

ESAN

**Expertise and Skill
Acquisition Network**

10th meeting of Expertise and Skill Acquisition Network

Manchester Metropolitan University, Institute of Sport, Manchester, UK

Wednesday 17th and Thursday 18th May 2023

In association with:

tobii



Programme

Wednesday 17th May 2023

12:00-13:00: **Arrival and registration**

13:00-13:05: **Introduction (Nick Smeeton, University of Brighton and Chair of ESAN)**

13:05-14:00: **Keynote speaker: Dr. Philip Furley (German Sport University Cologne)**

Keynote title: Sports expertise and executive function

14:00-14:15: **Questions and discussion**

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

14:30-15:45: **Oral presentations 1**

Each presentation is 10 min + 3 min questions.

Presentation 1: Katherine Sparks (University of Birmingham)

Co-author: Christopher Ring (University of Birmingham)

Sport-specific mindfulness interventions: Effects on mindfulness, enjoyment and athletic functioning

Presentation 2: David J. Harris (University of Exeter)

Co-authors: Tom Arthur (University of Exeter), David P. Broadbent (Brunel University), Mark R. Wilson (University of Exeter), Samuel J. Vine (University of Exeter), Oliver R. Runswick (Kings College London)

An active inference account of skilled anticipation in sport

Presentation 3: Marie Simonet (University of Lausanne)

Co-authors: Paolo Ruggeri (University of Lausanne), Etienne Sallard (University of Lausanne), Jérôme Barral (University of Lausanne)

The field of expertise modulates the time course of neural processes associated with inhibitory control in a sport decision-making task

Presentation 4: Harry Ramsey (University of Portsmouth)

Co-authors: Matt Miller-Dicks (University of Portsmouth), Lorraine Hope (University of Portsmouth), Vasu Reddy (University of Portsmouth)

The influence of action sequence and deception on defenders' anticipation and gaze behaviour when facing basketball bounce passes

Presentation 5: Tom Arthur (University of Exeter)

Co-authors: David J. Harris (University of Exeter), Gavin Buckingham (University of Exeter), Mark Brosnan (University of Bath), Mark R. Wilson (University of Exeter), Genevieve Williams (University of Exeter), Samuel J. Vine (University of Exeter)

Understanding sensorimotor difficulties in autism

15:45-16:00: **Break / General Discussion**

16:00-17:15: **Oral presentations 2**

Each presentation is 10 min + 3 min questions.

Presentation 1: Hannah Mortimer (University of Birmingham)

Co-author: Christopher Ring (University of Birmingham), Neil Dallaway (University of Birmingham)

Intermittent brain endurance training improves bodyweight endurance performance

Presentation 2: Adam L. Kelly (Birmingham City University)

Co-author: Thomas Brown (Birmingham City University/ Warwickshire County Cricket Club), Rob Reed (Corsham Cricket Club), Jean Côté (Queen's University), Jennifer Turnnidge (Queen's University)

Relative age effects in male cricket: A personal assets approach to explain immediate, short-term, and long-term developmental outcomes

Presentation 3: James Hodgetts (Bangor University)

Co-author: Andrew Cooke (Bangor University), Germano Gallicchio (Bangor University)

Effects of personality and executive function on feedback-based learning

Presentation 4: Matthew W. Scott (University of British Columbia)

Co-authors: Jonathan Howard (University of British Columbia), Aneesha Mehta (University of British Columbia), April Karlinsky (California State University), Tim Welsh (University of Toronto), Nicola J. Hodges (University of British Columbia)

Evidence of co-representation of a partner's task in golf putting practice; but no learning benefits or costs

Presentation 5: Dave Bright (University of Chichester)

Co-authors: Oliver R. Runswick (Kings College London), Jenny Smith (University of Chichester), Philip Kearney (University of Limerick)

A comparison of the effects of autonomy and cognitive effort during the learning of a novel motor skill

17:15-17:30: **Break / General Discussion**

17:30-18.30: **Evening posters and refreshments**

19:30: **Social**

Thursday 18th May 2023

09:30-09:55: **Arrival**

10:00-10:05: **Introduction: Nick Smeeton (University of Brighton and Chair of ESAN)**

10:05-11:00: **Keynote speaker: Prof. Nikki Hodges (University of British Columbia)**

Keynote title: *Embracing discomfort on the skill acquisition path in practice and in research*

11:00-11:15: **Break: Tea and coffee**

11:15-12:30: **Symposium:**

Title: *Talent identification and development in female sport*

Each presentation is 15 mins + 5 min questions.

Presentation 1: Matthew Andrew (Manchester Metropolitan University)

Talent identification of youth female soccer players in the United States: Assessing the current landscape

Presentation 2: Sam Alder (Liverpool John Moores University)

The macro- and micro-structure of practice of youth elite female soccer players in England

Presentation 3: James Feist (University of Chichester)

Co-authors: Naomi Datson (Kings College London), Oliver R. Runswick (Kings College London), Alice Harkness-Armstrong (University of Chichester), Chris Pocock (University of Chichester)

Visual exploratory activity in elite women's soccer: An analysis of the UEFA Women's European Championships 2022

Presentation 4: Alexandra Lascu (University of Canberra)

Co-authors: Wayne Spratford (University of Canberra), David B. Pyne (University of Canberra), Naroa Etxebarria (University of Canberra)

'Train how you play': Representative learning design for amateur athletes

12:30-13:00: **General Discussion** (including keynote)

13:00-14:30: **Lunch, Posters, and Networking plus Tea/Coffee**

14:30-15:45: **Plenary Session Discussion**

Title: *The future of skill acquisition in UK sport*

Each presentation is 10 min + 45 min discussion at end

Presentation 1: Paul R. Ford (St Mary's University London)

Skill acquisition in the UK

Presentation 2: Danny Powell (Manchester Metropolitan University)

Skill acquisition in elite level swimming: A multiple case studies approach to bridging the gap between scientific research and applied practice

Presentation 3: Oliver R. Runswick (Kings College London)

The British Association of Sport and Exercise Sciences (BASES) - Skill Acquisition Special Interest Group

General Discussion

15:45-16:00: **Conference closing statement and awards**

Keynote presentations

Sports expertise and executive function

Philip Furley¹

¹*German Sport University Cologne, Germany*

A growing body of literature has argued that other factors besides practice likely contribute to expertise in various sport domains. One of these additional factors that has received increasing research attention in the sports domain are basic cognitive abilities, in particular Executive Functions (EF). The logic behind this research typically goes something like this: Playing sport at the highest level requires a wealth of cognitive functions such as attention, decision making, and cognitive flexibility to be functioning at optimal levels in highly challenging, time constrained environments. As EFs have been linked to all of these facets of behaviour, the most successful players should also test high on EF measures. Initially, this line of reasoning seemed to have been supported by some empirical studies. Besides critically reviewing the existing research on this topic, the presentation will provide a comprehensive synthesis of the underlying theory and the typical methodology (and problems with the methodology) in the study of EFs in relation to superior performance/expertise in sports. A critical evaluation on theoretical and methodological work on EF shows numerous problems on how to conceptualize and measure the EF construct. These problems within the basic research on EF seem to be sometimes overlooked in the sport literature and have contributed to ambiguous empirical evidence on the question if EF can be

considered a contributing factor to sports expertise. Further, the presentation will summarize the empirical research on the related question of the malleability of EFs and whether these can be trained to improve performance in remote domains like sports. The presentation will conclude by pointing out avenues for future theoretical and empirical work regarding the important topic of what (cognitive) factors contribute to skill acquisition and expertise in the domain of sports.

