

# 7th Annual Meeting of Expertise and Skill Acquisition Network (ESAN)



Hosted by

Coventry University

Wednesday 24<sup>th</sup> May and Thursday 25<sup>th</sup> May, 2017

## *Book of Abstracts*

Wednesday 24<sup>th</sup> May, afternoon

12:30-13:00: **Arrival**

13:00-13:15: **Opening Statement and ESAN update (Nick Smeeton, *University of Brighton*)**

13:15-14:30: **Oral presentations**

### **Identifying the minimal essential information underpinning familiarity detection in dynamic displays containing multiple objects**

Jamie S. North<sup>1</sup>, Ed Hope<sup>2</sup>, A. Mark Williams<sup>3</sup>

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We examined the minimal essential information that is required to successfully recognize patterns in stimuli consisting of multiple dynamic objects. Skilled and less-skilled participants were presented with point light display sequences representing dynamic patterns in an invasion sport and subsequently required to make familiarity based recognition judgments in three different conditions, each of which contained only a select number of features that were present in the initial viewing. No differences in recognition accuracy were observed between skilled and less-skilled participants when just objects located in the periphery were presented. Yet, when presented with just the relative motions of two centrally located attacking objects, skilled participants were significantly more accurate than less-skilled participants and their recognition accuracy improved further when a target object was included against which these relative motions could be judged. Skilled participants can perceive and recognize global patterns on the basis of localized relational information. It is the relative motion between centrally located objects that represents the minimal essential information required to recognize patterns in dynamic displays containing multiple objects.

## **Context and Cognitive Load in Anticipation Skill: A Novel Application of Cognitive Load Theory**

Oliver R. Runswick<sup>1</sup>, André Roca<sup>1</sup>, A. Mark Williams<sup>2</sup>, Neil E. Bezodis<sup>3</sup>, Allistair McRobert<sup>4</sup> Jamie S. North<sup>1</sup>

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The ability to anticipate is essential when performing under severe time constraints. Sports performers use kinematic information from opponents' movements and contextual information (e.g., score, field positions) to facilitate anticipation. We test predictions of Cognitive Load Theory (CLT; Sweller, 1988), which has rarely been applied to perceptual-cognitive skill, to investigate the relative importance of these two information sources and explore how context may affect cognitive load in different performers. Nine skilled and nine novice cricket batters faced bowlers on a life-size screen in four conditions that manipulated access to context and a secondary task. Trials were occluded immediately prior to ball release and anticipation accuracy was measured from scaled predictions of ball location (McRobert et al., 2009). Secondary task performance, verbal reports, and mental effort scores were recorded. Skilled batters showed better anticipation accuracy ( $p < 0.05$ ) and both groups performed better with context ( $p < 0.05$ ). In dual task conditions, both groups showed an increase in mental effort scores but improved anticipation accuracy (both  $p < 0.05$ ), while secondary task performance was maintained ( $p > 0.05$ ). Verbal reports revealed both groups relied upon kinematic information in the absence of context. When context was provided, skilled performers reported statements relating to sequencing and game information in addition to kinematic information, while both groups reported using information concerning opponent positioning. Findings add to the understanding of the role context plays in skilled anticipation and suggest that CLT may not apply to performance in dynamic perceptual-cognitive skills.

## **Anticipating the Intentions of Others in Soccer: The Impact of Probabilistic Information**

N. Viktor Gredin<sup>1\*</sup>; Daniel T. Bishop<sup>1</sup>; David P. Broadbent<sup>1</sup>; A. Mark Williams<sup>2</sup>

<sup>1</sup> *Brunel University London, UK*

<sup>2</sup> *University of Utah, USA*

Currently there is little evidence of how contextual and kinematic information influences anticipatory behaviour and no understanding of when and how the different sources of information enter anticipatory behavioural processes (Cañal-Bruland & Mann, 2015). We examined the impact of probabilistic information on skilled and less skilled soccer players' anticipatory performance and attentional allocation. Sixteen skilled and 15 less skilled soccer players viewed video simulations of 2-vs-2 counterattacking situations from a defensive first-person perspective. Response time and response accuracy, as well as gaze behaviour and expectation accuracy across a trial, was compared on trials where probabilistic information about the opponents' final action was provided, to trials where no additional information was given. When the final action was congruent with the information presented, probabilistic information enhanced both skilled and less skilled players' anticipatory performance. During incongruent trials, probabilistic information was detrimental for less skilled, but not skilled players. Early in the trial skilled players allocated their visual attention towards the players off the ball to a greater extent when probabilistic information was provided. This in turn biased the skilled players' expectation accuracy. Importantly though, the skilled players were able to utilise kinematic cues in the final stage of the trial to update their pre-held expectations and negate the detrimental effect of probabilistic

information on incongruent trials. This effect was not found for less skilled players. These novel findings provide the first insight in to how contextual information is integrated with kinematic information to guide anticipatory behaviour for skilled and less skilled athletes.

