatible theory, posited by Compas, Banez, Malcarne, & Worsham's (1991), also indicates a match between stress appraisal and emotion-focused coping should be effective. This study examined how the matches between control and coping function proposed in these models predicted outcomes associated with effective coping (i.e., perceived effectiveness, goal attainment, affect, change in athletic competence, and change in stress level). An online questionnaire assessing stress appraisal, coping function, control appraisals, and outcome measures was filled out by 130 college athletes. Using hierarchical regression, moderation hypotheses were tested to determine if the process of coping effectiveness congruent with goodness-of-fit and Compas, et al.'s (1991) models predicted effectiveness outcomes. The matches between control and coping function proposed by the models were supported and consistent with previous literature (Kowalski, Crocker, Hoar & Niefer, 2005) and the effectiveness outcomes were all significantly correlated with one another. However, none of the moderation hypotheses were supported, demonstrating that the matches between coping function and appraisals are not associated with the outcomes. These findings show that though athletes are coping in a way that is consistent with coping effectiveness process theory, these matches were not sufficient in predicting outcomes. Future studies should address this disconnect, potentially placing more attention on the importance of control and appraisals in the understanding of coping effectiveness, and the assessment of perceived effectiveness.

### **Descriptive norms for physical activity: Looking to others when the path is not clear**

Priebe, Carly S, University of Saskatchewan; Kevin S Spink, University of Saskatchewan

In previous research, the physical activity (PA) of others (descriptive norms) has been related to individual PA even though what others were doing was reported as less motivating than personal reasons (Priebe et al., 2009). In terms of norms, it also has been suggested that individuals are more likely to rely on what others are doing in situations where the appropriate course of action is unclear (Lapinski & Rimal, 2005). Given that attending university is a time when students experience ambiguity as to appropriate behavior (Rimal, 2008) and academics tend to compete with time for PA (Gyuresik et al., 2006), it may not be clear to students how much PA is appropriate. An exception to this assumption might be Kinesiology students who learn about the importance of regular PA in their courses. The purposes of this study were 1) replicate previous research by examining whether normative

reasons would be reported as less motivating than personal reasons for PA 2) examine the relationship between descriptive norms and PA in two groups differing in ambiguity about PA - Kinesiology ( $n = 90$ ) and non-Kinesiology students ( $n = 42$ ). It was expected that engaging in PA would be less clear for non-Kinesiology students and, as such, descriptive norms would be better predictors of PA for them versus Kinesiology students. Participants completed a survey assessing reasons for being active, current PA (Godin & Shephard, 1985), and descriptive norm perceptions about others' PA. As expected, planned contrasts revealed that normative reasons were rated as less motivating than personal reasons for being active in both groups,  $p$ 's  $< .001$ . Results from two regression analyses (Kinesiology and non-Kinesiology) revealed that descriptive norm perceptions predicted PA over and above individuals' reasons for being active in non-Kinesiology students only,  $F(1, 39) = 7.45$ ,  $p < .01$ . The fact that the relationship between descriptive norms and PA did not emerge for the Kinesiology students provides tentative support for the possibility that norms may be more influential in ambiguous situations.

### **The social-psychological antecedents of burnout in dance: A longitudinal test of Basic Needs Theory**

Quested, Eleanor, University of Birmingham; Joan L Duda, University of Birmingham

Previous research grounded in the basic needs theory (BNT), a mini-theory in the self-determination theory (SDT) framework (Deci and Ryan, 2000), points to the role of diminished autonomy, competence and relatedness satisfaction in the manifestation of burnout among athletes. To date, these investigations of the motivation-related predictors of burnout have been marked by an over-reliance on cross-sectional research designs and have neglected to consider the role of the social environment. Moreover, a paucity of research has considered the motivation-related antecedents of indicators of compromised well-being (e.g., burnout) among dancers. This study examined whether changes in vocational dancers' autonomy, competence and relatedness satisfaction mediated the relationships between changes in the dancers' perceived autonomy support and burnout over a year of fulltime training. A questionnaire package tapping the variables of interest was completed by 219 vocational dancers at three time points over a 36-week period. Results supported the tenets of BNT with respect to the social-psychological predictors of changes in dancers' burnout over the dance school year. *SEM* indicated that the observed decreases in the dancers' perceptions of autonomy support positively predicted observed decreases in autonomy and relatedness satisfaction and changes in competence need satisfaction that occurred over the school year. In turn, increases in the dancers' global burnout were negatively predicted by decreases in autonomy and relatedness satisfaction and changes in competence need satisfaction. The three basic needs fully mediated the 'autonomy support – global burnout' relationship. When the sub-dimensions of burnout were examined independently, there were inconsistencies in the salience of each basic need. Taken in their totality, findings indicate that promoting and sustaining autonomy supportive training environments in the vocational dance milieu may help to reduce the prevalence of burnout among dancers.

### **Examining the Mediating Relationship Between Body Image Satisfaction and its Biopsychosocial Correlates From the First to Second Pregnancy Trimester**

Rauff, Erica, The Pennsylvania State University; Danielle Symons Downs, The Pennsylvania State University

**Background.** Pregnancy is a unique time in a woman's life that is accompanied by substantial changes in body shape and weight that are likely to impact her body image satisfaction. However, there is a paucity of research examining the biological, psychological, and social influences impacting women's body image satisfaction during pregnancy. **Study Purpose.** The purpose of this study was to assess if 1st trimester body image satisfaction (BIS) mediated the relationship between 1st trimester depressive symptoms (DS), gestational weight gain (GWG), and exercise behavior (EB) and 2nd trimester BIS. We hypothesized that 1st trimester BIS would mediate the relationship between 1st trimester DS, GWG, and EB and 2nd trimester BIS. **Methods.** The participants ( $n = 209$ ,  $M$  age = 30) prospectively completed measures of their BIS, DS, GWG, and EB at 20- and 32-weeks gestation. **Results.** Three mediation models were tested using 4-step hierarchical regression analyses (HRA; Baron & Kenny, 1986), and the findings from the last step in these HRA's are reported here. In the first model, 1st trimester BIS mediated the relationship between 1st trimester DS and 2nd trimester BIS ( $\beta = 0.64$ ,  $p < 0.001$ ). In the second model, 1st trimester BIS ( $\beta = 0.64$ ,  $p < 0.001$ ) partially mediated the relationship between 1st trimester GWG ( $\beta = -0.14$ ,  $p < 0.05$ ) and 2nd trimester BIS. In the third model, no mediation was observed between 1st trimester EB, 1st trimester BIS, and 2nd trimester BIS ( $\beta = 0.04$ ,  $p > 0.05$ ). **Conclusions.** These preliminary study findings illustrate that explaining BIS in pregnancy may be better understood by examining the trimester-specific changes in this construct as well as the influences of DS and GWG. Due to the public health implications associated with poor body image, depression, and high weight gain in pregnancy, these findings inform the development of interventions targeting these constructs to improve health outcomes during this important developmental phase of life for both mothers and their infants.

### **Is there 'feedback' during imagery: Evidence from a specificity of practice paradigm**

Reilly, Niamh E, Bangor University; Gavin P Lawrence, Bangor University; Michael A Khan, Bangor University

Incorporating the specificity of practice hypothesis, Krigolson et al. (2006) investigated the possibility that the feedback obtained through the use of visual imagery could produce specificity of practice effects during a line walking task. The present study furthered that of Krigolson et al. (2006) by investigating the specificity of practice effects of both visual and kinesthetic imagery. More specifically, whether the 'feedback' obtained from practicing with either visual imagery or kinesthetic imagery would lead to the development of a similar movement plan as that acquired during actual practice. Participants ( $n = 40$ ) performed a novel 10m line walking task for 100 acquisition trials in one of four feedback groups; full vision (FV), no vision (NV), visual imagery (VI) and kinesthetic imagery (KI). For every 10 trials of acquisition, participants in the VI and KI groups performed one actual trial (under normal vision conditions) followed by 9 imagined trials. During the imagery trials participants were instructed to imagine either the visual feedback (VI group) or kinesthetic feedback (KI group) received from the previous acquisition trial. All participants were provided with movement time (ms) KR after each acquisition trial. Participants performed two no vision no KR transfer tests; one after 10 acquisition trials and one at the end of acquisition. The number of steps taken, movement time and endpoint error (both amplitude and direction) were measured and specificity of practice was investigated by comparing performance on these variables between early and late transfer. Results revealed that the FV and VI groups performed significantly worse in late transfer compared to early transfer, whereas per-



formance was maintained in the KI group and actually improved in the NV group. These findings suggest that the imagined visual feedback obtained from the use of visual imagery is utilized in a similar fashion to the visual feedback acquired during actual practice when developing movement plans for future performance.

### **Comparison of physical activity motivation and behaviour between age-matched parent and nonparent couples**

Rhodes, Ryan E, University of Victoria; Cecilia Benoit, University of Victoria; Chris M Blanchard, Dalhousie University; Danielle Symons Downs, Pennsylvania State; Ryna Levy Milne, BC Cancer Agency; Patti-Jean Naylor, University of Victoria

The demands of parenthood necessitate lifestyle changes and they may compromise the leisure-time physical activity (LTPA) behaviors of new parents. The purpose of this study was to predict and compare LTPA in a cohort of first-time parent couples (six-months after their newborn's birth) with a nonparent couples comparison group using the theory of planned behavior (TPB). It was hypothesized that parents would participate in less LTPA and would report lower mean values of perceived behavioral control (PBC) due to parenting demands. It was also hypothesized that intention would predict LTPA and attitude and PBC would predict intention. Participants were aged 25-40 classified as either parents ( $n = 85$ ) or nonparent couples ( $n = 56$ ). Groups completed measures of demographics, TPB, and LTPA. Demographics were not significantly different between the two groups. LTPA was significantly higher for nonparent couples when compared to parents ( $t_{138} = 3.02; p < .01$ ). No significant mean differences were identified in global TPB measures, however, control beliefs about housework ( $t_{138} = 3.45; p < .01$ ), occupational work ( $t_{138} = 2.04; p < .01$ ), time ( $t_{138} = 2.1; p < .01$ ), and health ( $t_{138} = 2.07; p < .01$ ) were all higher for nonparents when compared to parents. Regression analyses showed that intention predicted LTPA across both groups ( $\beta = .37; p < .01$ ) but PBC was moderated by parenthood status [ $F_{\text{change}}(1,134) = 5.84; p < .05$ ]. Follow-up comparisons of the two groups in separate regression models showed that PBC ( $\beta = .27$ ) was higher for parents than nonparents ( $\beta = -.04$ ). Instrumental attitude ( $\beta = .26$ ) and PBC ( $\beta = .31$ ) were significant ( $p < .01$ ) predictors of intention; these findings were not moderated by parenthood status. The regular LTPA for parent couples shortly after the birth of their child is lower than their nonparent counterparts, and this may be due to greater workload and compromised health. Further, it appears that parents may have a larger PBC relationship with LTPA, even when holding intention constant. Parents may require targeted interventions that facilitate higher PBC compared to nonparents.