Embracing discomfort on the skill acquisition path, in practice and in research

Nicola J. Hodges¹

¹*University of British Columbia, Canada*

In this talk, I will use the notion of discomfort to discuss some recent extensions to the challenge point framework and its application to coaching practice. I will discuss ideas concerning the relationships between challenge, practice specificity to competition, and motivation and relate these ideas to some research related to the empirical study of challenge and related topics. In addition to some lab work, I will also highlight current projects in which we attempt to measure challenging practice among girls and women soccer players through a longitudinal project. I will also entertain some thoughts about personal research and practice discomforts and ways to embrace these challenges, as well as if time permits some tangential research projects.

Plenary session discussion

The future of skill acquisition in UK Sport

Paul R. Ford¹, Oliver R. Runswick², Danny Powell³

¹*St Mary's University London, UK*

²*Kings College London, UK*

³*Manchester Metropolitan University, UK*

Skill acquisition research and theory is currently a large knowledge base, and it continues to expand and evolve along with its related areas of motor learning, motor control, expert performance, and pedagogy. The knowledge base is highly practical, addressing key real-world variables for sports coaches, athletes, administrators, and other sports scientists. Several academics and “pracademics” believe that this knowledge base is sufficient to warrant skill acquisition being fully recognised as a key independent area of knowledge and to have specialist support staff in this area working across sport. In this session, we will discuss these beliefs and present recent developments that seek to move the area towards these goals in the United Kingdom (UK). This plenary discussion session will begin with three short presentations. First, Dr Paul R. Ford will detail the current state and issues facing the skill acquisition field in sport in the UK, if and as it seeks to become further recognised as a key independent area of knowledge that has many specialist support staff in sport. Second, Dr Danny Powell will provide perspective on the role of coach education in embedding skill acquisition research and theory into UK

sport. He will detail recent research that evaluated the effects on coaching practice of a six-week online skill acquisition development intervention with two senior coaches from British Para Swimming. Data from observations and interviews will be presented from before and after the intervention showing coaching practice became more aligned with scientific recommendations in key areas of the knowledge base. The third presentation will detail ESAN’s response to the current position of skill acquisition in the UK. Dr Oliver R. Runswick will outline the new Skill Acquisition Special Interest Group within The British Association of Sport and Exercise Sciences (BASES) - the professional body for sport and exercise sciences in the UK. He will briefly detail the BASES accreditation framework and highlight future research that will develop new information on the competencies and knowledge that skill acquisition support staff should possess, which will potentially be used in the future development and accreditation of new specialists. Following these presentations, an open discussion involving a panel of key stakeholders will be held about the information in and topics of these presentations and, more generally, about the position and future of skill acquisition in sport in the UK and beyond. Attendees are encouraged to contribute to this discussion session with their own views, knowledge, and experiences on this topic.

Symposium

Talent identification and development in female sport

Talent identification of youth female soccer players in the United States: Assessing the current landscape

Matthew Andrew¹

¹*Manchester Metropolitan University, UK*

To continue the success of the women's national team at senior and youth levels, United States (US) Soccer are continuing to advance their talent identification processes. The US has many 'unique' factors (e.g., pay-to-play; collegiate system) that influence the talent identification process. The following presentation highlights some early observations as well as future directions for examining talent identification in youth female soccer players from the United States.

The macro- and micro-structure of practice of youth elite female soccer players in England

Sam Alder¹

¹*Liverpool John Moores University*

Soccer continues to be one of the most popular female sports worldwide, particularly in England. The increased popularity has led to professional clubs advancing their youth talent development pathways (e.g., WSL academy; Lionesses Pathway). To support this, researchers have extensively examined the factors associated with talent development, such as coaching practices and developmental activities. Many studies have explored such factors within male soccer, with findings occasionally extrapolated to female soccer which may be erroneous, thus calls for female specific research have been made (Kryger et al., 2020; Williams et al., 2020). The following presentation highlights early findings as well as future research directions examining talent development in youth elite soccer players in England, particularly the macro-activities including the amount, type, and perceptions of soccer-specific activities in youth (U18-23) FAWSL academy soccer players, as well as the micro-activities, such as the behaviours and activities employed by professional soccer coaches working with youth elite female soccer players (U10-U16) of a single Regional Talent Club. Findings from these studies may play a critical role in the development of future generations of professional female soccer players in England.

Visual exploratory activity in elite women's soccer: An analysis of the UEFA Women's European Championships 2022

James Feist¹, Naomi Datson², Oliver R. Runswick², Alice Harkness-Armstrong¹, Chris Pocock¹

¹*University of Chichester*

²*Kings College London*

Recent research has developed understanding of the technical and tactical determinants of success in elite women's soccer, however a lack of research exists on analysing how elite female players visually explore their environment to support skilled soccer performance. This study aimed to describe the visual exploratory activity (VEA) of elite female central midfield players and understand the relationships between VEA, performance with the ball and specific contextual factors. Thirty female central midfield players (M age = 26.7 years, SD = 3.8) from the eight teams who competed in the knock-out stages of UEFA Women's EURO 2022 were analysed. Television broadcast and UEFA tactical footage were combined to analyse players across the seven knock-out stage matches, totalling 1,038 individual ball possessions. The mean scan frequency in the 10 seconds before receiving the ball was 0.35 (scans/s), which can be compared with elite youth (0.42 scans/s) and professional (0.44 scans/s) male soccer respectively (Aksum et al., 2021; Jordet et al., 2020). Results showed pitch location when receiving the ball as the main predictor of scan frequency, with scan frequency also related to action result ($p < 0.003$). Therefore, pitch location appears an important variable when understanding VEA in elite women's soccer.

'Train how you play': Representative learning design for amateur athletes

Alexandra Lascu¹, Wayne Spratford¹, David B. Pyne¹, Naroa Etxebarria¹

¹*University of Canberra*

Training task design typically comprises of deconstructed and monotonous tasks, with growing recommendations for learning environments to effectively represent the game environment athletes are training for. Currently, there is lack of clear guidelines to apply representative learning design (RLD) in community sport settings,

where resources, facilities and coaching staff are limited. The aim of this study was to promote skill development in amateur female cricketers by manipulating four tenets of RLD in cricket: feed, decision making, variability and information sources. A total of 15 bowling and 12 batting characteristics were developed by Lascu et al. (2020), where each activity was scored as a number out of 12 or 15, and converted to a percentage to reflect the training design (moderate 67%, distinct 75%, extensive 83-100%). Two female cricket teams completed a five-week RLD

training intervention, where skill development was recorded as changes in skilled actions for batting and bowling. Six of ten batters and seven of eight bowlers exhibited increases in skill development ranging between 7-49%. Changes in batting and bowling behaviour improved substantially between moderately and extensively designed sessions. This suggests that RLD does not need to perfectly replicate the performance environment, but rather effectively simulate it.