### **The impact of probabilistic information and anxiety on performance effectiveness and processing efficiencies in a soccer-based anticipation task**

David P. Broadbent<sup>1\*</sup>; N. Viktor Gredin<sup>1</sup>; Jason Rye<sup>1</sup>; A. Mark Williams<sup>2</sup>; Daniel T. Bishop<sup>1</sup>

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It is now widely accepted among coaches and athletes that statistics provided by performance analysts form an integral part of the coaching process; for example, probabilistic information relating to an opponent's action preferences (Carling et al., 2014). However, relatively little is known about the impact of such information on athletes' perceptual skills (Cañal-Bruland & Mann, 2015). Moreover, even less is known about the impact of anxiety on the use of probabilistic information (Nieuwenhuys & Oudejans, 2012). The current study examined the combined impact of probabilistic information and anxiety on performance effectiveness and processing efficiencies during a video-based soccer anticipation task. 12 high-skilled soccer players were required to predict the direction of an oncoming opponent's run (left/right) in a 2-vs.-2 soccer scenario. Performance effectiveness (response accuracy) and processing efficiency (response accuracy divided by cognitive effort) was measured under four conditions: no probabilistic information (PI) and low anxiety (LA), no PI and high anxiety (HA), PI and LA, and PI and HA. PI was provided in the form of the percentage likelihood of an opponent's upcoming action. While PI did not affect processing efficiency, it was beneficial to performance effectiveness for congruent actions, but detrimental to incongruent actions. Processing efficiency was impaired under HA conditions, but contrary to predictions this did not interact with PI. Furthermore performance effectiveness was not affected when PI and HA were combined compared to the other conditions. Findings will be presented with regards to both the applied and theoretical implications.

14:30-15:00: **Break**

15:00-16:30: **Oral presentations**

### **The Role of Deliberate Practice and Sampling for Talent Identification in Professional Academy Football: The early preparation concept**

Kelly, A., Williams, C. A., Wilson, M.

*University of Exeter, UK.*

With the capability of professional football Academies signing players as young as eight years of age, current theories offer limited practical suggestions around this contemporary process. Thus, the aim of this research is to offer an alternative concept that is appropriate for both the development of elite youth football players and professional Academies. Ninety-eight outfield Academy players were split into the Foundation Development Phase (FDP; age 8 to 11 years;  $n=40$ ) and the Youth Development Phase (YDP; age 12 to 16 years;  $n=58$ ). They each completed a Participation History Questionnaire which produced eight different variables including started football age, started Academy age, total match hours, total coach-led hours, total individual practice hours, total

peer-led play hours, total sports played, and total multi-sports hours. Results were standardised using Z-scores to allow an unbiased grouping, with assumptions tested by examining high- and low-performers within the FDP and YDP using a two-tailed independent samples *t*-test. In the FDP, high-performers participated in significantly more coach-led hours compared to low-performers ( $p=.037$ ). Within the YDP, high-performers participated in significantly more match-play hours ( $p=.011$ ) and multi-sports hours ( $p=.044$ ) compared to low-performers. The 'early preparation' concept supports elite youth football players to invest in significant time specialising in football at a young age, while continuing to gain additional appropriate developmental skills through sampling other sports.