### **Automatic and Motivational Correlates of Physical Activity: Does Intensity Moderate the Relationship?**

Rhodes, Ryan E, University of Victoria; Gert-Jan de Bruijn, University of Amsterdam; Rachel Mark, University of Victoria

The purpose of this study was to examine the predictive capability of a habit construct, controlling for intention and perceived behavioural control, with moderate and strenuous intensity physical activity. This approach was expanded through an examination of whether conscious deliberation in the initiation of physical activity would attenuate these findings and a test of the intention-habit interaction. Participants were a random sample of 337 undergraduate students who completed the habit measure and measures of intention, deliberation and perceived behavioural control phrased in either moderate or vigorous intensities (randomly assigned) at time 1. This was followed by a measure of behaviour (Godin Leisure-Time

Questionnaire) two weeks later where either moderate or vigorous physical activity was matched to their corresponding time 1 condition. Results using stacked structural equation models (moderate, vigorous intensity) demonstrated the direct effect of habit (standardized effect = .30;  $p < .01$ ) accounted for a significant effect on physical activity after controlling for intention (standardized effect = .40;  $p < .01$ ) and perceived behavioural control ( $p > .05$ ); this effect was invariant to intensity and conscious deliberation (Delta  $\chi^2$  was  $p > .05$ ; Delta CFI = .00). A three-way interaction, however, was identified for the habit  $\times$  intention relationship and intensity (Delta  $\chi^2$  (1) = 17.84;  $p < .01$ ; Delta CFI = .04). In the moderate intensity condition, those who report higher habits showed a lower intention-behaviour relationship when compared with those who report modest or low habits. By contrast, those who reported high habit in the vigorous physical activity condition demonstrated a larger intention-behaviour relationship than their modest and low habit counterparts. The results support the notion that some properties of physical activity may have an automatic component and that habits may be important to physical activity action initiation.

### **Trends and Changes in Behavioural Physical Activity Research over the last Two Decades: A Quantitative Review**

Rhodes, Ryan E, University of Victoria; Gabriella Nasuti, University of Victoria

Although the behavioural science of physical activity (PA) is a relatively new discipline, it is important to track changes to mark its progress and general impact in the health science community. The purpose of this study was to investigate content in this research over the past twenty years. Volumes of 10 flagship journals, identified by impact factor and relevance to PA were audited every other year, during the period of 1990-2008. Inclusion criteria were studies that measured a PA outcome, and/or a psychological outcome as a result of PA. Data were extracted and coded based on 15 factors. The review yielded 889 studies for analysis. Overall, the total volume of studies has increased significantly across 20 years ( $\chi^2(9) = 843.07$ ;  $p < .01$ ) as well as the proportionate content space allotted to journals. This is particularly noteworthy in high impact health journals where behavioural PA science comprised only 4.4% of possible content in the 1990s but 13.6% of possible content in the last decade (dependent  $t_4 = 3.16$ ;  $p < .05$ ). Study characteristics by gender (more mixed samples), and ethnicity (more mixed samples) were significantly different in their make-up across time ( $p < .01$ ), while sample size, continent of study, income, design, and PA measurement have remained similar. Studies have been primarily North American in origin (69%), Caucasian in ethnic make-up (39%), cross-sectional in design (61%), and have used self-reported PA (65%). Theories have also changed in proportionate use over time ( $\chi^2(45)=103.20$ ;  $p < .01$ ). The major shift has been the application of environmental research which was not applied in the 1990s but represented 34% of studies in the last decade. In summary, behavioural PA research has shifted in terms of the theories applied to understand the behaviour and samples have become more ethnically diverse. Interestingly, much of the research is still employing cross-sectional designs and self-reported PA. Most prominent, however, is the shift in proportionate representation that behavioural PA has had in high impact health journals.

### **Moderators of the Intention-Behaviour Relationship for Physical Activity: A Systematic Review**

Rhodes, Ryan E, University of Victoria; Leanne Dickau, University of Victoria

Intention is theorized as the proximal determinant of behaviour in most leading theories that have been applied to understand physical activity (PA). The intention-behaviour (I-B) relationship, however, is fairly modest. As a result, researchers have investigated a host of potential moderators of I-B in order to explain its discordance. The purpose of this review was to theme/appraise the variables that have been evaluated as potential moderators of the I-B relationship. Literature searches were conducted among 5 key databases and several search terms for I-B. The search yielded a total of 688 potentially relevant records. Fifty-four passed the eligibility criteria and were therefore included. Studies were themed by variable; themes were developed and appraised if at least three samples had tested I-B moderation with the variable. The search identified 29 different potential moderators of I-B and 10 of these variables contained enough evidence to be themed and appraised in the review. Anticipated regret (3/3 studies; regret = > I-B), intention stability (7/9 studies; > stability = > I-B), and conscientiousness (5/6 studies; > conscientiousness = > I-B) had convincing evidence as reliable moderators of I-B. Age (2/3 studies; young and old = > I-B), perceived control/self-efficacy (5/10; control > I-B), extraversion (3/5 studies; extraverted > I-B) and environmental proximity to recreation (2/3 studies; close proximity = > I-B) showed some evidence for moderation, while planning (1/8 studies), gender (2/9 studies) and ethnicity (1/6 studies) showed convincing evidence for no moderation. This review showed that I-B is consistently moderated by intention stability; indeed, there was evidence this variable acts as the mediator of all other moderators. A considerable number of variables, from personality to environment, also moderate I-B. The findings suggest that traditional theories that consider intention as the proximal determinant of behavior may need augmentation to better account for I-B discordance.

### **The Coach-Athlete Dyad (CAD) and the Basic Psychological Needs in American Collegiate Athletics**

Ross, Raylene, Eva Monsma, University of South Carolina

While previous research has shown a positive relationship between the duration of relationship and the dyad, surprisingly, assessing interdependent dyadic relationships of coaches and their athletes has been overlooked. This investigation examined the relations between collegiate athletes and their coaches' perceptions of the CAD, basic psychological needs and autonomy supportive climates and possible moderating variables such as coach's age, sport type, discussing personal progress and personal issues with coaches and athletes perceptions of meeting with their coaches. Participants were 124 coach-athlete dyads from a variety of individual and team sports. Participants completed the Coach-Athlete Relationship Questionnaire (CART-Q), the Basic Satisfaction Needs in Relationship Scale (BSNRS), and the Sport Climate Questionnaire (SCQ). Paired sample t-test indicated coaches reported higher closeness, commitment, complementarity, and relatedness but lower need for autonomy than their athletes ( $p < .01$ ). Coaches' perceptions of promoting autonomy support in the dyad were significantly higher than their athletes' perceptions of their coaches ( $p < .01$ ). After controlling for coach's age, stepwise regression analysis indicated sport type (5%), athletes' discussion progress (7%) and personal issues (7%) with their coaches, and athletes' perceptions of meeting with coaches (9%), coach-athlete difference scores for closeness (31%), autonomy (6%), and competence (2%) explained 63% of the variation in athletes' perception of autonomy supportive climates. Athletes who did not discuss personal issues and felt meetings with their coaches helped their relationships and those with lower athlete-coach closeness, autonomy, and competence difference scores reported higher perceptions

of autonomy support. Future research should examine how these variables relate to athletes performance and coaches quality of life.

### **A longitudinal examination of self-determination theory in participants of a UK based exercise on referral program.**

Rouse, Peter C, University of Birmingham; Joan L. Duda, University of Birmingham; Nikos Ntoumanis, University of Birmingham; Kate B. Jolly, University of Birmingham; Geoffrey C. Williams, University of Rochester

Self-determination theory (Deci & Ryan, 2000) has been frequently implemented as a framework to examine the mechanisms that underpin change in a variety of health behaviors. This study aimed to explore the mechanisms responsible for mental health, physical activity intentions and subsequent behavior by testing an SDT based motivational model in an exercise setting. Participants ( $n = 145$ ) who were recruited by health and fitness advisors (H&FA) across a major UK city, were individuals who completed a 3 month exercise on referral program (ER). The majority of participants were middle aged ( $M = 53.70 \pm 12.99$  years), female (73%), overweight or obese ( $M \text{ BMI} = 33.21 \text{ } SD = 6.70$ ), and 20% could be considered depressed. Data were collected at three time points; T1 (baseline), T2 (post ER program) and T3 (3 months after exiting the ER program). All psychological questionnaires revealed good psychometric properties ( $\alpha > .70$ ). A re-specified structural equation model revealed good fit to the data:  $\chi^2(181) = 222.36$ , CFI = .98; NNFI = .98, RMSEA = .04 (90% CI, .02-.06) and SRMR = .06. The model indicates that autonomous motivation at T1 (RAI) did not predict the corresponding T2 RAI. However, the RAI (T1) revealed a non-hypothesized positive relationship with need satisfaction at T2. Post-program perceptions of H&FA autonomy support (T2) positively predicted need satisfaction (T2) which in turn predicted change in the RAI. Further, physical activity intentions (T2) were positively predicted by need satisfaction, but not by changes in the RAI. Finally, physical activity intentions positively predicted physical activity behavior at T3 and changes in the RAI were negatively associated with depressive symptoms (T3). Our results provide longitudinal support for an SDT-based motivational sequence and indicate that psychological need satisfaction may be a mechanism that underpins physical activity behavior change and mental health. Findings have important implications for training H&FAs in how to provide effective environmental support to satisfy the basic needs in ER participants.

### **A self-modeling intervention with novice trampolinists: Its effects on physical performance, strategic planning and self-evaluation processes**

Rymal, Amanda M, University of Ottawa; Kelly Vertes, University of Ottawa; Rose Martini, University of Ottawa; Diane M Ste-Marie, University of Ottawa

Athletes and coaches are continuously striving to find new ways in which they can increase the effectiveness of skill acquisition. In this research, a self-modeling video was used as such a technique. Self-modeling is an observational learning method wherein observers view themselves on a video showing only the desired behaviours (Dowrick, & Dove, 1990). Twenty-seven participants who were involved in a two week recreational trampoline camp viewed a self-modeling video for one of two five-skill routines. Thus, a within design was used such that the five-skill routine that received the self-modeling video was the experimental condition and the other five-skill routine acted as the control condition. There were three experimental phases comprising 6 sessions; pretest (1 session), acquisition (4 sessions),

and retention (1 session). We verified that the experimental and control conditions' pretest physical performance scores were not different from each other. The physical performance scores were determined by a qualified trampoline judge. The acquisition results for physical performance showed a main effect for session,  $F(1, 26) = 4.27$ ,  $p < .01$ , with no differences found for condition. At post-test, however, a significant difference was found between the five-skill routine that received the self-modeling video ( $M = 3.80$ ,  $SD = 0.21$ ) (compared to that routine learned without the video intervention ( $M = 3.58$ ,  $SD = 0.54$ ),  $t(26) = 2.05$ ,  $p = .05$ ). In addition to physical performance, two self-regulatory processes from Zimmerman's (2000) self-regulation framework were assessed; specifically, quantitative measures were developed for self-evaluation and strategic planning. No differences, however, were found for the self-evaluation and strategic planning measures during acquisition or post-test. Discussion will be based on the practical applications and future directions of this research.