Oral Presentations

Sport-specific mindfulness interventions: Effects on mindfulness, enjoyment and athletic functioning

Katherine Sparks¹, Christopher Ring¹

¹*University of Birmingham*

Mindfulness can have beneficial effects on performance, but initial studies have used generic practices which have been met with scepticism and low adherence rates, therefore tailored sport-specific practices may eradicate this and have greater impact. Accordingly, our objectives were 3-fold: first, to develop a rowing and running-specific mindfulness intervention, second, to investigate the feasibility and acceptability of the interventions, and finally, examine its effects on mindfulness, flow, reinvestment, fatigue and performance. Runners and rowers were randomly assigned to either a 6-week sport-specific mindfulness intervention, which included generic and sport-specific practices, or a control group. Participants completed pre-test and post-test measures of performance, mindfulness, flow, and rowing-specific reinvestment. Lastly, athletes completed an evaluation form following the intervention. The results demonstrated that the intervention group increased flow, mindfulness, and improved performance, additionally conscious motor processing decreased from pre-test to post-test. Participants provided favourable qualitative feedback and evaluated the intervention positively. Overall, our 6-week sport-specific mindfulness intervention demonstrated promise, it promoted flow, enjoyment, encouraged mindfulness and aided performance.

An active inference account of skilled anticipation in sport

David J. Harris¹, Tom Arthur¹, David P. Broadbent², Mark R. Wilson¹, Samuel J. Vine¹, Oliver R. Runswick³

¹*University of Exeter*

²*Brunel University*

³*Kings College London*

Time-constrained and dynamically changing sporting environments require performers to anticipate the future states of the game; the conditions of the ground, the bounce of the ball, or the movement of opponents. To anticipate effectively, performers must identify and use relevant information from both the current environment and their prior knowledge. Important questions remain, however, about how performers select and combine

different information sources to aid anticipation, and whether they do so in a statistically optimal way. Neuroscientific theories, such as predictive processing and active inference, characterise perception and action as a Bayesian inference process, and provide a principled account of how performers may enact this information integration process. We will present recent work that has outlined a model of anticipation based on active inference. This work has proposed a series of hypotheses about anticipation derived directly from Bayesian computational models, some of which are consistent with existing evidence and some point to future research questions. We will discuss how active inference may provide a promising framework for future work on anticipation.

The field of expertise modulates the time course of neural processes associated with inhibitory control in a sport decision-making task

Marie Simonet¹, Paolo Ruggeri¹, Etienne Sallard¹, Jérôme Barral¹

¹*University of Lausanne*

Inhibitory control (IC), the ability to suppress inappropriate actions, can be improved by regularly facing complex and dynamic situations requiring flexible behaviors, such as in the context of intensive sport practice. However, researchers have not clearly determined whether and how this improvement in IC transfers to ecological and nonecological computer-based tasks. We explored the spatiotemporal dynamics of changes in the brain activity of three groups of athletes performing sport-nonspecific and sport-specific Go/NoGo tasks with video footages of table tennis situations to address this question. We compared table tennis players (n = 20), basketball players (n = 20) and endurance athletes (n = 17) to identify how years of practicing a sport in an unpredictable versus predictable environment shape the IC brain networks and increase the transfer effects to untrained tasks. Overall, the table tennis group responded faster than the two other groups in both Go/NoGo tasks. The electrical neuroimaging analyses performed in the sport-specific Go/NoGo task revealed that this faster response time was supported by an early engagement of brain structures related to decision-making processes in a time window where inhibition processes typically occur. Our collective findings have relevant applied perspectives, as they highlight the importance of

designing more ecological domain-related tasks to effectively capture the complex decision-making processes acquired in real-life situations. Finally, the limited effects from sport practice to laboratory-based tasks found in this study question the utility of cognitive training intervention, whose effects would remain specific to the practice environment.

The influence of action sequence and deception on defenders' anticipation and gaze behaviour when facing basketball bounce passes

Harry Ramsey¹, Matt Miller-Dicks¹, Lorraine Hope¹, Vasu Reddy¹

¹*University of Portsmouth*

Whilst it is widely documented that performers can deceive by manipulating their unfolding kinematics, the role of manipulating an opponent's contextual pattern of actions for successfully employing a deceptive action is yet to be explored. The aim of the present study was to determine how manipulating the sequence of a player's pass direction influences an opposing defender's ability to successfully anticipate and intercept deceptive passes. 20 skilled basketball players were recruited to participate as the role of a defender and were fitted with Tobii Pro 2 eye tracking glasses whilst being tasked with anticipating and intercepting bounce passes in a novel in situ basketball pass scenario. Whether the passes were (i) deceptive or non-deceptive, and (ii) congruent, incongruent, or with no previous pattern (no congruence) were manipulated. It was found that deceptive passes led to less interceptions; a lower interception score; more misdirections; and more response corrections than non-deceptive passes. Defenders' first saccade in the correct pass direction occurred significantly later for deceptive actions compared to non-deceptive actions, and defenders' gaze was misdirected during deceptive passes more often than non-deceptive passes. Manipulation of pass congruence appeared to have minimal effect on defenders' behaviour for all variables apart from misdirection.

Understanding sensorimotor difficulties in autism

Tom Arthur¹, David J. Harris¹, Gavin Buckingham¹, Mark Brosnan², Mark R. Wilson¹, Genevieve Williams¹, Samuel J. Vine¹

¹*University of Exeter*

²*University of Bath*

Many autistic people have difficulties performing and/or learning motor skills. These difficulties can limit a person's independence and affect how much physical activity they do. Studies have suggested that such

movement-related issues could be underpinned by differences in predictive sensorimotor control. The present research examined this idea, before exploring whether autistic movement skills can be enhanced using assistive coaching cues in virtual reality (VR). Specifically, autistic and non-autistic participants completed a simulated racquetball task, in which they were required to hit normal and unexpectedly-bouncy balls using a handheld VR controller. The probability of facing each type of ball was varied on a trial-by-trial basis, such that sensory environment became more or less uncertain over time. Results showed that autistic individuals displayed poorer task performance and more restricted swing kinematics than their non-autistic counterparts. These motor difficulties were accompanied by atypical anticipatory gaze behaviours, which indicated that predictions were being updated sub-optimally over time. Notably, though, these sensorimotor outcomes were not affected by our assistive VR-based coaching cues, which provided explicit information about likely upcoming ball trajectories on each trial. Results therefore support the development of evidence-based programmes that make learning environments more predictable for autistic people.

Intermittent brain endurance training improves bodyweight endurance performance

Hannah Mortimer¹, Christopher Ring¹, Neil Dallaway¹

¹*University of Birmingham*

Background: Mental Fatigue (MF) has been found to negatively impact physical performance. To counteract the negative effects of MF, Brain Endurance Training (BET) has been proposed as a method to help athletes build resilience to MF, through a combination of cognitive and physical training. BET is suggested to build resilience to MF via central neurophysiological adaptations to the heightened demands associated with increased MF. Thus, when the additional cognitive demands are removed post-training, physical performance should be improved. Objective: To explore the effects of combined prior and intermixed BET (cBET) on bodyweight exercise performance. Design: A pre-test, training, post-test design with participants randomly allocated to cBET or control (physical training alone). Method: In the pre and post-test, participants completed body-weight exercises (burpees, plank, squat jumps, leg raises, and press ups) until voluntary exhaustion before and after a four 5-min cognitive tasks. Training consisted of these exercises intermixed with cognitive tasks (cBET) or rest (control) with 3 sessions per week over 4 weeks (12 sessions total training). Results: Compared to control, cBET improved physical performance. Conclusions:

Mixed BET training can improve physical performance more than standard physical training alone.