### **A database analysis of the youth sport system in United Kingdom track and field athletics**

Philip Kearney

*University of Chichester, UK*

Databases which host performance records for athletes may provide a wealth of information for sport scientists interested in talent development. This study examined an on-line United Kingdom athletics database for (i) information relating to the age grade at which top ranked senior athletes had first achieved success, (ii) the relationship between performances at the various age grades (Under 13–Under 20) and senior performance, (iii) the extent to which current U13 and U15 athletes were meeting UK Athletics' Run-Jump-Throw agenda (i.e., early diversification), and (iv) the existence of relative age effects (RAEs) across age grades, disciplines, and performance level. Results showed that only at U17 were the majority of current top ranked senior athletes present on the national age grade rankings. Correlations between performances at various age grades were weak to moderate. Specialisation within a single discipline by U13/U15 was relatively rare, with 0-38% athletes competing within one event group only. Depending on discipline, 28-73% of U13/U15 athletes met the Run-Jump-Throw criterion for diversification. An over-representation of athletes born in the first quarter of the year was evident in 86/90 contexts examined (Cohen's  $w$  ranged from 0.1-0.62). RAEs were more pronounced in males relative to females, in top ranked athletes, and weakest in middle distance events. The primary concern raised by this investigation is RAEs. As such, phase two of this project is surveying coaches, athletes and parents to establish whether stakeholders are aware of these RAEs, and if so, what actions they are taking to mitigate their effects.

### **The effect of action observation and motor imagery on performance of target performance**

Stephanie Romano Smith<sup>1</sup>, Caroline Wakefield<sup>1</sup>, Greg Wood<sup>2</sup>

<sup>1</sup> *Liverpool Hope University, UK*

<sup>2</sup> *Manchester Metropolitan University, UK*

Motor imagery (MI) and action observation (AO) are techniques that have been shown to be effective for enhancing motor skill learning. While both techniques have been used independently, recent research has begun to employ combined AO and MI interventions (AOMI) to investigate the potential effects on motor skill learning. However, little is known about the most effective way to combine these techniques. This study examined the effects of simultaneous and alternative AOMI combinations on motor skill learning in a dart-throwing task. Participants ( $n=50$ ) were randomly allocated to one of five training groups: action observation (AO), motor imagery (MI), simultaneous action observation and motor imagery (S-AOMI), alternate action observation and motor imagery (A-AOMI) and a control group. Interventions were conducted three times per week for six weeks and pre and post measures of radial error were collected. Results revealed that all conditions

except for control and AO significantly improved performance following the intervention. Post hoc analyses showed that S-AOMI group improved to a significantly greater degree than the MI and AO groups. Furthermore, participants in the A-AOMI group improved to a significantly greater degree than the AO group. Lastly, participants in the A-AOMI and S-AOMI, groups improved significantly compared to the control condition, but participants in the MI and AO conditions did not. These findings have important implications for the design of motor learning strategies, as encouraging performers to engage in simultaneous and alternate motor imagery and action observation may be the optimal method for motor stimulation.

## **Visual attention and neural co-activation reflect conscious processing during prosthetic hand use, but only during object manipulations**

Parr, JVV<sup>1</sup>., Harrison, NR<sup>2</sup>., Vine, SJ<sup>3</sup>., Wilson, MR<sup>3</sup>., & Wood, G<sup>4</sup>.

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Prosthetic hand devices are often poorly utilised and frequently rejected. High rejection rates have been attributed to the high cognitive burden that these devices impose on the user. Here, we investigated the nature of this burden by simultaneously examining gaze behaviour and EEG coherence between the verbal-analytical (T7) and motor planning (Fz) regions in able-bodied participants using a prosthetic hand simulator. Twenty participants were required to perform 30 trials of the “lifting a heavy object” task from the Southampton Hand Assessment Procedure (SHAP) using their anatomical hand and a myoelectric prosthesis simulator. During performance, gaze behaviour was recorded to determine the spatial (target locking strategies) and temporal (gaze-shifting) characteristics of visual attention. EEG was also recorded to compute T7-Fz coherence for the high-alpha (10-12Hz) bandwidth to determine the extent of conscious movement control during the reaching and grasping phases of the task. Participants were significantly slower, used more hand-focused gaze and exhibited significant delays in the time to disengage vision from hand movements when using the prosthetic simulator. These disruptions were multiplied during the manipulation of the jar. The dependence on vision during the manipulation phase coincided with increased T7-Fz coherence, suggesting conscious movement control during this movement phase. Findings suggest a link between increased visual attention and verbal-analytical processing is related to the cognitive burden associated with prosthetic hand rejection. These metrics can now be used to test the efficacy of rehabilitation strategies and may inform hand prosthesis design.