### **Beyond the Comforts of Social Physique Anxiety: Exploring Other Body-Related Emotions and Links to Physical Activity**

Sabiston, Catherine M, McGill University; Jennifer Brunet, McGill University; Kent C Kowalski, University of Saskatchewan

Two studies were conducted to describe body-related emotional profiles and explore links to physical activity. Study 1 identified emotion profiles. Young adults ( $n = 124$ ;  $M$  age = 20.95,  $SD = 2.43$  yrs; 61.2% female) completed an emotion checklist to assess core and self-conscious emotions relating to the physical self. Hierarchical cluster analysis revealed a two-cluster solution: positive body-related emotions (profile 1;  $n = 88$ , 60% female) and negative body-related emotions (profile 2;  $n = 33$ , 75.8% female). Study 2 sought to (i) confirm the profiles that emerged in study 1, (ii) validate the profiles using psychometrically sound measures assessing body-related self-conscious emotions, and (iii) examine group-level differences on physical activity motivation and behavior. Young adults ( $n = 325$ ;  $M$  age = 19.57,  $SD = 1.95$  yrs; 64.3% female) completed the same emotion checklist as in study 1, as well as measures of self-conscious emotions, physical activity motivation, and behavior. The two-cluster solution identified in study 1 was confirmed (profile 1:  $n = 148$ ; 53.3% female; profile 2:  $n = 177$ , 73.3% female). The MANOVA examining differences on the self-conscious emotions according to profile was significant, Wilks's lambda = .55,  $F(5, 320) = 50.25$ ,  $p < 0.001$ . Participants in profile 1 reported higher body-related authentic pride and lower guilt, shame, and anxiety compared to profile 2. The MANOVA examining profile differences on level of physical activity motivation and behavior was also significant, Wilks's lambda = .83,  $F(6, 318) = 10.58$ ,  $p < 0.001$ . Profile 1 reported more self-determined motives and higher levels of physical activity compared to profile 2. Findings suggest young adults report a range of body-related emotional experiences that may be conceptualized as positive and negative affective dimensions; and these profiles have implications for physical activity motivation and behavior. This study highlights the need to move beyond the focus on social physique anxiety by tapping underused theoretical frameworks to understand body-related emotions and links to health behavior.

### **Exercise and Metamemory: Walking Before Study Can Improve Memory and Judgment of Learning Accuracy**

Salas, Carlos R., University of Illinois at Chicago; Katsumi Minakata, California State University, Long Beach; William L Kelemen, California State University, Long Beach

The main purpose of this study was to examine the degree to which a brief bout of aerobic exercise can influence subsequent memory or predictions of memory (i.e., metamemory).

In past research, college students' memory performance has increased up to 25% following exercise (Coles & Tomporowski, 2008; see Pesce, et al., 2009 for a study using children), but no studies have examined whether or not students can monitor the cognitive benefits of exercise. A secondary purpose was to examine whether changes in memory or metamemory would be state dependent. Although state-dependent memory has been found with exercise (e.g., Miles & Hardman, 1998), this issue has not yet been addressed for metamemory. A total of 80 college students were tested using a 2 (Encoding condition: walking vs. sitting)  $\times$  2 (Retrieval condition: walking vs. sitting) between-subjects factorial design. Students initially completed either 10 minutes of walking or 10 minutes of a sedentary task. Then, they studied 30 words and predicted their likelihood of future recall for each word, followed by another 10-minute walking or sedentary task. All participants then completed a free recall test. Cognitive performance was assessed using (a) proportion correct on the free recall test, (b) magnitude of confidence judgments, and (c) both absolute and relative measures of metamemory accuracy. Students who walked before encoding had significantly higher levels of recall ( $M = 0.45$ ,  $SD = 0.17$ ) compared with students who sat before encoding ( $M = 0.36$ ,  $SD = 0.15$ ),  $F(1,76) = 6.34$ ,  $p < .05$ . No significant effect of retrieval emerged, and no interaction between encoding and retrieval conditions was observed,  $F(1,76) = 0.71$ ,  $p > .05$ , indicating that state-dependent learning was not evident. Although the magnitude of confidence judgments did not change due to the encoding manipulation,  $t(78) = 0.31$ ,  $p > .05$ , absolute metamemory accuracy did improve significantly,  $F(1,76) = 6.64$ ,  $p < .05$ . Overall, these results suggest that students can gain significant memory and metamemory benefits from exercise before study.

### **Relationship of Need Satisfaction and Self-Determined Motivation to Well-Being among Regular Exercisers and Non-Exercisers**

Samantaray, Dr. Sudhir K, Post Graduate Govt. College, Sector-11; Akanksha Tripathi, Post Graduate Govt. College, Sector-11

Grounded in self-determination theory (SDT), this study aimed at studying the relationship of need satisfaction and self determined motivation to well-being in exercise. Participants ( $n = 200$ ) were exercisers who visited gym regularly. Psychological Needs were studied by Psychological Needs in Exercise Scale (Wilson et al. 2006) and to assess Self Regulatory Motivational Styles, Exercise Self-Regulation Questionnaire (Ryan, & Connell, 1989) was used. To measure well being, Subjective Vitality Scale (Ryan and Frederick, 1997) and Positive Affect and Negative Affectivity Scale (Watson et al., 1988) were used. Also Self Rating of Perceived Health Status (Blaxter, 1995) was used to assess the health status of the exerciser. These tests were administered on 200 males in the age range of 18-25 years. Descriptive statistics and correlation were adopted to analyze the data. Results revealed that the Psychological needs of competence, autonomy and relatedness and the intrinsic motivational style indicated a positive and significant relationship with the different indices of well being among exercisers.

### **Exploring the relationship between basic psychological needs and physical activity among transplant recipients**

Segatto, Bianca, McGill University; Catherine Sabiston, McGill

Basic needs theory asserts that individuals have innate and universal basic psychological needs for autonomy, relatedness and competence (Deci & Ryan, 1985, 2002). The fulfillment of these needs in an exercise context may enhance overall well-being. One population that

may benefit from exercise, and associated basic needs support in this context, is transplant recipients. Regular physical activity has been associated with reduced physical limitations and increased vitality in transplant recipients (*p* ainter, Krasnoff, Paul, & Ascher, 2003). The purpose of this study is to understand the relationship between basic psychological needs for exercise and levels of health-enhancing physical activity among transplant recipients. Participants ( $n = 139$ ;  $M$  age = 48 years; 58% male), who were primarily heart, liver, lung, and kidney transplant recipients, completed scientifically-supported questionnaires. Transplant recipients reported high levels of competence, high levels of autonomy, and moderate levels of relatedness. Controlling for transplant specific factors (i.e., age at transplant, time waiting for transplant, and time since transplant), separate regression analyses were conducted to assess predictors of health-enhancing physical activity. The need for competence  $F(4, 109) = 6.45, p < .01, R^2 = .19$  and autonomy  $F(4, 108) = 3.04, p < .05, R^2 = .10$  were significant predictors of health enhancing physical activity in separate models. The need for relatedness was not significantly associated with physical activity in this sample. These findings suggest that promoting feelings of competence and autonomy in an exercise setting may help improve transplant recipients levels of health enhancing physical activity.

### **Peer Relationships and Loneliness in Athletes with Physical Disabilities**

Shapiro, Deborah R., Georgia State University; Jeffrey J. Martin, Wayne State University

Youth sport represents an important contributor to the development of valuable peer relationships. Friendships facilitate well being, including positive adjustment, prosocial behavior and self-esteem. The increased importance of peers to competence perceptions across childhood, and the importance of social acceptance and affiliation as primary sport participation motives together highlight the value of understanding peer relationships in sport (Smith, 2002; Weiss, Smith & Theeboom, 1996). In contrast to able bodied youth, children and adolescents with physical disabilities generally have fewer opportunities and incentives to engage in physical activities and are often considered unpopular and unskilled. Limited opportunities lead to less extensive social networks, fewer friendships compared to peers without disabilities and feelings of loneliness or dissatisfaction with social relationships. The purposes of this study were to investigate quality of friendships among youth athletes with physical disabilities and to determine the relationships among friendship, loneliness and multidimensional perceived competence. Participants included 46 athletes with physical disabilities (males = 35, female = 11) between the ages of 12 and 21 ( $M$  age = 15.37,  $SD = 2.45$ ) involved in adapted sport. Participants completed the Sport Friendship Quality Scale (SFQS), a Loneliness Rating Scale and the Self-Perception Profile for Adolescents (SPPA). Participation in adapted sport provided athletes an opportunity to interact with friends more like themselves who provided important self-enhancing benefits including validation and caring, help and guidance, and companionship. Over 71% of participants reported feelings of overall social satisfaction and positive multidimensional self-perceptions ranging from 3.0 to 3.4 out of 4. Ratings of loneliness were significantly and negatively related to all SPPA subscales. The findings support the value of adapted sport to the development of positive competence perceptions, social acceptance and affiliation for youth with physical disabilities.

### **Validation of the Athlete Burnout Questionnaire with youth athletes**

Sharp, Lee-Ann, University of Birmingham; Charlotte Woodcock, University of Birmingham; Mark J.G. Holland, University of Birmingham; Joan L Duda, University of Birmingham; Jennifer Cumming, University of Birmingham

The Athlete Burnout Questionnaire (ABQ; Raedeke & Smith, 2001) has emerged as a valid and reliable theory based tool to measure burnout in adult-aged athletes. However, the psychometric properties of the ABQ have yet to be extensively tested within youth sport populations. The present study tested the validity and reliability of the 15 item ABQ with 445 young British athletes (322 males and 152 females;  $M$  age = 15.36,  $SD$  1.23 years). The internal consistency was examined for each of the three subscales, emotional/physical exhaustion (EPE), sport devaluation (SD) and reduced sense of accomplishment (RA), resulting in alpha coefficients of between .78 and .89. Preliminary confirmatory factor analysis indicated the model for the ABQ was an adequate fit ( $\chi^2 = 361.99$ , RMSEA = .08, SRMR = .06, CFI = .92, TLI = .90). Modification indices suggested that the model could be improved if two items within the reduced accomplishment subscale be allowed to covary. A re-specified model showed a greater model fit ( $\chi^2 = 266.91$ , RMSEA = .07, SRMR = .05, CFI = .95, TLI = .94) and was utilised in further analysis. Investigations by Raedeke and Smith (2001) and Price and Weiss (2000) suggested that high levels of trait anxiety predispose athletes to the risk of burnout. To establish convergent validity, all athletes also completed the 17 item revised Competitive State Anxiety Inventory (CSAI-2R; Cox, Martens & Russell, 2003). Analysis for the present study indicated Cronbach alpha coefficients of between .61 and .78 for the CSAI-2R. Bivariate correlations indicated that the subscales of the ABQ and CSAI-2R were related. As expected, intensity measures of somatic anxiety (EPE  $r = .25$ ,  $p < .01$ ;  $SD$   $r = .17$ ,  $p < .01$ ; RA  $r = .16$ ,  $p = .01$ ) and cognitive anxiety (EPE  $r = .22$ ,  $p < .01$ ;  $SD$   $r = .10$ ,  $p < .05$ ; RA  $r = .14$ ,  $p < .01$ ) positively correlated and self-confidence negatively correlated ( $SD$   $r = -.16$ ,  $p < .01$ ; RA  $r = -.16$ ,  $p < .01$ ) with ABQ subscales. In conclusion, preliminary results indicated the ABQ to be a valid measure of burnout in youth athlete populations.