Relative age effects in male cricket: A personal assets approach to explain immediate, short-term, and long-term developmental outcomes

Adam L. Kelly¹, Thomas Brown^{1, 2}, Rob Reed³, Jean Côté⁴, Jennifer Turnnidge⁴

¹*Birmingham City University*

²*Warwickshire County Cricket Club*

³*Corsham Cricket Club*

⁴*Queen's University*

The purpose of this study was to adopt the Personal Assets Framework to examine the immediate, short-term, and long-term developmental outcomes associated with relative age effects in male cricket. Accordingly, this study was comprised of three aims: (a) examine the birth quarter (BQ) distribution of players throughout the England and Wales Cricket Board national talent pathway (i.e., Regional U15, Regional U17, England U19, England Lions, England T20, England ODI, and England Test; n=1,800; immediate timescale), (b) explore the youth-to-senior transitions based on BQ and skill-set (i.e., batters and bowlers; short-term timescale), and (c) analyse the average number of games played at senior levels based on BQ and skill-set (i.e., long-term timescale). In the immediate timescale, results showed that relatively older players were overrepresented throughout all the youth levels ($p < 0.05$, $V = 0.16-0.30$), whereas there were no differences at senior levels ($p > 0.05$, $V = 0.05-0.15$). In the short-term timescale, when the senior cohorts were compared to the Regional U15 cohort, relatively younger players were more likely to transition from youth to senior levels ($p < 0.05$, $V = 0.22-0.37$). In the long-term timescale, relatively older batters were selected for more games ($p < 0.05$, $V = 0.18-0.51$), whereas relatively younger bowlers were selected for more games ($p < 0.05$, $V = 0.17-0.39$).

Effects of personality and executive function on feedback-based learning

James Hodgetts¹, Andrew Cooke¹, Germano Gallicchio¹

¹*Bangor University*

Biofeedback interventions allow individuals to learn to self-regulate certain biological functions to promote to gain improvements in health or performance. However, some individuals learn better than others. Our objective was to explore the reasons for individual differences in reactivity to real-time feedback. A two (Group) x forty (Trial) mixed-model design whereby 111 participants

completed 40 trials of a feedback bespoke computer task requiring them to react to auditory and visual feedback to navigate a target through a maze. Participants were allocated to a contingent group (financial reward based on performance) or non-contingent group (financial reward given through lottery). We assessed their absolute error to monitor performance change over trials and their personality via questionnaire traits (including alexithymia) plus motivation. Results revealed that openness was a predictor of feedback based improvement for both groups. Participants in the contingent group improved more, displayed a greater rate of improvement than participants in the non-contingent group. Rate of improvement was moderated by personality; participants scoring higher in openness (both groups) and emotional stability (non-contingent group) improved more than their less open and emotionally stable counterparts. We conclude that openness and emotional stability are traits that could facilitate the ability to self-regulation via real-time feedback.

Evidence of co-representation of a partner's task in golf putting practice; but no learning benefits or costs

Matthew W. Scott¹, Jonathan Howard¹, Aneesha Mehta¹, April Karlinsky², Tim Welsh³, Nicola J. Hodges¹

¹*University of British Columbia*

²*California State University*

³*University of Toronto*

Actions in social settings are often adapted based on co-actors. This influence may emerge because one actor “co-represents” the actions and plans of another actor. Co-representation can result in motor contagion errors, whereby another’s actions unintentionally interfere with (negatively impact) the actor. In sports, practice often takes place alongside or alternating with a partner - situations wherein “interference” from co-representation of another’s task could either harm or benefit learning through added variability and cognitive effort in practice. Here, dyad groups that either alternated or putted simultaneously to different targets were compared to alone groups (n=30/group). We focused on errors in distance from the target and expected overshooting for near-target partners paired with far-target partners (and undershooting for far paired with near), when compared to alone groups. We saw evidence for co-representation, but only for near-target partners paired with far-target partners ($p = .01$). Both dyad groups overshoot more in practice than alone groups. These differences in practice did not generally show up in costs or benefits for learning measures. Only the alternating group showed evidence of compensatory-type errors based on their partner’s

previous trial. Practising with a partner impacts short-term performance, but not to the detriment or benefit of overall learning.

A comparison of the effects of autonomy and cognitive effort during the learning of a novel motor skill

Dave Bright¹, Oliver R. Runswick², Jenny Smith¹, Philip Kearney³

¹*University of Chichester*

²*Kings College London*

³*University of Limerick*

Better motor learning can be achieved in conditions that promote autonomy and increased cognitive effort, but few studies compare the affects within the same novel skill. Additionally, use of single time point measures of motivation mean outcomes could be due to perceptions of

performance rather than experimental manipulation. Here four groups (fixed difficulty [FD], autonomous difficulty [AD], challenge point [CP], and yoked [YK]) completed an on-screen task intercepting three targets with a racquet of changeable size to manipulate difficulty and autonomy. Absolute error, motivation, and cognitive effort were recorded at multiple time points. Retention checks immediately followed acquisition, and were repeated at 24 hours. All groups reduced absolute error over the acquisition period [$F(3, 80) = 82, p < 0.001, \eta^2_p = 0.507$], but no group differences were observed at immediate [$F(3, 77) = 0.197, p = 0.898$] or 24 hour retention tests [$F(3, 77) = 1.658, p = 0.183$]. All groups displayed a drop in both motivation and cognitive effort across acquisition [$F(3, 80) = 92.908, p < 0.001, \eta^2_p = 0.469$] with no between group differences. Neither factor demonstrates a dominant effect on learning, although trends in data suggest some degree of variable difficulty in practice sees improved learning.

Poster Presentations

Motor imagery and interoception sensibility in musicians: An exploration of pianists' motor imagery and interoceptive skills

Delfin Tursin, Martina Gandola, Naomi Tistarelli, Federica Boschetti, Gabriella Bottini

Motor imagery represents the ability to imagine a movement without overt execution (Decety, 1996). On the other hand, interoception is the ability to perceive visceral sensations consciously (Garfinkel et al., 2015). Musicians represent a valid model for the studying brain plasticity in the previous studies (Schirmer-Mowka et al., 2015). Previous demonstrated that it was expected pianists had better motor imagery abilities than those who were not musicians (Brochhard et al., 2004). The recent research could have an insight into the nature of complex motor imagery tasks, because there was no adequate evidence on how pianists while playing the piano and at the same time while using their hand, which was examined explicitly via the "Mental Chronometry Task", and implicitly via the "Hand Laterality Task", and to investigate interoceptive sensibility components in a population of pianists. Hence, the present study developed an advanced understanding of the complex nature of motor imagery, which is characterised by a certain level of investigations and heterogeneous contributions according to the less evidence on the relationship between musical learning and brain plasticity. The current study aimed at evaluating the motor imagery skills, which are associated with explicit and implicit imagery, and interoceptive awareness. There was an investigation between pianists and non-pianists' motor imagery skills, then investigate those differences based on the level of the expertise in motor imagery. Second, there was a particular examination of the existence of differences between pianists and control groups in the ability of motor imagery in relation to the exercised limbs (hands) compared to unexercised limbs (feet). Lastly, the research focused on investigating the interoceptive awareness, with the different levels of expertise in the capability of interoception skills. Hence, the recent study hypothesised that pianists had better motor imagery skills and interoceptive awareness than non-pianists. Thus, the present work fits into a research field characterised by a certain complexity of investigations and heterogeneous contributions. In terms of assessing the differences in cognitive abilities between musicians and control groups, we used a methodology aimed to analyse motor imagery