16:30-17:00: **Break**

17:00-18:00: **Annual General Meeting (AGM)**

18:30: **Social Event** **Drapers Bar, CV1 5RU**

**Thursday 25<sup>th</sup> May, all day**

9:00-9:30: **Arrival**

9:30-9:45: **Introduction (Nick Smeeton, University of Brighton)**

9:45-10:45: *Keynote speaker:* **Prof. Geert Savelsbergh, Vrije University, Netherlands**

*'Athletic Skills Model: A new innovative programme for optimizing talent development'*

Today's generation kids are significantly less fit than their peers who lived thirty years ago. Due to limited physical education at school, children have a limited motor development. For this reason it is important to invest in movement experience of these children. However, training and development of young athletes is a complicated process. In a study amongst Olympic athletes researchers looked for trends in the development from child to Olympic athlete. Almost all of the athletes were involved in *different sports* when they were young before they start to specialize in one or two sports (late specialization approach). However, early engagement in a sport and thus training of specific technical aspects of that particular is suggested will lead to superior techniques at a later age. The Athletic Skills Model (ASM) aims to combine these two approaches and is about wellbeing, health, and talent development of children and adolescents to adults, and the aims of optimal balance between performance and health. Both scientific findings and practical professional experience is the foundation of this evidence-based model. The ASM helps athletes and children to improve their physical intelligence by engaging them in structured and varied movement program. The ASM aims for the following development: first one should become an all-round, good mover; this good mover will develop into an athlete; this athlete will specialize in one sport; finally, the athlete will develop into a specialist within his sport. The ASM approach will lead to fitter players with a longer athletic life because they have lesser injuries and more career opportunities. Adaptation and variation are fundamental key concepts of this approach.

10:45-11:15: **Keynote discussion**

11:15-11:30: **Break**

11:30-13:00: ***Symposium 1: The dynamic and multifaceted development of expertise***

**The Relative Age Effect: If you want to be 'super elite' Mum and Dad better get hot in May...**

Benjamin D. Jones, Gavin P. Lawrence, & Lew Hardy

*Institute for Psychology of Elite Performance, Bangor University, UK*

Within sport, the relative age effect (RAE) describes an overrepresentation of players born early (Q1) in a selection year and is highly prevalent within youth sport pathways. This effect is generally shown to dissipate at senior-elite level, and a dearth of research has investigated the RAE at the 'super-elite' level. The present research assessed the presence of RAE in 'super-elite' performers. Study 1 investigated RAE in the world's best international Test cricketers ( $N = 262$ ) over a 20 year period according to a robust and stringent 'super-elite' criteria. Results revealed an overall RAE (Q1) when all disciplines were combined. Upon closer examination, this effect was also observed for the batting and spin bowling disciplines, whereas no RAE was found for the

pace bowling discipline. Study 2 investigated RAE in super-elite rugby union players ( $N = 691$ ) over a 20 year period. Results revealed the RAE for backs (Q1) and a reversal of the traditional RAE (Q4) for forwards, and when all rugby union positions were combined. These findings provide new evidence of RAEs at the super-elite level and present both inter and intra sports differences. Potential explanations for these findings are explored, owing to the *survival* and *evolution* of the fittest concepts, and the implications for future research and applied practice are presented.

## **The Developmental History of Elite Spin Bowlers: 12 Game-Changers**

Benjamin D. Jones<sup>1</sup>, Gavin P. Lawrence<sup>1</sup>, Lew Hardy<sup>1</sup>, Peter Such<sup>2</sup>, Raphael Brandon<sup>2</sup>, Ludmila Kuncheva<sup>3</sup>, & David Mann<sup>4</sup>

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This novel study applied pattern recognition machine learning software to identify the precursors of expertise development that discriminated between elite and sub-elite English cricket spin bowlers. Previous expertise research has relied on linear analysis methods to examine the development of expertise factors, often assessing statistical differences between isolated variables, e.g. deliberate practice hours (Ericsson, Krampe & Tesch-Römer, 1993). In the present study, non-linear pattern recognition analysis of quantitative data obtained from structured interviews revealed 12 factors of development that discriminated between the elite and sub-elite, out of a possible 144 factors, with 96.4% accuracy. The findings are indicative of a non-linear developmental pathway to spin bowling expertise, encompassing: Initial Cricket Development; Cricket Developmental Milestones; Cricket Developmental Practice; Cricket Pathway Performance Indicators, which may explain why previous studies, confined to linear analytical methods, have overlooked the dynamic nature of expertise development. The factor model's discriminant validity was further demonstrated by its successful prediction of the expertise group of an unseen elite spin bowler thereby extending support for its applied value. To the best of our knowledge, this is the first time that pattern recognition analysis has appeared in talent research in the public domain. Such methods allow a concurrent investigation of the holistic and dynamic nature of expertise development, and have much to commend them, especially for “wide, shallow” data sets such as those found in talent research.