### **The prediction of the aggressive nature of sport and perceived coaching behaviors to aggressive beliefs and behaviors in young athletes**

Shen, Wei-Jiun, Graduate Institute of Physical Education; Chu-Min Liao, National Taiwan Sport University; Wei-Ren Chen, National Taiwan Sport University

It has been argued, based on anecdotal evidence, that participating in sports with an aggressive nature (ex. dodge ball) may induce a higher level of aggressiveness in young athletes. However, we believe that it is the coach's behaviors (ex. autocratic behaviors) rather than the nature of the sport will lead to aggressiveness. Thus, we examined the prediction of perceived coaching behaviors and the aggressive nature of sport to aggressive beliefs and behaviors in young athletes with a series of multiple hierarchical regression analyses. We expected that there would be no improvement in prediction of the aggressive nature of sport, beyond that afforded by perceived coaching behavior. Participants of this study were 308 young athletes (192 boys, 116 girls, grade 4th to 6th) from a variety of varsity teams (basketball, handball, soccer, volleyball, table-tennis, tennis, badminton, and dodge ball). Their perception of their coaches' behaviors (via Leadership Scale for Sports), aggressive beliefs (self-defending, rationalization and self-centering) and aggressive behaviors (verbal, physical and toward objects) were measured. The sports which participants were from were divided into three groups according to their aggressive nature (cross-net sports, contact sports, and dodge ball) and were used as a dummy variable in the regression analyses. The results showed that perceived coaching behaviors significantly predicted all aggressive beliefs and behaviors ( $R^2 = .06$  to  $.13$ , all  $p$ 's  $< .001$ ), with autocratic behavior was the only contributor to the prediction. The addition of the aggressive nature of sport improved the



prediction only on verbal and physical aggressive behaviors with little  $R^2$  changes (.04 and .03, respectively). This data supports our hypothesis that the aggressive nature of sports contributes very little, if any, to young athletes' aggressive beliefs and behaviors. It is coaches' behaviors that play a major role.

### **Establishing determinants of future efficacy: Initial proxy-efficacy as a predictor of post-program self-regulatory efficacy**

Shields, Christopher A, Acadia University; Lawrence Brawley, University of Saskatchewan; Karen Glazebrook, University of Saskatchewan; Tara Anderson, University of Saskatchewan; Parminder Flora, University Saskatchewan

It has been suggested that in situations of proxy-agency in exercise (e.g., exercise instructor), relational efficacies such as proxy-efficacy (PE: confidence in the proxy's ability to help you) and RISE beliefs (appraisals of how another views one's competence) may be important determinants of future self-efficacy. This may be the case for novice participants in need of guidance from a proxy-agent. Little research has attempted to influence both RISE beliefs and PE as potential determinants of future efficacy. Recent evidence about the effect of leader delivery style on efficacies is not conclusive. Estimating the association between relational efficacies and future self-efficacy may clarify the status of relational efficacies as potential determinants of exercise self-efficacy. Our purpose was to examine if RISE beliefs and PE (relational efficacies) predicted future self-regulatory efficacy in a field experiment. Novice exercisers ( $n = 51$ ) were randomly assigned to two exercise conditions that varied leader delivery style in classes about learning resistance and body weight supported exercise. In order to give participants a basis for their relational efficacies, measures of PE and RISE beliefs were taken after an initial exposure (1 class) to delivery style. Initial self-regulatory efficacy (SRE) was assessed, as was post program SRE for future activity an initial exposure following six instructor-led classes. Hierarchical regression revealed that after controlling for baseline SRE and leader style, relational efficacies collectively accounted for 27% additional variance ( $p < .001$ ) in post-program SRE (Overall model  $R^2_{adj} = .36$ ,  $p = .001$ ). However, PE was the only significant contributor to the relational efficacy effect on SRE ( $B = .52$ ,  $p = .001$ ). These findings suggest that PE, formed after initial exposure to a proxy, is a correlate of SRE and may be examined for its causal effect as potential efficacy information in future experimental research. Support-SSHRC grant 41020060927.

### **Can Imagery be used to Enhance Anticipation Skill?**

Smeeton, Nicholas J, University of Brighton; Jonathan Hibbert, University of Brighton; Karl Stevenson, University of Brighton; Jennifer Cumming, University of Birmingham; A. Mark Williams, Liverpool John Moores University

We examined the effectiveness of using imagery, video replay and outcome KR as interventions when attempting to improve anticipation skill in elite junior cricket batters. Altogether, twenty-three participants were tasked with reading the spin direction of a cricket bowler over a four-week period and received feedback on their anticipation decision in the form of imagery, video replay or outcome KR after each training trial. During acquisition, participants across all three intervention groups improved their anticipation performance. Over the pre and post-test, participants in the imagery and video replay groups improved their mean response time and accuracy. However, participants in the Outcome KR group only improved their response accuracy. Imagery ability improved in all groups, measured by the VMIQ-2. However, only participants in the imagery group improved their VMIQ-2 scores in the kinesthesia dimension.

Findings suggest that imagery and video replay feedback provide effective methods to enhance anticipation skill. Additionally, imagery leads to improved kinaesthetic imagery ability.

### **Physical Activity Counseling as an Adjunct in the Treatment of Depression**

Smith, Janice, East Carolina University; Thomas D. Raedeke, East Carolina University

Both epidemiological and clinical trial research have shown that physical activity (PA) is inversely related with depression and thus PA is recommended as an adjunct to the traditional treatment of depression. However, individuals suffering from depression have lower PA levels compared to population averages. Consequently, a critical issue involves how to promote active lifestyles in individuals with depression. This study involved evaluating the effectiveness of a PA counseling intervention delivered by psychotherapists as an adjunct in the outpatient treatment of depression. Individuals ( $n = 25$ ) diagnosed with clinical depression were randomly assigned to a lifestyle counseling intervention delivered by their regular therapist or a minimal pedometer intervention. Lifestyle counseling condition participants received PA counseling as part of their regularly scheduled therapy over a 12-week period, whereas the other group was given a pedometer and encouraged to increase their step counts. Participants in both conditions reported decreased depression from pre- to post-test assessed via the Beck Depression Inventory II ( $M = 25.9$  pre to  $8.5$  post;  $p = .0001$ ;  $d = 1.6$ ) and improved quality of life based on SF-36V2 subscales ( $d$  range from  $.24$  to  $1.5$ ). They also reported increased PA ( $p = .051$ ,  $d = .43$ ) with a mean increase of 846 steps per day. However, the lifestyle counseling did not result in greater improvements in well-being or daily step counts compared to the minimal pedometer intervention ( $p > .05$ ). Correlation analyses revealed that step counts were moderately related to depression and quality of life scores both pre- and post-test, with step count changes being less strongly related to changes in well-being. Participants who received more lifestyle counseling sessions and higher quality counseling evident by progress note content reported greater improvements in PA and well-being. Also, enjoyment, PA self-efficacy, barrier self-efficacy and use of self-management strategies were associated with higher step counts with the correlations moderate in magnitude.

### **The Role of Individual- and Group-focused Self-talk on Efficacy Beliefs and Dart-throwing Performance**

Son, Veronica, Michigan State University; Ben Jackson, The University of Western Australia; Bob Grove, The University of Western Australia

The purpose of this study was to examine how modifying the referent of self-talk statements with respect to the level of agency (i.e., individual versus group) may influence individuals' self-efficacy and collective efficacy perceptions, as well as performance levels within a team-based laboratory task. In addition, this investigation sought to explore the way in which one's individualist or collectivist orientation may shape the development of individual- and team-related efficacy perceptions. Undergraduate students ( $n = 80$ ) were assigned to 'individualist' or 'collectivist' teams comprising 3 or 4 members, and were provided with either an individual- focused, group-focused, or neutral self-talk script prior to performing a dart-throwing task in a 2 (orientation)  $\times$  3 (self-talk) design. Although no differences emerged according individualist/collectivist orientations, ANOVAs revealed that self-efficacy, collective efficacy, and performance were all greatest for those participants implementing self-talk which focused on the group's capabilities ( $p < .05$ ). Findings are considered in light of their novel theoretical contribution, and accompanying practical applications as well as directions for future research are discussed.

### **Sources of enjoyment among young soccer players**

Sousa, Catarina, University California Los Angeles; Jaume Cruz, Autonomous University of Barcelona; Carme Viladrich, Autonomous University of Barcelona; Miquel Torregrosa, Autonomous University of Barcelona; Alex Garcia-Mas, University of Balearic Islands

Sport enjoyment has been reported as a key factor in motivational studies. Sport enjoyment defined as “a positive affective response to the sport experience that reflects generalized feelings such as pleasure, liking and fun” (Scanlan, Carpenter, et al., 1993) is one of the strongest sport commitment predictors (Scanlan et al., 1993, 2009; Sousa et al. 2007). Moreover, is also one of the motives to engage in sport. There is evidence to consider that individual (e.g., perceived ability) and social factors (e.g. peer relationships) contribute to sport enjoyment (Scanlan, 2005). However, perceptions of climate induced by the coach have not been studied as a potential source of enjoyment. The purpose of this study was to analyse perceived ability, goal orientation and perceived motivational climate as sources of enjoyment among young athletes. A total of 852 (n1 = 437; n2 = 415) soccer players, between 14 and 16 years old, completed the Perception of Success Questionnaire (POSQ, Roberts et al., 1998), the Perceived Motivational Climate in Sport Questionnaire (PMCSQ-2, Newton, Duda & Yin, 2000), the Perceived Ability scale of the Intrinsic Motivation Inventory (IMI, McAuley, Duncan & Tammen, 1989) and the Sport Enjoyment scale of the Sport Commitment Questionnaire (SCQ, Scanlan, et al., 1993). Results showed that perceived ability, task orientation and perceived task motivational climate were positively associated with sport enjoyment. Hierarchical Multiple Regression analyses showed that perceptions of task-involved climate created by the coach are the strongest predictor of feelings of fun and liking, follow by the athletes’ task orientation and their perceived ability. An ego-involvement climate created by the coach predicts athletes’ enjoyment negatively. Results suggest perceived task-involvement climate created by the coaches as a source of enjoyment. This study underlines the importance of the climate generated by the coach as a factor that contributes to maintain the athletes sport participation and avoid sport dropout. This work was partly funded by the grant SEJ2007/64528/PSIC (Plan Nacional de Investigacion Desarrollo) and DEP 2006-56013.

### **Decision-Making in Poker Using the Skill-Level Paradigm**

St. Germain, Joseph, Florida State University; Gershon Tenenbaum, Florida State University

The purpose of this study was to delineate Decision-making (DM) processes among expert, intermediate, and novice poker players. An additional purpose was to follow the thought processes during the DM process, and to examine whether variations exist among players who differ in skill-level. DM hands of No-Limit Texas Hold ‘Em were examined at each stage of play (pre-flop, flop, turn, and river) using computer-simulated environment. DM performance and thoughts were measured within three playing styles (varied, all loose-passive, and all tight-aggressive), and two time conditions (no time limit and 15 second time limit). Furthermore, DM performance measures such as expected value (EV) and profit scores were recorded at each stage within the various experimental conditions. Results indicated that expert and intermediate players performed significantly better than novices across all trials. These differences were largest at the turn stages of the play. Experts displayed greater EV scores than intermediates, but this effect only tended towards significance. Expert and intermediate players outperformed novices in all styles conditions, which infer that the ability of experts to make better decisions is useful against any opponent style. All groups performed better in the timed condition, but contrary to research in other areas, the novices

displayed the greatest increase in DM performance in this condition. Expert and intermediate players reported thinking mainly about situational-relevant cues, while novices reported focusing the majority of their attention on basic or non-poker cues. The results of this study are in line with previous DM research as clear skill-level differences emerged in decision quality and reported thought processing. Furthered real-life poker studies must target the poker game as its popularity has increased significantly in the last decade.