abilities, explicitly with the chronometry and implicitly with the Hand Laterality Task (HLT), and interoceptive sensibility. 30 participants were recruited for the study, including 18 university students and 12 piano students, and graduated pianists, who were in academic level I and II courses in the Conservatory and graduated pianists at the Giuseppe Verdi Conservatory in Milan, and University of Pavia. HLT analysis showed that there was a main effect of the sight factor ($F(1,30) = 48.725$; $p < 0.001$; $\eta_p^2 = 0.062$) "Longest reaction time" for the palm images (mean: 1395; $SE = 42.8$), back views (mean: 1641; $SE = 45$), and angle ($F(7,210) = 109.606$; $p < 0.001$; $\eta_p^2 = 0.252$). The group factor was not significant $F(1,30) = 0.451$; $p < 0.507$; $\eta_p^2 = 0.004$). This may be explained within novel frames of mental rotation tasks in which performance at the task would underlie by visuoperceptual process. The interaction analyses showed that there was a three-way interaction laterality by view, by angle was significant ($F(7,219) = 10,550$; $p < 0.001$; $\eta_p^2 = 0.017$). In interoceptive sensibility, there were no significant differences emerging from the comparison between the two groups (BOA: $X^2 = 0.0891$; $p = 0.765$; SUP: $X^2 = 2.0617$; $p = 0.151$). Therefore, this may be explained in the light of the subsisting relationship between stress and interoception.

Action Observation in individuals with chronic back pain

Maaiké W. Esselaar, Paul Holmes, Dave Wright, Ben Marshall, Dave Smith, Zoe Franklin

Chronic back pain is complex and attentional biases during movement execution are thought to play a role in the development and maintenance. Attentional bias has been previously assessed using images however using videos might be more ecologically valid and reflects a therapy setting. In the current study, nine chronic back pain patients (BPP) and 29 pain-free controls observed actions based on the Back Pain Performance Scale ($n=5$) or control actions ($n=5$). Visual attention was assessed on three areas of interest (AOI), head, back, and object. Non-parametric analysis compared pain and fear ratings of the videos, as well as first-fixation duration, and total dwell time on each of the AOI between the BPP and the controls. Results showed that BPP scored all videos as more painful and fearful ($p < 0.001$). BPP had significantly longer first fixation ($p < 0.001$) and dwell time ($p < 0.001$) on the back compared to pain-free controls for all videos. BPP further

had a longer first fixation duration on the back for the back pain actions compared to the control actions ($p < 0.05$). These findings suggest that individuals with chronic back pain pay more attention towards the back and change their attention allocation depending on the type of video compared to controls.

Reducing grip uncertainty when first learning to use a prosthetic hand facilitates performance and visuomotor control

Mohamed Omar Mohamed, Greg Wood, David J. Wright, Johnny Parr

Hand-eye coordination is central to controlling upper-limb prosthetic devices. During the initial phase of prosthesis learning, users tend to watch their hand when grasping objects. This is due to the absence of sensory feedback, a lack of trust in their device, and a degree of uncertainty when interacting with objects. This study explored whether reducing grip uncertainty would facilitate the development of visuomotor control during the initial prosthesis learning phase. Twenty-one intact limb participants completed a cup pouring task using (i) their anatomic hand, (ii) a prosthetic hand simulator, and (iii) the prosthetic hand simulator with Velcro attached to the fingertips. Participants wore an eye-tracker to measure target and hand-focused fixations, and how quickly they shifted their gaze in between movement phases. Results show that reducing grip uncertainty with Velcro promoted faster performance, fewer hand-focused fixations, and faster shifts of gaze towards targets compared to when using the prosthesis without Velcro. These findings indicate that visuomotor control can be facilitated by reducing grip uncertainty during the initial phases of prosthetic hand learning.

An online investigation of the visual and motor influences on action prediction of a volleyball set action

Michael Dhaliwal, Matthew Krueger, Christian Vater, Nicola J. Hodges

In volleyball, predicting the direction of a set is a critical moment to stop an opposing attack. The setter has motor experience passing the ball to a teammate for a spike (attack) and the blocker has perceptual experience blocking the attack (defence). These differential experiences are thought to impact action predictions, implicating ideas concerning action simulation. The perspective shown when assessing predictions (setter's or blocker's) is also expected to impact accuracy and interact with experience. Here we designed an online temporal

occlusion prediction task, comparing across skill, player position and video perspective. So far, 17 skilled (M accuracy = 48%) and 21 novice (M accuracy = 40%) volleyball players have participated. Based on descriptive comparisons, experts were more accurate from the blocker's perspective (attack = 46%, defence = 51%), but perspective did not impact novice accuracy. There was a trend for setters to be more accurate than blockers, mostly due to accuracy at the setter's perspective. Although we are still recruiting, we hope this study will aid understanding of motor and visual action experiences to predictive decisions, impacting on the validity of online video assessments for perceptual skills with implications for training

Pattern recognition in soccer: Perceptions of skilled players and experienced coaches

James Feist, Oliver R. Runswick, Ed Hope, Jamie S. North, Chris Pocock

The ability to perceive and recognise patterns of play is important for skilled performance in sporting environments with strict spatiotemporal constraints. An extensive body of laboratory-based experimental research has examined pattern recognition, yet there has been a lack of qualitative investigations into pattern recognition underpinning skilled performance. We interviewed six skilled soccer defenders and seven experienced coaches to investigate the perceived importance of pattern recognition to 'game reading' in soccer and its development in practice. A two-stage reflexive thematic analysis identified seven higher-order and twenty-two lower-order themes relating to the contribution of pattern recognition to game reading in competition and practice. Participants reported that danger and distances, visual perception, anticipation, experience, opposition team, organisation and communication, and development in practice were deemed fundamental to performance in competition. Participants explained that developing pattern recognition skills in representative practice environments supported transfer of these skills into competition. Defenders and coaches emphasised the importance of distance between player and ball, as well as identifying 'triggers' which appear linked to a defender's experience, positional awareness, and organisational skills. Providing defenders with representative scenarios during practice is recommended to stimulate problem-solving and promote familiarity with an opposition team's patterns of play to support skilled performance.

An evaluation of the impact of the Irish Rugby Football Union Coach Education Framework on the coach-athlete dyad across the age and stage spectrum in rugby union

Kevin Smith, Con Burns, Cian O'Neill, Noreen Quinn, Nick Winkelman, Matthew Wilkie, Edward K. Coughlan

As coach education is a complex process, assessing its efficacy can be quite difficult. The purpose of this research was to evaluate the implementation of the novel Irish Rugby Football Union Coach Education Framework (CEF) on coach-athlete interactions and perceptions. Participants were coaches (n=4) and athletes (n=54) from two rugby union teams. Coaches were observed pre- and post-intervention of an education workshop based on the CEF. Coaches had nine training sessions video-recorded and analysed using the Coach Analysis and Intervention System (CAIS). Coach perceptions of their relationship with their athletes were measured using the Coach-Athlete Relationship Questionnaire (CART-Q), while athlete perceptions of their coaches behaviours were measured using the Coaching Behaviour Scale for Sport (CBS-S). CAIS results revealed coaches increased the use of 'Management' and 'Feedback' behaviours ($p < 0.05$) post-CEF, without altering prominent high-volume behaviours (e.g., 'Instruction'). Coaches utilised similar time proportions for CAIS 'Practice', 'Playing' and 'Management' states respectively with no significant change post-CEF. CART-Q and CBS-S results revealed positive perceptions between coaches and athletes for both pre- and post-CEF. The alteration in coach behaviours post-CEF, coupled with the positive perceptions of both agents of the coach-athlete dyad, is an encouraging step forward for the further implementation of the CEF.