### **Expertise Development in Practice**

Vicky M. Gottwald

*Institute for Psychology of Elite Performance, Bangor University, UK*

This presentation will focus on expertise development from an applied perspective. With a growing body of literature informing talent development, there remains a need to bridge the gap between theoretical underpinnings and practical application. The presentation will cover some key areas of talent development in practice within Welsh Basketball for example, applying selection criteria that don't favour athletes born earlier in the year, selecting athletes for national team programmes whilst not encouraging early specialisation, ensuring athletes are provided with sufficient challenge to nurture psychological characteristics important for development and creating environments, which foster both mastery and ego orientations.

13:00-14:30: **Lunch, Posters and Networking**

14:30-16:00: **Symposium 2: The neural underpinnings of motor skill acquisition: An electroencephalographic perspective (Introduction from Chair, Christopher Ring<sup>2</sup>)**

**Electroencephalographic high-alpha power and connectivity distinguish experts from novices and successful from unsuccessful golf putts**

Andrew Cooke<sup>1</sup>, Germano Gallicchio<sup>2</sup> & Christopher Ring<sup>2</sup>

<sup>1</sup> *Institute for Psychology of Elite Performance, Bangor University, UK*

<sup>2</sup> *School of Sport, Exercise & Rehabilitation Sciences, University of Birmingham, UK*

This study aimed to shed light on the neurophysiological processes that support expertise and successful motor performance. Ten expert and ten novice golfers completed 120 putts while EEG high-alpha power and connectivity were recorded and analysed as a function experience (experts versus novices) and performance (holed versus missed putts). Results revealed that in the final seconds preceding movement, experts displayed a greater reduction in high-alpha power, and less left-frontotemporal connectivity, when compared to novices. Premovement brain activity also distinguished holed from missed putts; brain activity preceding holed putts resembled the expert-like pattern described above. Our findings suggest that expertise and successful movement outcomes in golf are characterised by increased resources allocated to motor response programming, along with the concurrent suppression of verbal-analytic processes.

**Practice makes efficient: Effects of golf practice on brain activity**

Germano Gallicchio<sup>2</sup>, Andrew Cooke<sup>1</sup> & Christopher Ring<sup>2</sup>

<sup>1</sup> *Institute for Psychology of Elite Performance, Bangor University, UK*

<sup>2</sup> *School of Sport, Exercise & Rehabilitation Sciences, University of Birmingham, UK*

This study employed a test-retest design to examine changes in brain activity associated with practice of a motor skill. We recorded EEG activity from twelve right-handed recreational golfers (mean handicap: 23) as they putted 50 balls to a 2.4m distant hole, before and after a 3-day practice. We measured changes in putting performance, conscious processing, and regional EEG alpha activity. Putting performance improved and conscious processing decreased after practice. Mediation analyses revealed that performance improvements were associated with changes in EEG alpha, whereby activity in task-irrelevant cortical regions (temporal regions) was inhibited and functionally isolated from activity in task-relevant regions (central regions). These findings provide evidence for the development of greater neurophysiological efficiency with practice of a motor skill.

**The mosaic of reinvestment: motor chunks, conscious processing, and EEG activity during sequence acquisition and performance under pressure**

Eduardo Bellomo, Andrew Cooke & James Hardy

*Institute for Psychology of Elite Performance, Bangor University, UK*



Two experiments combined measures of chunking, conscious processing, and EEG activity during visuomotor sequence acquisition and performance under pressure to thoroughly examine reinvestment theory. Explicit acquisition (Experiment 1,  $N = 31$ ) was characterised by chunking, a decrease in performance errors, reduced conscious processing and refined cortical activity (increased frontal, parietal and right-temporal high-alpha power). No such changes accompanied chunking when acquisition was implicit (Experiment 2,  $N = 29$ ). Upon transfer to the high-pressure condition, performance improved, while a selective increase in conscious processing and T7-Fz connectivity occurred after explicit but not implicit acquisition. In line with reinvestment theory, our results endorse implicit modes of skill acquisition as a means of promoting chunking while limiting conscious processing, and supporting robust motor performance under pressure.

16:00-16:15: Conference closing statement and awards

### **Poster Presentations**

#### **Effects of Brain Endurance Training on Endurance Exercise Performance**

Dallaway, N., Lucas, S.J.E., Ring, C.