### **Dance students' self-control of different videoed model types**

Ste-Marie, Diane M, University of Ottawa; Amanda M Rymal, University of Ottawa; April Karlinsky, University of Ottawa; Chantale Lussier-Ley, University of Ottawa

To date, no research has examined the model type learners would choose to watch if given self-control over their use of observational learning via video. In this study, eight ballet students ranging from ages 11-17 and working at a Cecchetti grade 2-elementary level were provided with a DVD that consisted of three different model types [mastery (M); self-observation (SO); and self modeling (SM)] of a dance combination they were learning. The M model was the dance teacher performing the dance combination. The SO model was one of the first few trials of the dance student herself performing the dance sequence, whereas the SM model was the best dance sequence performed by the dancer in the first learning session. All dance students were given the DVD for 10 days and were told that they could use it as they desired. They were also given a log book to record information and respond to qualitative questions. Based on the log book analysis, all dance students chose to watch all three model types, but the SM type was viewed more often (41.5%) than both the M model (33.8%) and the SO model (24.7%). Moreover, two dominant patterns for watching the sequence emerged; specifically an M-SM-SO pattern and an SO-SM-M pattern. Interpretation of the dance students' reasoning for their sequence choices fell in line with Bandura's (1997) social cognitive theory. In addition, Zimmerman's (2000) self-regulatory model of learning was used to deductively code the qualitative thoughts and feelings of the dance students surrounding the use of the DVD. While several self-regulatory processes were used by the students, the dominant phase involved was that of self-reflection with 84.8% of the codes falling within this phase. Within the self-reflection phase, self-evaluative processing (43.2% of codes) was the main process engaged in by the dance students. The discussion will focus on the strengths, limitations and implications of this research.

### **Elliot's (1999) hierarchical model of achievement motivation in physical activity and education: A meta-analytic review of antecedents and consequences**

Stevenson, Sarah J, Texas Tech University

The purpose of this research was to test the relationships of antecedents and consequences of the 2 × 2 goal orientations, as defined by Elliot's (1999) hierarchical model of achievement motivation in physical activity (PA) and education using meta-analytic techniques. Overall, 55 studies from 1994 to 2009 met inclusion criteria, thus were examined; 35 in education, 19 in PA, and one contained both. Antecedents such as entity ( $r$  range = 0.13 to 0.20) and incremental theory ( $r$  range = 0.16 to 0.37), perceived competence (PC;  $r$  range = 0.31 to 0.33) and fear of failure (FoF;  $r$  range = 0.29 to 0.58) were identified as significant correlates of the goals. Consequences such as effort ( $r$  range = 0.23 to 0.59), enjoyment ( $r$  range = 0.30 to 0.64), intrinsic motivation (IM;  $r$  range = 0.15 to 0.53), performance, positive affect, and negative affect were identified as significant correlates of the goals. These results provide partial

support for several relationships hypothesized in Elliot's (1999) model. Eight hypotheses were tested for each goal orientation. For the mastery-approach goal, all relationships were supported in PA. All but one hypothesized relationship was supported in education. New relationships emerged between entity theory and FoF for PA, as well as FoF and negative affect for education. For the mastery-avoidance goal, supported relationships exist for incremental theory, FoF, and effort for PA, as well as for enjoyment, intrinsic motivation and education. For the performance-approach goal, all relationships were supported. New relationships emerged between incremental theory and gender for education, as well as enjoyment in both domains. For the performance-avoidance goal, three relationships were unsupported in PA (PC, effort, and IM) and four were unsupported in education (PC, effort, IM, and performance). This may imply problems with either the validity of the model or instruments used to measure  $2 \times 2$  goal orientations in various domains. Therefore, future research should be aimed to determine fault in the current model.

### **Individual and Social Predictors of Supplement Use Among Athletes**

Stuntz, Cheryl P., St. Lawrence University; Jonathan C. Edwards, Florida Atlantic University

Supplements are commonly used by athletes, often to enhance performance. The purpose of the present study was to examine individual and social predictors of frequency of use for a variety of supplements (anabolic steroids, caffeine, creatine, glutamine, multivitamins, protein powder, weight loss pills). This study built on past supplement research by incorporating multiple achievement goal theory predictors and separating out different supplements in analyses. Male collegiate athletes ( $n = 141$ ) completed questionnaires assessing substance use, year in school, task and ego orientations, level of self-determination, mastery and performance climates, and moral atmosphere. While older class year, higher ego orientation, less self-determined motivation, higher performance climate, and moral atmosphere approving of substance use were hypothesized to predict greater frequency of use (e.g., Bartee, Grandjean, Dunn, Perko, Eddy, & Wang, 2004; Donahue, Miquelon, Valois, Goulet, Buist, & Vallerand, 2006; Dunn & Dunn, 1999; Miller, Roberts, & Ommundsen, 2005; Stephens, 2004), results only partially supported hypotheses. Regression analyses predicting frequency of protein powder, caffeine, glutamine, and multivitamin use were statistically significant ( $p < .007$ , explaining 15%, 20%, 18%, and 23% of the variance, respectively). Only moral atmosphere consistently predicted use of these four supplements. Believing that more teammates would use the substance to help the team win predicted more frequent drug use. In addition, lower performance climate predicted more frequent use of protein powder, and higher class year and higher ego orientation predicted more frequent use of glutamine. Regression analyses predicting use of weight loss pills, anabolic steroids, and creatine did not reach statistical significance ( $p > .007$ , explaining 12%, 3%, and 7% of the variance, respectively). These results emphasize the important role teammates play in influencing athletes' supplement use and the need to consider supplements individually rather than collectively in research.

### **Predicting athlete's perceptions of coaching behavior in youth sport.**

Sullivan, Philip, Brock University; Kaitlyn LaForge, Brock University; Nicholas Holt, University of Alberta; Gordon Bloom, McGill University

Coaching behaviors in youth sport have typically been operationalized through either objective assessment (e.g., the Coaching Behavior Assessment Scale) or by self-report of the coaches (e.g., Leadership Scale for Sports). The current study incorporated the athletes' assessment

of coaching behavior. It was hypothesized that athlete assessment of coaching behaviours would be predicted by coach-reported efficacy and behavior. A sample of 259 (129 male, 128 female) youth sport athletes (ages 12-16) in 39 teams completed the Coaching Behavior Scale for Sport (CBS-S; Côté et al., 1999). This scale measures five dimensions of coaching behavior: physical training and conditioning, technical skills, mental preparation, goal setting, and competitive strategies; as well as a dimension of overall effectiveness. Their coaches (34 male, 5 female) completed the Coaching Efficacy Scale (CES; Feltz et al., 1999) and the Revised Leadership Scale for Sport (RLSS; Zhang et al., 1997). The CES measures coaches' confidence in four interrelated factors. The RLSS measures coaches' perception of their frequency of six different coaching behaviors. The results showed that four athlete perceptions of coaching behavior were significantly predicted: overall coaching effectiveness, training behavior, mental preparation and strategy behavior. Coaching efficacy was a more consistent predictor of athlete perceptions than coaching behavior. Specifically, coaches' confidence with respect to their strategy and teaching abilities were repeatedly found to be significant predictors, whereas coaches' democratic behavior was the sole significant predictor from the RLSS variables. The hypothesis was partially supported, as there were some significant relationships between coaches and athletes' perception of the coaches' behaviors. However, this relationship is not as robust as was expected. As previous studies have shown that coach perceptions tend to be fairly realistic (Cumming et al., 2006; Feltz et al., 2008), this may be due to the youth of the participants.

### **The relationships between athletes' assessment of coaching behavior and positive youth development.**

Sullivan, Philip, Brock University; Tammy Whitaker-Campbell, Brock University; Nicholas Holt, University of Alberta; Gord Bloom, McGill University

Youth sport coaches play a critical role in structuring appropriate sporting experiences for youth. The outcomes for the participants may comprise attitudes and behaviors relevant to sport, as well as more general, positive development (Smith, Smoll, & Barnett, 1995; Smith & Smoll, 1997; 2002). According to Horn's (2008) conceptual model of coaching effectiveness, this impact of the coaching process on such participant outcomes is dependent on the athlete's interpretation of their coaches' behavior. The purpose of the present study was to examine the relationships between athletes' perception of coaching behavior and how this relates to psychosocial growth and development. A sample of 259 (129 male, 128 female) youth sport athletes (ages 12-16) athletes completed Cote et al.'s Coaching Behavior Scale for Sport (CBS-S) The CBS-S examines the frequency of six coaching behaviours: physical training and conditioning, technical skills, mental preparation, goal setting, competitive strategies, and overall effectiveness. The athletes also completed the Youth Experiences Survey (YES 2.0). YES is a self-report scale that measures a seven different aspect of youth's developmental experiences in an organized activity: identity experiences, identity reflection, initiative experiences, basic skills, positive relationships, teamwork and social skills, adult networks and social capital, and negative experiences. A canonical correlation examined the relationships between these two constructs. There was one significant canonical correlation ( $r = .431, p < .001$ ). This correlation was characterized by significant loadings on each of the seven CBS-S coaching behaviour scales, and the PYD measure of negative experiences. These results suggest that in youth sport, athletes' negative experiences, such as stress and negative group dynamics, are significantly related to their perceptions of their coaches' behaviors. Furthermore, these perceptions refer to all aspects of the coaching process (e.g., physical training, mental preparation, strategy).

### **Is there a Relationship between Leisure-Time Physical Activity and Satisfaction with Life?**

Sylvester, Benjamin D, Brock University; Diane E Mack, Brock University; Philip M Wilson, Brock University; Susanna Cheung, Brock University; Samuel Rimmer, Brock University; Paige Gregson, Brock University

Emergent evidence has supported the relationship between leisure-time physical activity (LTPA) with varied indices of psychological well-being (Fox & Wilson, 2008). Evidence specific to the LTPA-Satisfaction with Life (SWL) relationship remains equivocal in healthy adults (Warburton et al., 2007), despite SWL being a fundamental marker of well-being (p avot & Diener, 2009). The purpose of this study was to examine the relationship between LTPA and global SWL. The aforementioned purpose was investigated across three separate studies. Female participants (*n*'s ranged from 142 - 444) completed the Satisfaction with Life Scale (SWLS; Diener, Emmons, Larsen, & Griffin, 1985). LTPA scores were derived from either the Godin Leisure-Time Exercise Questionnaire (LTEQ; Godin & Shepard, 1985) or from motion accelerometry (PAM BV, Doorwerth, the Netherlands). Employing a cross-sectional design, participants in the first study (*M* age = 18.59; *SD* age = 1.05) reported a weak positive relationship between LTEQ scores and SWL ( $r = 0.13$ ). The second study utilized estimates of LTPA derived from motion accelerometry gathered across a seven day period in a sample of young adults (*M* age = 20.89; *SD* age = 0.76). The relationship between LTPA and SWL was small ( $r = .21$ ). Finally, participants (*M* age = 38.40; *SD* age = 7.29) completed the LTEQ at one time point with the SWLS administered one month later in a prospective design. The LTPA-SWL relationship ( $r = 0.22$ ) was consistent with those derived from studies 1 and 2. The magnitude of the association between LTPA and SWL was in line with conclusions emanating from previous literature documenting small, but meaningful, associations between LTPA and indices of well-being (Fox & Wilson, 2008). The magnitude of the observed LTPA-SWL should be encouraging and should not be discounted given the role of health behaviors in relation to global markers of well-being that are likely influenced by a variety of sources (Lyubomirsky, Sheldon, & Schkade, 2005).