Fair starts for all: Exploring multisensory reaction times in deaf and hearing populations to develop a novel athletics standardised starting system

Libby Steele, Gavin Lawrence, Vicky Gottwald

When competing alongside hearing athletes, d/Deaf athletes typically use variable starting systems. Methods to increase d/Deaf inclusion like lights or vibrating armbands exist but the opportunities for fast reaction times (RT) - a critical element of a fast 100m sprint start - are unequitable, resulting in marginalisation of d/Deaf athletes. To inform the development of a standardised starting system, research investigating RT differences in auditory, visual, tactile, and bimodal stimuli across d/Deaf and hearing groups was conducted. Thirty nine

participants (d/Deaf n=17; hearing n= 22) completed a rapid arm movement towards a target upon stimulus presentation on a manipulandum to measure RT. Results showed significant main effects for group and stimulus modality, and a significant group x stimulus modality interaction ($p < .001$). Breakdown of this interaction revealed group RT differences for all modalities except for visual-tactile stimuli. These findings not only emphasize the need to develop a starting system that promotes equality between populations but also highlights sensory inequities on the starting line. Present findings advocate a visual-tactile system since neither group has a sensory RT advantage on the start line. This provides sound evidence and direction to inform the development of a standardised starting system, increasing equality and access for d/Deaf athletes.

The relationship between conscious movement control and monitoring and inhibition of golf putting

Yihong You, John van der Kamp

Increased conscious movement control and monitoring has been found to impair motor performance in sports. Nonetheless, emerging evidence suggests increased conscious movement control and monitoring may facilitate inhibition of movements. Because the evidence is still weak, we further examined the relationship between conscious movement control and monitoring and inhibition. We reasoned, based on ecological and dynamic systems approaches, that conscious movement control and monitoring acts to reduce the degrees of freedom to be controlled, allowing faster inhibition compared to movements for which control is distributed over larger number of degrees of freedom. We asked novice golfers to putt balls. In 37.5% of trials, an auditory cue was presented during the downswing, signalling participants to stop the downswing as quickly as possible. Participants also completed the Movement Specific Reinvestments Scale (MSRS). Individuals with high inclination for conscious movement monitoring (CMM, as indexed by the movement consciousness factor of the MSRS) displayed higher stopping rate. We also found that higher CMM was associated with longer stopping times. Further exploration of the kinematics suggested that the inclination for CMM did not directly affect inhibition. Rather participants with high inclination tended to make relatively slow, large amplitude downswings, which granted successful but late stops.

Motor imagery and interoception in the musical brain: A holistic understanding on how professional piano players use the mental imagery and interoceptive skills

Delfin Tursin, Martina Gandola, Naomi Tistarelli, Federica Boschetti, Gabriella Bottini

Motor imagery represents the ability to imagine a movement without overt execution. On the other hand, interoception is the ability to perceive visceral sensations consciously. The present research conducted to investigate associations between the practice of a musical instrument and motor imagery and interoception abilities in a population of pianists. Thus, the present work fits into a research field characterised by a certain complexity of investigations and heterogeneous contributions. It was expected that pianists had better motor imagery abilities than those who were not musicians. In terms of assessing the differences in cognitive abilities between musicians and control groups, we used a methodology aimed to analyse motor imagery abilities, explicitly with the chronometries and implicitly with the Hand Laterality Task (HLT), and interoceptive sensibility. Particularly, HLT analysis showed that there was a main effect of the sight factor ($F(1,30) = 48.725$; $p < 0.001$; $\eta_p^2 = 0.062$) “Longest reaction time” for the palm images (mean: 1395; $SE = 42.8$), back views (mean: 1641; $SE = 45$), and angle ($F(7,210) = 109.606$; $p < 0.001$; $\eta_p^2 = 0.252$). The group factor was not significant ($F(1,30) = 0.451$; $p < 0.507$; $\eta_p^2 = 0.004$). This may be explained within novel frames of mental rotation tasks in which performance at the task would underlie by visuoperceptual process. The interaction analyses showed that there was a three-way interaction laterality by view, by angle was significant ($F(7,219) = 10,550$; $p < 0.001$; $\eta_p^2 = 0.017$). In interoceptive awareness, there were no significant differences emerging from the comparison between the two groups (BOA: $X^2 = 0.0891$; $p = 0.765$; SUP: $X^2 = 2.0617$; $p = 0.151$). Therefore, this may be explained in the light of the subsisting relationship between stress and interoception.

Feasibility of Parkour-style training in team sport practice: A Delphi study

Ben William Strafford, Keith Davids, Jamie Stephen North, Joseph Antony Stone

To better understand the potential applications of Parkour-style training for athlete development, this study aimed to interrogate expert consensus on the feasibility of integrating Parkour-style training into team sport practice, by employing a three-round, online Delphi method. Strength and conditioning coaches and talent

development coaches working in team sport settings were invited to participate. Twenty-four coaches completed Round One, 21 completed Round Two and 20 completed Round Three. In Round One, coaches answered 15 open-ended questions across four categories: (1) General Perceptions of Parkour-style training; (2) Potential Applications of Parkour-style training; (3) Designing and Implementing Parkour-style training Environments; and (4), Creating an Inclusive Learning Environment. Responses from Round One were analysed using reflexive thematic analysis with deductive and inductive coding resulting in 78 statements across three dimensions (Application of Parkour Style Training in Team Sports; Designing and Implementing Parkour-style training Environments; Overcoming Potential Barriers when Integrating Parkour-style training). In Rounds Two and Three, coaches rated these statements using a four-point Likert scale and measures of collective agreement or disagreement were calculated. This study established consensus around a set of design principles for integrating Parkour-style training into team sport practice routines.

Conscious or Unconscious? A neurophysiological examination of explicit and implicit motor learning

Eduardo Bellomo, Andrew Cooke, Germano Gallicchio, Christopher Ring, James Hardy

Motor learning can be explained via a chunking mechanism whereby individual elements of a movement are progressively combined with practice. Different modes of training (e.g., explicit, implicit) are said to influence the rate of learning and robustness under pressure, but the underpinning mechanisms are unclear. This experiment examined the behavioural and neurophysiological features of explicit and implicit modes of training. Forty participants were assigned to an explicit or an implicit learning group. They practiced (day 1: 4 x 40 trial blocks) and were then tested (day 2: 40 trials low-pressure, 40 trials high-pressure, 40 trials low-pressure) on a 12-element serial reaction time task. We used electroencephalography to measure premovement cortical activity across the scalp, and we used the time intervals between each element of the sequence to assess practice-induced chunking. Both modes of training conferred chunking. However, explicit learners achieved greater chunking than their implicit counterparts, and displayed more parietal activation and less connectivity between parietal and other scalp regions, inferring a more anticipatory mode of control. The performances of both groups peaked during the high-pressure test. Our findings reveal distinct neurophysiological features of explicit and

implicit learning pathways. Implications for future skill acquisition research will be discussed.