*Sport, Exercise & Rehabilitation Sciences, University of Birmingham, UK*

Mental fatigue (MF) impairs endurance exercise performance (Van Cutsem et al, 2017). Brain endurance training (BET) – such as engaging in cognitive tasks during exercise - can develop resilience to MF and improve physical performance compared to physical training alone (Marcora et al, 2015). Only one study to date has demonstrated the effectiveness of BET and the underlying mechanisms have yet to be determined. This study examines if BET enhances performance over physical training and investigates any potential mechanisms. Pre-training: 36 participants completed a rhythmic handgrip task requiring generation of as much force as possible once a second for 300s, performed under 3 counterbalanced conditions: following 600s of a 2-back memory/attention task (subsequent); while performing a 2-back task (concurrent); and on its own (solo). Cardiac activity (ECG), electromyographic (EMG) forearm activity, pre-frontal cerebral haemodynamic (near infrared spectroscopy), and force were recorded. Training: Participants (randomized to a Control or BET group) completed 24 (6 weeks) submaximal hand contractions sessions. The BET group also completed concurrent cognitive tasks (2-back, word incongruence Stroop). Post-training: Repetition of the pre-training protocol plus a novel cognitive task (number Stroop). Measures of motivation, physical and mental exertion, mental fatigue and mood were collected via self-report throughout. Endurance performance, across the 3 tasks, improved more following BET (23%) than Control (5%) ( $p=.001$ ). BET improves endurance performance over physical training alone.

## **The effect of visual occlusion on receiving and passing a football in soccer**

Alan Dunton, Edward K. Coughlan, Cian O' Neill

*Cork Institute of Technology, Ireland*

Visual Occlusion is the process of limiting the vision of an object, limb or critical information source from the visuomotor workspace (Vickers, 2007). The purpose of the current study is to assess the impact of visual occlusion on receiving and passing a football in soccer, while attending to a secondary cognitive task. Fifteen skilled male soccer players were participants; randomly assigned to one of three groups: Visual Occlusion (VO), Practice (PRA) and Control (CON). The task required participants to control a passed football before scoring into one of two small goals while concurrently recalling randomised numbers. The study design consisted of a pre-test, an acquisition phase (400 trials), a post-test and a 2-day retention test. A 3 group x 3 test ANOVA was conducted to analyse the impact of the acquisition phase on number identification (secondary cognitive task) and performance outcome. There was a significant improvement in number identification ( $p < 0.05$ ) and performance outcome ( $p < 0.05$ ) for the VO group from pre- to post test and pre- to retention test. No significant improvement was found from post-test to retention test ( $p > 0.05$ ) demonstrating a learning effect. There was no significant improvement for the PRA or CON group across any variable. Visual occlusion during receiving and passing a football in soccer positively impacts on peripheral engagement and performance outcome.

### **References**

Vickers, J.N. (2007). *Perception, cognition, and decision training: The quiet eye in action*. Human Kinetics, Champaign, IL.

## **The effect of attentional focus on flow**

David Harris<sup>1</sup>, Gabriele Wulf<sup>2</sup> & Mark Wilson<sup>1</sup>

<sup>1</sup>*Sport and Health Science, University of Exeter, UK*

<sup>2</sup>*Kinesiology and Nutrition Sciences, University of Nevada, Las Vegas, USA*

The state of flow involves a complete absorption in the present activity, and has been linked with confidence, ease, automaticity and optimal sporting performance (Jackson & Csikszentmihalyi, 1999). Recent research has highlighted the importance of attention in flow (Harris, Vine & Wilson, 2017), suggesting that interventions to optimise attention control may promote peak states such as flow. Given the established benefits of an external focus of attention for promoting efficient, automated performance (Wulf, 2013), an attentional focus manipulation was used to examine whether interventions to appropriately direct attention can have beneficial effects for finding flow. 32 participants were given internal and external focus instructions across a counterbalanced design in a simulated car racing task. Instructions directed participants to an internal (hands on the wheel) or distal external (heading direction) focus of attention. Participants completed self report measures of flow experience, with changes in attention (eye tracking) and motor control (wheel movements) assessed as potential mechanisms for any beneficial effects of attentional focus on flow. Results will compare attentional focus conditions in terms of performance (time), flow experience, gaze measures and motor control. The findings are potentially beneficial for developing interventions for finding flow, as well as contributing to our theoretical understanding of the mechanisms underpinning the state.