### **An Analysis of Developmental Differences in Perceptions of Motivational Climate and Achievement Goals in Competitive Swimmers**

Trenz, Rebecca C, Fordham University

The purpose of this paper is to analyze swimmers' perceptions of motivational climate and their achievement goals relative to their developmental ability in competitive youth swimming. One-hundred and eighteen participants in this study were given a rank order dependent upon their level of achievement in swimming. This level was determined by each swimmer's highest level of achievement using standard qualifying times for championship meets. The developmental levels ranged from level 1 to level 6, with 6 being the highest or most advanced level. This level of achievement was used as the independent variable. Participant scores on the Perceived Motivational Climate in Sport Questionnaire-2 and the Achievement Goal Questionnaire-2 were used as the dependent variables. A one-way analysis of variance indicated that there was a significant difference between groups on perceptions of a performance-oriented motivational climate,  $F(5, 112) = 3.88, p < .05$ . Independent samples t-tests were conducted between developmental levels of achievement to look closer at the differences between developmental abilities with regard to swimmers' perceptions of motivational climate and achievement goals. Several significant differences between developmental level and swimmers' perceptions of motivational climate were found.

In addition, there were significant differences between developmental level and swimmers achievement goals. Several implications for these findings are addressed such as how these findings may relate to persistence in sport and how coaches can address the changing climate and goals of the developing athlete.

### **One Year Follow-Up of a Physical Activity Based Positive Youth Development Program**

Ullrich-French, Sarah C., Washington State University; Meghan H. McDonough, Purdue University; Amanda J. Kraemer, Purdue University

Sport settings can be prime developmental contexts when key elements such as a positive social connection are fostered (Danish et al., 2005). The purpose of this study was to examine the long-term impact of an intervention designed to foster social connections on psychological outcomes. Participants included youth ( $n = 73$ , 47% female, 51% overweight/obese) who participated in a 4-week physical-activity based positive youth development (PYD) program for underserved youth during the summer of 2008, and who returned to the program in 2009. Questionnaires were administered at three time points (T1 = pre-program 2008, T2 = post-program 2008, T3 = pre-program 2009). Psychological variables assessed were perceived physical competence, global self-worth, physical self-worth, attraction to physical activity, and hope. A repeated measures multivariate analysis of variance was conducted to examine change across the three time-points on the study variables. There was a significant multivariate effect for time, Wilks's lambda = .61,  $F(10, 280) = 7.78$ ,  $p < .01$ , partial  $\eta^2 = .22$ . Follow-up univariate analyses showed effects for global self-worth ( $p < .01$ , partial  $\eta^2 = .28$ ) and hope ( $p < .05$ , partial  $\eta^2 = .07$ ). Pairwise comparisons of estimated marginal means were examined. Global self-worth increased from the beginning ( $M = 3.00$ ,  $SE = .06$ ) to the end ( $M = 3.31$ ,  $SE = .08$ ) of the 2008 program ( $p < .01$ ), and then decreased at the beginning ( $M = 2.78$ ,  $SE = .04$ ) of the 2009 program ( $p < .01$ ). Perceptions of hope were similarly high across the 2008 program, and increased ( $p < .05$ ) from the end of 2008 program ( $M = 4.48$ ,  $SE = .13$ ) to the beginning of 2009 program ( $M = 4.93$ ,  $SE = .18$ ). Examination of post 2009 program data will provide additional insight into long-term program implications. Maintaining regular contact with participants across the school year is recommended to maximize positive long-term impact of PYD programs.

### **Physical Activity Motivation and Behavior Across the Transition to University**

Ullrich-French, Sarah C, Washington State University; Matthew Bumpus, Washington State University

University freshmen experience freedom to make lifestyle decisions, either healthy or unhealthy. There is very little data that describes physical activity motivation and behavior across the transition to university. The purpose of this study was to describe how motivation regulations, defined by self-determination theory (SDT), and self-reported physical activity behavior change after entering university. Incoming freshmen were emailed an invitation to complete an online questionnaire in the late spring or early summer prior to entering university and again during the middle of the fall semester. Participants with complete data at both time points ( $n = 205$ ) were predominantly European American (72%) and female (68%) with an average age of 18.64 ( $SD = .30$ ). Questionnaires included reliable assessment of physical activity motivation regulations and self-report behavior. A repeated measures multivariate analysis of variance was conducted to examine change across the transition on physical activity motivation regulations and behavior. There was a significant multivariate effect for time, Wilks's lambda = .12,  $F(6, 199) = 2.53$ ,  $p < .01$ , partial  $\eta^2 = .88$ . Follow-up



univariate analyses showed decreases ( $p < .01$ ) of sizable magnitude for amotivation (partial  $\eta^2 = .64$ ), external regulation (partial  $\eta^2 = .66$ ), introjected regulation (partial  $\eta^2 = .44$ ), identified regulation (partial  $\eta^2 = .73$ ), and intrinsic motivation (partial  $\eta^2 = .61$ ) and a decrease ( $p < .05$ ) of marginal magnitude for physical activity behavior (partial  $\eta^2 = .03$ ). Additionally, physical activity post-entry was positively predicted ( $F(10, 196) = 6.25, p < .01, R^2 = .24$ ) by pre-university intrinsic motivation ( $p < .05$ ) and by identified and intrinsic motivation post-entry ( $p < .01$ ). Self-determined motivation predicted physical activity behavior, supporting SDT. The decrease in all motivation regulations and in physical activity behavior across the transition to university demonstrates this is an important period of time to further investigate.

### **Effects of an Acute Exercise on Cognitive Aspects of the Wisconsin Card Sorting Test**

Wang, Chun-Chih, National Taiwan Sport University; Yu-Kai Chang, National Taiwan Sport University; Feng-Tzu Chen, National Taiwan Sport University; Kang-Hao Lu, National Taiwan Sport University; Tzu-Hui Kuo, National Taiwan Sport University

The Wisconsin Card Sorting Test (WCST), a well known neuropsychological assessment, has been widely used for testing executive function, while very little research has been applied to exploring the effects of acute exercise on cognitive performance. Therefore, the primary purpose of this paper is to examine the effects of acute aerobic exercise on executive function using the WCST specifically. 22 College participants (age = 22.50 yrs,  $SD = 2.28$ ) were randomly assigned into either exercise condition ( $n = 12$ ) or control condition ( $n = 10$ ) groups, and were instructed to perform the WCST at baseline and immediately following the performances of the treatment. The exercise condition involved 30 minutes of ergometer cycling at a 60% heart rate reserve. A two-way mixed ANOVA was computed between conditions and times ( $2 \times 2$ ) on subcomponents of the WCST, separately. The results indicate that time factor has a significant main effect, but interaction fails to reveal a significant effect on subcomponents of the WCST. The findings suggest that exercise-related benefits might not be sensitive to the executive functions measured by WCST. Possible interpretations of the results are discussed.

### **Unsportsmanlike Aggression in Youth Hockey: Attitudes, Perceived Social Approval, Situational Temptation, and Role Models**

Weiss, Maureen R, University of Minnesota; Lindsay E Kipp, University of Minnesota; David Goodman, Simon Fraser University

Unsportsmanlike attitudes and actions in youth ice hockey are learned through modeling of and approval by significant adults and peers (Weiss, Smith, & Stuntz, 2008). The present study extended the knowledge base by assessing: (a) competitive league and gender differences on attitudes toward unsportsmanlike actions, (b) relationships between perceived approval by significant others and youths' attitudes toward unsportsmanlike actions, (c) whether specific hockey situations affect legitimacy of acting in unsportsmanlike ways, and (d) youth hockey players' NHL role models and whether type of model is related to youths' sportsmanlike attitudes. Youth hockey players (192 male, 86 female) representing atom ( $M = 10.9$  yrs), peewee ( $M = 12.6$  yrs), and bantam/midget ( $M = 14.8$  yrs) leagues read three scenarios about unsportsmanlike actions and responded to questions assessing legitimacy, intention, perceived social approval, and situation-specific legitimacy and intention of performing the actions. Analyses of variance showed that legitimacy and intention of engaging in unsportsmanlike acts increased with competitive league, as did perceptions of approval by best friend, team-

mates, coach, and parents. Male players scored higher than female players on legitimacy, intention, and best friend, teammate, and coach approval. Regression analyses revealed strong relationships between perceived social approval and unsportsmanlike attitudes, with best friend and teammate approval the strongest predictors. Of the hockey situations, players indicated they were most tempted to engage in unsportsmanlike behavior if it would help win the championship game and if one's opponent did it first. Chi-square analyses showed that players scoring in the upper 20% of legitimacy of unsportsmanlike actions were more likely than those in the lower 20% to name aggressive, fighter players as their NHL idols and less likely to name gentlemanly, skillful players. Results extend research on individual and social factors influencing endorsement of unsportsmanlike behaviors in youth ice hockey.

### **Application of the Sport Commitment Model to Strength and Conditioning**

Weiss, Windee M., University of Northern Iowa; Danae Halupnik, University of Northern Iowa

The Sport Commitment Model developed by Scanlan and colleagues (e.g., Scanlan et al., 1993) has been widely used to explore the determinants of not only commitment to sport, but also continued participation (Weiss & Weiss, 2006), training behaviours (Weiss & Weiss, 2003), and burnout tendencies (Raedeke, 1997). Research has also utilized (and found support for the use of) the Sport Commitment Model as a theoretical framework for examining commitment within other aspects of the "sport bubble" including: coaching (e.g., Raedeke et al., 2002) and officiating (Van Yperen, 1998). Thus, the purpose of this study was to examine commitment to strength and conditioning using the SCM as a theoretical framework. A total of 193 male and female intercollegiate athletes completed SCM measures designed to tap perceptions of strength and conditioning enjoyment, commitment, investments, attractive alternatives, social constraints, benefits, and costs. Simultaneous multiple regression analysis revealed that higher perceptions of strength and conditioning investments ( $\beta = .40$ ), enjoyment ( $\beta = .24$ ), and benefits ( $\beta = .11$ ), and lower perceived costs ( $\beta = -.11$ ) and attractive alternatives ( $\beta = -.22$ ) were related to higher strength and conditioning commitment. Multivariate analysis of variance also revealed several gender differences with males reporting higher strength and conditioning commitment, benefits, enjoyment, and best friend social constraints than females. Additionally, for males, higher enjoyment ( $\beta = .21$ ), investments ( $\beta = .46$ ), and best friend social constraints ( $\beta = .26$ ) and lower costs ( $\beta = -.15$ ) predicted higher strength and conditioning commitment, whereas for females higher enjoyment ( $\beta = .20$ ) and investments ( $\beta = .42$ ) and lower attractive alternatives ( $\beta = -.32$ ) predicted higher commitment. Findings from the current study are consistent with theoretical and empirical predictions within the competitive sport context. Future research should continue to explore the application of the SCM in other related aspects of sport.