Effects of neurofeedback training on frontal midline theta power, shooting performance and attentional focus in experienced biathletes

Thomas Toolis, Andrew Cooke, Marko Laaksonen, Kerry McGawley

Frontal midline theta power (FMT) has been associated with superior rifle shooting performance. Our experiment examined whether electroencephalographic-based training could increase FMT, shooting performance and attentional focus in experienced and elite biathletes. Participants ($n = 28$; age, $M = 21.7$, $SD = 2.3$) were assigned to a control group or an intervention group (with 3 h of neurofeedback training). FMT increased from baseline during the neurofeedback training sessions ($p < 0.05$). However, there were no group \times pre-post training (test) interactions for FMT or shooting performance ($p > 0.05$). There was a small group \times test effect for attentional focus ($p = 0.07$; $\eta_p^2 = 0.12$), indicating a potential benefit of neurofeedback training. Superior shooters were more proficient at increasing FMT during neurofeedback training, but this did not translate to greater improvements in shooting performance. Inter-individual differences in the neurofeedback response and suggestions for how practitioners may adopt a more targeted approach to future neurofeedback interventions will be discussed.

The effect of rugby-specific physiological load on anticipation of genuine and deceptive cutting actions

Colm P. Murphy, Stefan C. Pagliarini, Robin C. Jackson

High levels of physiological load, such as those experienced in the dying moments of competition, have been shown to detrimentally affect athletes' ability to judge opponent intentions. However, researchers have thus far only investigated fatigue effects when anticipating genuine action outcomes. We hypothesised that the additional attentional demands of response inhibition associated with deceptive actions would result in more pronounced fatigue effects than for genuine actions. To test this, we investigated the effect of a rugby-specific fatiguing protocol on skilled rugby players' judgment of change-of-direction. Participants viewed 1-vs-1 defensive rugby scenarios in which the opponent performed either a genuine (no sidestep) or deceptive (sidestep) cutting action. Anticipation accuracy was maintained in the early stages of the four-phase fatiguing protocol with a drop in accuracy observed only in the final

compared to the first and second block of the protocol. The drop in performance occurred despite increased mental effort over the course of the protocol. The fatigue protocol similarly impaired all perceptual judgments and did not selectively impair the ability to inhibit an incorrect response to a deceptive action. Findings add to growing evidence highlighting fatigue effects on anticipation.

Examining golf putting performance in representative environments using the Zen Greenstage

Joseph Stone, Ben Strafford, Laura Carey, Nick Middleton, Will Stubbs

Research informing practice on golf putting can often lack a representative performance environment (e.g., laboratory-based). However, recent advances in technology (e.g., <https://www.zengreenstage.com/>) has enabled changes in how to design indoor, instrumented golf putting practice environments. Although empirical investigations on how to best enrich golf practice and performance using such technology are required. Here, we present initial findings from a series of research protocols which examine green reading skill and putting performance across varying representative environments. Thirty-three golfers (from -25 handicap to Tour Professionals) completed data collection. Each participant undertook a series of putting tasks in a counterbalanced order 1). Repetitive Test (16 straight putts); 2) Representative Test (24 unique putt locations 3ft- 20ft with a range of slopes on green stage from <1 to $>2\%$); 3). Green Reading (24 putts across three different surfaces). Performance measures, eye tracking and kinematic data were recorded for each task. Initial findings demonstrate the highest putting performance scores were during the repetitive putt design. Performance was lowest for the most representative putts with golfers unable to reliably read the green accurately. We are currently completing the final data analysis of all measures which will be ready to present at the conference.

Movement kinematic and postural control differences when performing a visuomotor skill in real and virtual environments

K. Brock, S.J. Vine, J.M. Ross, M. Trevarthen, D.J. Harris

There is growing interest in virtual reality (VR) for training sporting skills. There are, however, important questions to be answered before VR can be seen as an evidence-based training methodology. For instance, immersive technologies, like virtual, augmented, and mixed reality, pose a novel challenge for our sensorimotor

systems as they deliver simulated sensory inputs that may not match those of the natural environment. Consequently, skills learned in VR may also not match those of the natural environment. In this study we explored the impact of a VR environment on swing kinematics, postural control, and conscious movement processing. Participants completed 20 putts 1) on a real-world artificial putting green, 2) in a VR environment, and 3) in mixed reality, using VR putting with added haptic feedback from a real ball. Differences in swing were observed both between the real-world and VR, and between VR and mixed reality. Both virtual conditions were also associated with postural control that was more regular and less complex, indicative of a conscious mode of control. Conversely, participants reported less conscious awareness of their movements in VR. These findings highlight how fundamental differences may exist between virtual and natural environments, which may impact training applications.

Construct validity of 360-degree video to capture anticipation performance in international Pathway Cricketers

Oliver R. Runswick

Temporal occlusion approaches with 2D video are frequently employed to test and train anticipation. However, these stimuli cannot display all the information that would be present in a performance setting. Affordable and accessible 360-degree video cameras and virtual reality headsets (HMDs) offer alternatives. Here we aimed to assess the construct validity of these methods. A 360-degree temporal occlusion cricket anticipation test was created at a first-class ground and incorporated field settings and game scenarios with recommendations from international coaches. To test construct validity, we compared performance of three highly skilled groups and gathered participant feedback. 80 international pathway cricketers who were playing at Under 16, 18, or 19 level anticipated the landing point of 27 deliveries using 360-degree video in an HMD. Players found the method more engaging than the 2D counterpart and results supported construct validity through main effects of age group ($F_{2, 66} = 3.17, p = .04, \eta_p^2 = .09$) and specialist position ($F_{3, 76} = 6.10, p < .01, \eta_p^2 = .19$) on anticipation performance. Older batters and wicket keepers performed best. Temporally occluded 360-degree video displayed in HMDs offers a new valid method to capture anticipation performance with enough sensitivity to differentiate between highly-skilled groups.

Perceptions of presence and effort in international pathway cricketers using 360-degree video and virtual reality

Oliver R. Runswick

Virtual reality (VR) and 360-degree video can provide athletes with opportunities for practicing elements of performance that are not otherwise possible in training. 360-degree video is relatively cheap and simple to develop and implement but cannot offer an interactive experience. VR can offer an interactive and flexible tool but can be a much higher expense. This leaves organisations with questions as to the cost/benefit of implementing these technologies. Here we aimed to gain an initial understanding of players' perceptions of 360-degree video and VR training. 39 international pathway cricketers played five overs in the VR cricket simulation Cover Drive Cricket and in a 360-degree video recording where they were required to anticipate rather than strike the ball. After trying each technology, players completed questionnaires to measure perceptions of presence and task workload. Participants reported significantly higher levels of realism, possibility to act, and quality of interface in the VR simulator (all $p < 0.05$). Relating to workload, the VR simulator required significantly higher physical effort, imparted higher temporal constraints, and offered higher task control (all $p < 0.05$). VR offers enhanced presence and physical elements compared to 360-degree video, but the cost and purpose of implementation against 360-degree video should be considered based on individual needs.

Developmental activities in women's international pathway cricket

Oliver R. Runswick, Di Lewis

Growth of investment in women's cricket has led to development of new professional pathways. However, there is lack of specific evidence to support the development of female athletes. Understanding who is competing in new professional squads and their developmental backgrounds is key to supporting players. Here we study the development of 84 women who were selected into professional cricket academies in England. Players completed the Participation History Questionnaire (PHQ) to elicit the amount and type of activities engaged in across their development, including milestones, cricket activity, and engagement in other sport activity. Players displayed early engagement in cricket and over 75% of the sample has a brother. There were also large levels of diversification, with an average of four other sports played until the mid-teenage years. Time use was characterised by low levels of peer led-play

and high levels of engagement in practice and match play across the development span. Many players were engaged in boys or men's cricket before the women's game and played with men for the majority of their time until reaching their mid-teens. Findings don't support a single model of player development but offer useful insight for further development of the women's professional game.