## **Expertise differences in the gaze behaviour of rugby union referees during scrum scenarios**

Lee J. Moore<sup>1</sup>, Chris White<sup>2</sup> & Samuel J. Vine<sup>3</sup>

<sup>1</sup>*School of Sport and Exercise, University of Gloucestershire, UK*

<sup>2</sup>*Professional Game Match Officials Team, Rugby Football Union, UK*

<sup>3</sup>*Sport and Health Sciences, University of Exeter, UK*

Despite considerable research investigating expertise differences in perceptual-cognitive skill among sport performers (Mann, Williams, Ward, & Janelle, 2007), to date, relatively few studies have focused on sport officials (Hancock & Ste-Marie, 2013; Spitz, Put, Wagemans, Williams, & Helsen, 2016). Thus, this study examined the gaze patterns of rugby union referees of varying skill levels while assessing scrum scenarios. Twenty-seven elite ( $N = 9$ ;  $M_{\text{experience}} = 11.67$  years,  $SD = 6.26$ ), trainee ( $N = 9$ ;  $M_{\text{experience}} = 3.89$  years,  $SD = 2.16$ ), and novice ( $N = 9$ ;  $M_{\text{experience}} = 0.00$  years,  $SD = 0.00$ ) referees made decisions while watching ten projected scrum video clips and wearing a mobile eye-tracker. Decision accuracy and gaze behaviour were recorded for each scrum clip. The results revealed that the novice referees made less accurate decisions than both the elite and trainee referees. Moreover, the novice referees exhibited more fixations compared to the elite and trainee referees. The novice referees also displayed shorter mean fixation durations than the elite referees, but not the trainee referees. Furthermore, the novice referees fixated on more locations than the elite and trainee referees. Finally, the novice referees displayed greater entropy or randomness of gaze patterns than the elite and trainee referees. The results suggest that through experience, rugby union referees have developed superior decision-making that is underpinned by more efficient and organised gaze behaviour, fixating only on the most pertinent information for longer. The findings have implications for training perceptual-cognitive skill and improving the decision-making of sport officials.

## **Option Generation and Anticipation Behaviour in Tennis**

Colm P. Murphy<sup>1,2</sup>, Robin C. Jackson<sup>3</sup>, A. Mark Williams<sup>4</sup>

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<sup>2</sup>*Expert Performance and Skill Acquisition Research Group, St Mary's University, UK*

<sup>3</sup>*School of Sport, Health and Exercise Sciences, Loughborough University, UK*

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We aimed to determine the option generation strategies used by expert and novice tennis players when anticipating an opponent's intentions based on information that would normally be picked up sequentially prior to the opponent striking the ball. Altogether, 12 expert and 14 novice tennis players completed an option generation task when presented with the same rallies from real matches in two display conditions. Rallies were presented as normal videos or as animations, which were edited in such a way that participants either had access to contextual information and postural cues or solely contextual information (e.g., player positioning and relative movements, shot sequencing). Expert participants were more accurate than novices in both display conditions. Participants generated less options in the normal video compared with the animated condition. The expert participants generated more task-relevant and fewer task-irrelevant options than novices, with this effect being stronger in the animated than the normal video condition. The number of options generated was negatively related to performance in the normal video condition only. In dynamic, time-constrained tasks, performers adapt their option generation strategy depending on the information available. In keeping with Long Term Working Memory theory (Ericsson & Kintsch, 1995), when constrained to anticipate based on contextual information alone, effective anticipation is underpinned by being able to access both the likely outcome and

potential relevant alternatives. Moreover, when pertinent postural cues become available, the option generation strategies employed appear consistent with the Take The First heuristic model (Johnson & Raab, 2003).

### **The effect of consistent and varied follow-through practice schedules on learning a table tennis backhand**

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In table tennis the follow-through action after a shot is an important part of skill execution. In this experiment we aimed to extend literature around the contextual interference effect by investigating whether the way the follow-through is organised in practice affects learning of the backhand shot in table tennis. Thirty unskilled participants were allocated to a blocked practice, varied practice or control group and aimed backhand shots towards a target following ball projection from a machine. Each group completed these shots in a pre-test, a training phase with follow-through manipulations, a post-test and a retention test. The varied practice group improved their shot accuracy from pre-test to post-test and from pre-test to retention test (both  $P < 0.01$ ), whereas neither the blocked practice nor the control group displayed any change in shot accuracy. Practising the follow-through in a varied fashion enhanced learning of the preceding shot compared with blocked practice or no follow-through instructions. The benefits of learning motor skills under conditions of high contextual interference also apply to how follow-through actions are organised. The findings are of value to coaches and suggest that instructions related to the follow-through action should be considered as well as the primary skill itself.