### **An investigation of imaged meaning propositions to manipulate athletes' challenge-threat states**

Williams, Sarah E, University of Birmingham; Jennifer Cumming, University of Birmingham  
Based on Lang's bioinformational theory (1979), Williams, Cumming and Balanos (in press) altered the meaning propositions of a stress evoking imagery scenario to manipulate whether an athlete appraised the moments prior to hypothetical performance as a challenge or a threat. In turn, this appraisal influenced athletes' psychological responses and their perceptions regarding an upcoming performance. The purpose of this study was to extend Williams et al.'s findings to a real life performance setting by including a more comprehensive

assessment of psychological responses and examine subsequent effects on dart throwing performance. Seventy participants (40 male, 30 female, mean age = 19.31 years,  $SD = .53$ ) were randomly assigned to either challenge ( $n = 34$ ) or threat ( $n = 36$ ) imagery groups. Baseline measures were obtained for performance, stress appraisal, state anxiety, perceived control and predicted performance. Participants then listened to a stress evoking imagery script describing the moments immediately prior to performance and baseline measures were repeated. Results revealed that following imagery, the threat group perceived the dart throwing task as significantly more of a threat than the challenge group ( $p < .05$ ). Both groups experienced increased cognitive and somatic anxiety intensity, but the challenge group perceived these cognitive anxiety elevations to be significantly more facilitative to subsequent performance ( $p < .001$ ) and felt more in control of the situation ( $p < .05$ ). The threat imagery group also believed they would perform significantly worse after listening to the imagery script ( $p < .01$ ) compared to the challenge group. Despite these variations in psychological response between the groups, no differences in actual performance were found. The findings extend those of Williams et al. by demonstrating that imagery can be used to manipulate a challenge appraisal, which as a consequence leads to a more positive interpretation of competitive anxiety, greater perceived control and more positive predictions of an upcoming performance.

### **Assessing athletes' imagery ability: The development of the Sport Imagery Ability Questionnaire**

Williams, Sarah E, University of Birmingham; Jennifer Cumming, University of Birmingham

Screening athletes for their ability to image has become a standard procedure to include as part of imagery intervention studies (Cumming & Ramsey, 2008). Although these interventions generally involve imaging complex sport scenes, the most widely used imagery ability questionnaires only measure the ability to image simple movements (e.g., Movement Imagery Questionnaire-Revised; Hall & Martin, 1997). The purpose of this multi-studied paper was to develop a valid and reliable assessment of athletes' ability to generate different types of sport images called the Sport Imagery Ability Questionnaire (SIAQ). Three heterogeneous samples of male and female athletes, varying in age, sport and competitive level, rated their ease of imaging on a 7-point Likert type scale (1 = very hard to image, 7 = very easy to image). Study 1 consisted of 311 athletes (140 male, 171 female;  $M$  age = 25.22 years,  $SD = 8.88$ ), Study 2 involved 292 athletes (137 male, 155 female;  $M$  age = 24.79 years,  $SD = 9.31$ ), and 195 athletes (104 male, 91 female,  $M$  age = 19.46 years,  $SD = 1.27$ ) participated in Study 3. Principal axis factoring with oblimin rotation indicated the existence of four factors in Study 1 (skill, strategy, goal, and affect images). A confirmatory factor analysis (CFA) in Study 2 cross-validated these findings by demonstrating good fit of the data,  $\chi^2(48) = 79.69, p < .05, CFI = .97, TLI = .96, SRMR = .05, RMSEA = .05$  (90% CI = 0.03 - 0.07). In both studies, the results suggested the possibility of a fifth factor (mastery) but further item refinement was necessary. Following the inclusion of additional mastery items, a second CFA in Study 3 confirmed a 5-factor structure with a good fit,  $\chi^2(80) = 111.59, p < .05, CFI = .97, NNFI = .96, SRMR = .05, RMSEA = .05$  (90% CI = 0.02 - 0.07). Furthermore, significant correlations ( $p < .05$ ) between imagery ability and years of playing experience support the concurrent validity of the 15-item SIAQ. Overall, results support the validity of the SIAQ and its use as a comprehensive screening tool to assess athletes' imagery ability.

### **Sport friendship quality in adapted sport athletes: Do basic psychological needs matter?**

Wilson, Philip M, Brock University; Enrique G. Bengoechea, McGill University; Diane E. Mack, Brock University; Paige Gregson, Brock University; Samuel Rimmer, Brock University; Benjamin Sylvester, Brock University

Peers can play an important role in motivating sport involvement (Weiss & Smith, 1999) yet limited research has examined the factors posited to underpin the development of sport friendships in adapted sport athletes. The purpose of this study was to examine the utility of Basic Psychological Needs Theory (BPNT; Deci & Ryan, 2002) as a framework for understanding friendship quality in adapted sport athletes. Participants ( $n = 52$ ; 55.80% male) reporting either a congenital (41.50%) or acquired (58.50%) disability completed a self-report instrument on a single occasion. The instrument included indices of perceived competence (Ryan, 1982), autonomy (Gagne, 2003), and relatedness (Wilson & Garcia Bengoechea, 2007) experienced from adapted team sport involvement and the Sport Friendship Quality Scale (SFQS; Weiss & Smith, 1999) that served as an index of perceived friendship quality in sport. Simultaneous multiple regression models indicated that perceptions of psychological need satisfaction accounted for small-to-moderate amounts of the variance in the 5 SFQS constructs ( $R^2$  adj. values ranged from 0.06 to 0.25). Perceived relatedness was the dominant predictor of sport friendship quality irrespective of the SFSQ dimension investigated per regression model (betas ranged from 0.33 to 0.55) with the strongest association evident with SFSQ-Companionship and Pleasant Play and the weakest with SFSQ-Things in Common. Overall, these observations provide initial support for the potential role afforded to psychological needs central to BPNT within the realm of adapted sport as a vehicle for understanding sport friendships. It appears that perceived relatedness with fellow athletes in adapted sport contexts is a plausible route for developing secure friendships within the realm of adapted sport. The role afforded feelings of perceived autonomy and competence in terms of sport friendships experienced by adapted sport athletes remains unclear and worthy of investigation. Supported by the Social Sciences and Humanities Research Council of Canada

### **On the nature and function of scoring protocols used in exercise motivation research: An empirical study of the Behavioural Regulation in Exercise Questionnaire**

Wilson, Philip M, Brock University; Diane E Mack, Brock University; Chris M. Blanchard, Dalhousie University; Xie Bin, Xi'an Physical Education University; Susanna Cheung, Brock University

The Behavioral Regulation in Exercise Questionnaire (BREQ) is the instrument of choice in exercise motivation using Self-Determination Theory (SDT; Deci & Ryan, 2002). Several different scoring protocols for SDT-based instruments are evident (Vallerand et al., 2008) yet limited attention has focused on this aspect of construct validation with reference to the BREQ. The purpose of this study was to address two questions: (a) What are the implications of applying different scoring protocols to BREQ data for exercise motivation research?, (b) What procedure can be used to calculate internal consistency reliability when using a Relative Autonomy Index (RAI) derived as a weighted composite of BREQ scores? Participants across 3 different samples ( $n$ 's = 104-1200) completed the BREQ or BREQ-2 and estimates of leisure-time physical activity (LTPA). Reliability coefficients ranged from 0.72 to 0.94 across samples regardless of the scoring protocol applied to BREQ/BREQ-2 data with alpha-values of 0.84 to 0.89 noted for the RAI. Identified regulation (betas = 0.25 to 0.39) was consistently the strongest predictor of LTPA when BREQ subscales were modeled individually ( $R^2$  adj. = 0.09 to 0.30). Controlled motives negatively predicted LTPA in two of three samples (betas = -.05 to 0.10) with autonomous motives consistently predicting

greater LTPA (betas = 0.28 to 0.55). Using the RAI approach as the third scoring protocol revealed a noticeable decrement variance predicted in LTPA across samples compared with the other two scoring protocols ( $R^2$  adj. = 0.04 to 0.21; betas > 0.19). Overall, this study provides evidence supporting the tenability of three scoring protocols used with BREQ/BREQ-2 data in terms of links with LTPA that are consistent with Deci and Ryan's (2002) assertions and offers insight into the reliability of an RAI calculated from BREQ/BREQ-2 scores. The use of distinct scoring protocols appears central in terms of clarifying the role of identified regulation as a motive for exercise. Supported by the Social Sciences and Humanities Research Council of Canada

**'Just to See How Little She Did Was Shocking': Cues Leading to Parental Social Control During Declines in Adolescent Physical Activity.**

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Adolescence is a period when activity declines (Belanger et al., 2009). How both parents and adolescents perceive and react to such declines is important to understand. Parental social control (e.g., parental regulation) has been linked to lapses (Wilson & Spink, 2007), but little is known about what cues parents and adolescents use to react to these declines. This study explored perceived declines in adolescents' activity among parent-adolescent dyads and factors that cue reactions from adolescents and parents (i.e., use social control). A multiple case study design (Stake, 2006) was employed where six parent-adolescent (age 12-14) dyads were interviewed using a semi-structured format (a) as a dyad and (b) as individuals. Interviews as dyads were conducted to identify and discuss a decline, and as individuals to discuss cues that parents and adolescents use to react to this decline. Transcripts were first analyzed for themes within dyads and then a cross-case analysis was used to identify across-dyad themes (Stake, 2006). Two perspectives of these declines emerged: (1) adolescent was viewed as being unmotivated and spending time watching TV or on the computer, (2) adolescent was viewed as still physically active, but at a lower level, and the decline was perceived as rejuvenating after a busy schedule, with knowledge that activity level would resume in the future. Dyads reported that feeling bored or tired cued adolescents to react to the decline especially those from the second perspective. These cues translated into physical activities for adolescents from the second perspective while led to less active alternatives for adolescents from the first perspective. In terms of the parents' reaction, dyads from the first perspective discussed more efforts by the parents to exert social control than the second perspective. Dyads from both perspectives reported that parents cued and acted when viewing the adolescent as being engaged in sedentary activities. Results will be discussed in the context of Lewis and Butterfield's (2005) conceptual model of social control.

**Self-regulatory efficacy and activity: Examining gradations of challenge**

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Consistent with Bandura's (2004) suggestion that self-efficacy (SE) beliefs should be measured against gradations of challenges to successful performance, recent research has revealed a strong relationship between SE and exercise intentions for students during exams, a time when students have additional impediments to surmount in their attempts to be active (Spink & Nickel, 2010). Given that only one time period was used in that study, comparative statements about the relative strength of SE both inside and outside times of significant

challenge cannot be made. The purpose of this study was to examine the association of self-regulatory efficacy for scheduling (SRE) and physical activity (PA) during two periods in a school year that had different scheduling demands – October (high scheduling, HS) and May (lower scheduling, LS). We hypothesized that a stronger relationship would emerge between SRE and PA during the HS versus LS periods. A prospective design was used wherein high school students ( $n = 275$ ) completed measures of SRE once and PA (MAQ-A; Kriska, et al., 1990) twice for each time period. To verify that the periods differed, a greater number ( $ES = .32, p < .001$ ) and frequency ( $ES = .32, p < .001$ ) of organized physical activities, a greater homework load ( $ES = .22, p < .001$ ) and a higher frequency of perceived barriers ( $ES = .11, p = .07$ ) were reported during the HS versus the LS period. Hierarchical multiple regressions were used to evaluate the relationship between SRE and PA, controlling for previous PA on the first step as suggested by Weinstein (2007). Results revealed that the addition of SRE significantly added to the prediction of previous PA,  $R^2$  change = .03,  $F(1,272) = 16.58, p < .001$ , with previous PA (beta = .59,  $p < .001$ ) and SRE (beta = .20,  $p < .001$ ) predicting PA in the HS period. The same analysis for the LS period revealed that the addition of SRE did not add anything above previous PA,  $R^2$  change = .004,  $F(1,272) = 1.5, p = .22$ . These findings support Bandura's (2004) assertion that SRE is more important in predicting PA in the face of greater versus lesser challenges.

### **Psychological Skill Use in Adolescents: Exploring Structural and Temporal Validity of the TOPS**

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The Test of Performance Strategies (TOPS, Thomas, Murphy, and Hardy, 1999) is one of the most popular questionnaires in sport psychology to measure athletes' mental skill use. However, doubts concerning the instrument's appropriateness for adolescent athletes have limited its use within this population (Lane, Harwood, Terry, & Karageorghis, 2004). Moreover, the stability of the TOPS has yet to be discerned despite it being used to establish pre to post intervention changes in mental skill use. The aim of the present study was to re-examine and validate the TOPS to measure psychological skill use over a season long mental skills training program for adolescent athletes. Following a needs analysis of the target population (Holland, Woodcock, Cumming, & Duda, 2010), 469 British athletes (321 male and 148 female,  $M$  age = 15.36 yrs,  $SD = 1.22$ ) completed a reduced 10 subscale version of the TOPS. The structural validity of a practice and a competition 5-factor model was tested using confirmatory factor analysis (CFA). For practice, goodness of fit indices failed to reach acceptable cut-off limits suggesting a poor model fit ( $\chi^2(160) = 649.89, p > .001$ , SRMA = .11, TLI = .80, CFI = .83, RMSEA = .08). For competition, only adequate support was found in the case of indices reflecting comparative fit to the baseline model signifying potential for improvement ( $\chi^2(160) = 411.00, p > .001$ , SRMA = 0.06, TLI = 0.90, CFI = 0.92, RMSEA = 0.06). Both models were respecified and acceptable fit emerged. Gender and competitive level differences in subscale scores were examined. The predictive validity of the modified measure of psychological skill use was determined in terms of competitive trait anxiety and confidence. Finally test-retest reliability was assessed on a subsample of 29 athletes over 3 months. All subscales revealed poor to moderate intraclass correlation coefficients ranging from .25 to .70. Findings are discussed in relation to previous literature exploring the psychometric properties of the TOPS.

### **Children's peer status and psychological make-up in physical education**

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The purpose of this study was to examine the differences in ability expectancy, required effort, enjoyment, and physical, social, and moral self-concepts of children with different peer status in physical education class. Participants of this study were 229 students from three primary schools (128 boys, 101 girls, grade 4th to 6th) from Taiwan. Peer status was assessed by way of peer nomination in which each participant were asked to nominate three classmates he/she liked most (positive nomination) as well as those he/she like least (negative nomination). The sum of the number of positive and negative nominations showed the individual's social impact (SI). On the other hand, the difference of the number of positive and negative nominations showed the individual's social preference (SP). According to Coie, Dodge, and Coppotelli (1982), five different types of peer status could be identified based on the combinations of different levels of SI and SP, namely, popular, rejected, average, neglected, and controversial. MANOVA found that children with different peer status were significantly different in ability expectancy, and physical and social self-concepts. Post-hoc LSDs showed that the popular and the controversial had higher ability expectancy than the rejected, average, and neglected. The popular, rejected, and average had higher physical self-concept than the neglected. Finally, in terms of social self-concept, the popular were higher than the rejected and neglected. According to these findings, more attention should be given to not only those who are rejected but also those who are neglected socially in physical education class.

### **The Prediction of Sport Commitment in Athletes with Physical Disabilities**

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The purpose of this study was to examine if friendship quality and external rewards were significant predictors of two types of sport commitment (i.e., want to and have to) in athletes with physical disabilities, while enjoyment and perceived competence had been control for. Participants were 149 athletes with physical disabilities from Taiwan (95 males, 54 females, age 15-62,  $M = 38.34$ ,  $SD = 12.60$ ). Two multiple hierarchical regression analyses were conducted for both types of sport commitment. In each analysis, enjoyment and perceived competence entered first, following by friendship quality and external rewards. For the "want to" commitment, enjoyment and perceived competence significantly account for 66% of variance. Addition of friendship quality and external rewards showed a significant but very weak improvement of variance explained (0.9%), with friendship quality being the only significant contributor. For the "have to" commitment, on the other hand, enjoyment and perceived competence were not significant predictors. However, addition of friendship quality and external rewards significantly improved 21% of variance explained, but only external rewards was the only significant contributor. It appears that, for athletes with physical disabilities, enjoyment and perceived competence are two major antecedents of "want to" commitment as found in ath from a normal population. In addition, external rewards is also a major antecedent of "have to" commitment which we need to consider.

### **Towards Understanding the Effects of Psychological Copying Ability on Mental Toughness in Basketball Players**

Yen, Shih-Hsien, National Taiwan Sport University; Yu-Kai Chang, National Taiwan Sport University; Tzu-Hui Kuo, National Taiwan Sport University; Mu-Cheng Chin, National Taiwan Sport University

Despite the fact that the term “mental toughness” has been widely used by various athletic performers, related research on this concept has only recently received serious attention. Issues of possible antecedents and specific sports types should be examined for further understanding. Therefore, the purpose of this paper is to explore the potential antecedents of psychological copying abilities regarding mental toughness among basketball players in Taiwan. Participants included 546 basketball athletes with different ranks from the amateur college level to the national professional level. The Trait Mental Toughness Inventory of Sport (TMTIS) with 3 subscales and the Athletic Coping Skills Inventory-28 (ACSI-28) with 7 subscales were used for assessing mental toughness and psychological copying ability, specifically. Multiple regression was computed for the subscale of psychological copying ability on mental toughness and multiple hierarchical multiple regression was computed for additional athletic variables concerning mental toughness. The results indicated that achievement motivation, coachability, freedom from worry, and goal setting significantly predict positive efforts; coping with adversity, peaking under pressure, freedom from worry, and concentration predict significantly anti-pressure; and achievement motivation, coachability, and freedom from worry predict significantly endurance. In addition, along with specific psychological coping abilities, achievement levels in athletic variables predict mental toughness. In conclusion, subcomponents of mental toughness might be influenced by specific antecedents of copying abilities, and future research on these issues is warranted for determining practical implications.

### **Physical Self-Efficacy, Goal Orientation and the Degree of Participation for Physical Activity**

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Two empirical studies were conducted. In the first study, preliminary validation of Physical Self-Efficacy Scale (PSE, Ryckman, Robbins, Thornton, & Cantrell, 1982) was explored with exploratory factor analysis in Chinese cultural. The results indicated that the PSE showed some difficulty in cross-cultural adaptation. In study two, 884 the undergraduate were administered PSE (Chinese version), the Task and Ego Orientation in Sport Questionnaire (TEOSQ, Duda & Nicholls, 1992) and the Degree of Participation Inventory. A MANOVA revealed “gender” as having main effect on Physical Self-Efficacy. No differences were founded between junior and senior in Physical Self-Efficacy. No differences were founded in Ego and Task orientation between male and female. The significant main effects of grade were founded in different orientation. Partial-correlation revealed that physical self-efficacy was the closest variable with degree of physical exercise among others’. Structure Equation Model revealed that Physical self-efficacy was a strong predictor of physical activity. Moreover, Physical Self-Efficacy has influence on degree of physical exercise through task orientation rather than ego Orientation.

### **The Effect of Positive Emotions on Broadening Scope of Attention and Negative Arousal Undoing in Sport**

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The purpose of this study was to examine the broaden hypothesis and undo hypothesis of the Broaden-and-Build theory in sport. This study included two experiments. Experiment 1 examined how positive emotions affect athletes' scope of attention. Forty Division III collegiate basketball players were recruited to participate in the experiment. Participants were randomly assigned to positive emotion group, negative emotion group and neutral emotion group. These three groups were manipulated by watching different films in order to evoke respective emotions. One-way ANOVA were used to compare the difference on the scope of attention between groups. Results indicated that no significant difference between different emotion groups, and the results didn't support the broaden hypothesis in the sport domain. Experiment 2 examined the undo effect of positive emotion. Fifty-six senior high school student-athletes were recruited to participate in the experiment. Prior to the emotion manipulation, Participants were received a manipulation which evoke negative arousal. The heart rate recovery time was recorded by polar watch simultaneously. One-way ANOVA were used to compare the difference of heart rate recovery duration between groups. Results indicated that participants who were in positive emotion group had shorter time to recover their heart rate from negative arousal state to resting heart rate. The results supported the undo hypothesis in sport domain. Based on the results of this study, the discussion, implications, applications and future directions are also proposed.

### **The Relationship Between Reaction Time and EEG Activity in a Cued Reaction Time Task**

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In view of the fact that previous studies have examined the relationship between EEG frequency and reaction time prior to the onset of imperative signals, this study attempted to further examine EEG activity before a warning signal. Twenty-six pre-elite table tennis players in Taiwan were recruited and were requested to perform a cued reaction time task. Their performance was subsequently classified into three performance categories based on individual reaction time (RT). Fast RT (FRT) were trials with RT shorter than 1 *SD* while slow RT (SRT) were those longer than 1 *SD*. Those within 1 *SD* from the mean were the median RT (MRT). Four EEG epochs were segmented, one epoch of 500 ms before the warning signal and three epochs of 500 ms between the warning and the imperative signal. Several 3(RT performance) × 4(epoch) × 5(lobe) ANOVAs with repeated measures were utilized to examine the relationship between RT performance and EEG activity of theta, alpha-1, alpha-2, and beta-1. The results showed that alpha-2 was significant higher for FRT and MRT than SRT prior to the S1 signal in all brain regions. However, no such difference was observed among theta, alpha-1, and beta. For the S2 period, there was an interaction among FRT, MRT, and SRT in all brain regions. FRT maintained a relatively higher alpha-2 power prior to the S2, MRT stably declined when approaching the S2, and SRT held a relatively lower alpha-2 power prior to the S2. Alpha-2 has been related to task-specific and a state of inhibition. The different pattern of alpha-2 before the imperative stimulus among the three RT performances suggests that inhibition of the brain affects RT performance. The comparatively higher S2 prior to the imperative stimulus in FRT implies that inhibition of the brain is conducive to quick response. These findings may have some implications for sports requiring fast response.

**The Effect of 16 weeks of Different Athletic Activities on Students' Adjustment.**

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According to importance of compatibility and complicated relation of bodily and physiological adjustment with psychological adjustment and its effect on athletic success and progress, aim of this study was the effect of 16 weeks different athletic activities (endurance, speed and power) on students adjustment. This study included all boy students selected general physical education. Statistical sample involved 4 groups, each 20 people (witness group, power, endurance and speed groups) selected randomly ( $n = 20$ ). This study has been performed as field-descriptive method and investigates factors of personality characteristics using questionnaire. This study performed as pretest-posttest. Measurement tool of this study is questionnaire of athletic personality. One of measurement factors in this questionnaire is adjustment. The reliability of this questionnaire based on criterion reliability and examined by questionnaire that obtained value was equal and significant in  $p < 0.05$  level. Its stability obtained 0.800 by alpha Cronbach and was significant in  $p < 0.05$  level. After selecting sample people randomly, the questionnaires were given to subjects as pretest and gathered after completing. The subjects were divided into four groups. Athletic groups did regular and predesigned activities for 16 weeks, every week 3 sessions and every session 2 hours. The subjects recompleted questionnaires after 16 weeks activities that were considered as posttest. The results of the study showed that after 16 weeks athletic activity, is significant difference between adjustment of athletes and non-athletes. The results of study showed that 16 weeks athletic activity of endurance, speed and power has significant effect on adjustment of athletes and there is significant difference between athletes. According to the results, athletic activity increases adjustment. So, speed activities have more effect on the increase of adjustment; therefore, athletic trainers and teachers are recommended to consider speed activities in order to increase adjustment in athletes more effectively and quickly.