### **Effects of task and contextual constraints on place kicking performance at the 2015 Rugby World Cup**

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Place kicks in Rugby Union present opportunities to score points outside the spatiotemporal dynamics of open play, but are typically executed under varying task and contextual performance constraints. The average place kicking success value in international Rugby Union (2002-2011) was 72%, however, dropping to 61% in instances when a match outcome hinged on a single kick (Quarrie & Hopkins, 2015). To further current understanding, we analysed effects of specific task and contextual constraints on place kick performance in the 2015 Rugby Union World Cup. In addition to recording the outcome of each kick, contextual information recorded included: time of the kick in the match, score margin at the time of the kick, and the outcome of the kicker's previous kick. The recorded task constraints included distance (m) and lateral angle ( $^{\circ}$ ) to the goalposts. A binomial logistic regression model revealed that distance ( $p < 0.001$ ) and angle ( $p = 0.001$ ) to goalposts were significant predictors of kick outcome. Furthermore, the success percentage of kickers who missed their previous kick was 7% lower than those who scored their previous kick, and the success percentage of place kicks was 8% lower than the tournament average in the 10 minutes before half-time. Our findings highlighted the influence of relevant task constraints on place kicking performance success as well as the role that contextual constraints may have on elite kickers during competitive sports performance. These findings could

help performance analysts, sport scientists and coaches to design practice environments which successfully simulate the relevant demands of competitive performance environments.

### **Development of Expertise in Elite and Sub Elite British Rugby League Players: A Comparison of Practice Experiences**

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Unlike other studies which counted the number of hours engaged in specific types of practice, this study sought to understand and compare the micro structure of practice (e.g. practice tasks undertaken) experienced by elite and sub elite British rugby league players. Semi structured interviews from eight international and eight domestic level players' explored relevant issues such as exposure to deliberate play, amateur sport, and professional sport practice experiences. A two-staged thematic analysis was used to interpret the data. The analysis revealed that both player groups experienced a *rich and narrow landscape of affordances* and were exposed to *early diversification* of sport experiences during childhood. Differences were identified in domestic level players' experiences of amateur and professional sport, where, episodes of *negative developmental environments* were reported. International players' practice experiences revealed differences in their professional careers, where, exposure to *scenario-based practice* and *dynamic learning environments* (*autonomous learning* and *athlete-centered learning*) were reported. Players' insights were interpreted from an ecological dynamics theoretical framework to guide coaches in the design of practice environments. These shared insights can support coach educators in designing learning programs that help coaches recognise the skill acquisition and development needs of elite performers in moving between highly structured and highly varied learning experiences, based on the individual needs of an athlete at any one point in time.

### **The discrimination of deceptive information can be enhanced by training that removes superficial visual information**

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The ability to detect deceptive intent within actions is a crucial element of skill across many sporting tasks. The purpose of this study was to determine whether the ability to discriminate deceptive from non-deceptive actions could be enhanced by removing superficial visual information. Novice badminton players were allocated to one of three groups, who performed perceptual training over three days, while viewing manipulated action sequences that displayed either (i) normal vision; (ii) low spatial-frequency information only (low-SF; blurring to remove superficial information); or (iii) high spatial-frequency information only (high-SF; an 'edge detector' to highlight superficial information). During training, participants watched a series of badminton shots and were asked to anticipate the direction of the shuttle when footage was occluded at the moment of racquet-shuttle contact. The efficacy of training was assessed using tests of anticipatory skill conducted in a pre-test, post-test, and 1-week retention test. In the post-test, response accuracy was higher in the deceptive trials for the low-SF training group when compared to the normal training group ( $p = .005$ ), with the difference retained in the

retention test ( $p = .02$ ). The analysis of gaze provided some explanation for the findings, with the low-SF training group spending more time after training fixating on the location of racquet-shuttle contact than did the normal training group ( $p < .028$ ). The findings demonstrate that training which conveys only the basic kinematic movements visible in low-SF information may be effective in learning to 'see-through' deceptive intent.