Are you up for the challenge? Age trends of challenge in practice across female youth soccer athletes

Carrie M. Peters, David T. Hendry, Nicola J. Hodges

Engaging in appropriately challenging practice is critical to success in sport. Deliberate and purposeful practice amounts (instructor informed, effortful and specific to improving performance), are related to sport expertise. Based on definitions of quality practice from motor learning and expertise literature, we developed the Challenge, Effort and Purposeful Practice (CEPP) instrument. It was designed to assess whether athletes are engaging in good quality practice. Youth (U14-U18) female soccer athletes (N = 55), across different levels of competition, completed the CEPP and a practice history survey probing challenge in practice. CEPP scores were related to current practice hours/week ($r_s = .31$ to $.46$). Based on cross-sectional data, CEPP scores increased with age for athletes who were professionally coached, but not for grassroots athletes. When practice histories were considered on a within-participant basis and participants provided ratings of practice challenge each year, challenge perceptions generally increased from elementary to high-school for grassroots athletes, but surprisingly decreased for higher-level athletes. Although data collection is ongoing, with age and skill, higher-level athletes are more likely to be engaging in quality 'deliberate' practice. However, with increased capacity to engage in quality practice the overall perception of the practice as 'challenging' may decrease.

Gender differences in soccer penalty goalkeeping

Ran Zheng, John van der Kamp, Xinyong Song, Geert Savelsbergh

Despite of the importance of performer (i.e., time required defined by the action capabilities) and task constraints (i.e., time available defined by ball flight time and direction) in the soccer penalty goalkeeping, existing studies only examined variation in one pertinent constraint with male goalkeepers. To address the gaps, the current study compared penalty goalkeeping between male and female goalkeepers of similar skill level, since

time available, time required, and the result of the two (i.e., resultant constraints) may differ for male and female. Our findings revealed that female goalkeepers faced a more demanding resultant constraint than male goalkeepers. Consistent with the affordance-based control theory, both male and female goalkeepers adapted their diving onset to resultant constraints, but with different calibration. Female goalkeepers tended to initiate their lateral dive within the boundaries set by the resultant constraint, whereas male goalkeepers tended to initiate their dive late and beyond these boundaries. As a consequence of the early dive, female goalkeepers saved more penalties than male goalkeepers in non-deceptive penalty penalties. However, female goalkeepers also exhibited greater susceptibility to deception by the penalty taker than their male counterparts.

Relative Age Effects in international rugby union: Consequences of changing the cut-off date and exploring youth to senior transitions

Adam L. Kelly, Daniel Jackson, Donald Barrell, Kate Burke, Joseph Baker

Relative age effects (RAEs) are independent of specific cut-off dates that can vary from country to country. However, the consequences of changing the selection cut-off dates within a national sport organisation are unknown. Further, the transition from international youth to senior representation is yet to be explored in rugby union. Thus, the aims of this article were twofold: Study 1 compared the birth quarter (BQ) distributions of the England Rugby Football Union (RFU) under-18 representatives based on September to August and January to December selection cut-off dates. Study 2 explored the BQ distributions within the RFU international development pathway through analysing the under-18, under-20, and senior representatives, as well as the BQ distributions of youth players who were subsequently capped at senior level. Chi-square analysis was used to compare BQ distributions in each sample against expected distributions. Results revealed a corresponding shift of a skewed birthdate distribution favouring relatively older players that was mediated by specific cut-off dates ($p < 0.05$). Moreover, whilst RAEs were present within both youth cohorts ($p < 0.05$), it was not apparent at the senior level ($p > 0.05$). Furthermore, during the transition from international youth to senior representation, more relatively older players were successfully capped.

Player development pathways in Gaelic football

Philip Kearney

Different patterns of performance development exist in high level athletes (e.g., early entry and steady progression, late entry into high performance). However, limited data has evaluated the relationship between the pattern of performance development and subsequent senior success. Here, the relationships between participation at the three primary representative age groups (U17, U20 and Senior level) in Gaelic football was studied. Data was obtained from an online database. The retrospective pathways of 262 players who had played for the Kerry Senior football team, and the prospective pathways of 380 players who had appeared at U20 level, and the 596 players who had appeared at U17 level were analysed. The most common pathway to senior level involved playing at both U17 and U20 (57.2%), with an even representation of players from the other routes (Senior only, U17 and Senior only, U20 and senior only). Players represented at U17 and Senior only had the most Senior appearances, while players whose first appearance was at Senior level had the fewest Senior appearances. The data illustrates the prevalence of different patterns of performance development in Gaelic football, and raises questions about the quality of - or blindspots within - the current talent development system.

A comparison of in-person versus video-recorded player assessment by English category one football academy scouts

Robin Owen, Seamus Harvey, Ben Smith, Ben Jones

Talent identification is performed by football academies via scouts who traditionally attend football matches in-person. However, no previous study has compared in-person and video-recorded modalities for scouting in football. In the present study, a total of 30 scouts working for an English category one football academy observed the same U14 and U15 inter-academy matches either in-person ($n = 13$) or video-recorded ($n = 17$). Non-parametric analyses compared modalities (in-person vs video-recorded) in relation to: ratings of player performance; scout fatigue, joyalty, attentiveness, and effort during observations; and perceptions of modality accuracy and efficiency. Results did not reveal a significant difference between modalities' player ratings ($p > .05$), despite scouts rating in-person as being a more accurate modality than video-recorded ($p < .01$). The video-recorded modality resulted in significantly greater fatigue ($p < .05$), while requiring similar amounts of effort ($p > .05$), and being rated as significantly more efficient

overall ($p < .05$). The present findings suggest that video-based scouting of academy-level football players offers an adequately accurate, if not perfect in the opinion of scouts, alternative to in-person scouting.

How does pitch shape manipulation effect opportunities for action in 11-14-year-old grassroots footballers? A Pilot Study.

William Pattison, Eileen Africa, Lucas Guimaraes Ferreira, Michael J. Duncan

This study examined affordances for passing behaviour when pitch shape changes. Thirty-three 11-14-year-old grassroots footballers (mean 12.6 ± 0.74 ; height 159.6 ± 9.73 cm; weight 48 ± 10.14 kg) completed two 4-minute 5v5 (no GKs) small-sided games (SSGs) in three pitch conditions: rectangular (REG) measuring 36m x 25m (Length x Width), trapezium narrow to wide (NW) and trapezium wide to narrow (WN) measuring 36m x $(25m + 12m/2)$ (H x $(A+B/2)$). Passing behaviours were quantified as passes that travelled between pitch zones. Six zones were identified: Defensive Centre (DC), Defensive Wide (left and right) (DW), Attacking Centre (AC), and Attacking Wide (left and right) (AW). SSGs were recorded using Sony 4K camcorder, elevated using Sportsmast Pro. Passing behaviours were coded asynchronously using Nacsport Scout Plus. Results revealed WN pitch conditions afforded significantly more opportunities to pass DW-AC and significantly fewer passes DC-AW, thus demonstrating WN afforded greater opportunities to play directly into central attacking areas from defence. NW afforded significantly fewer opportunities to pass DC-DW and DW-DC, therefore indicating NW conditions may encourage expansive play during practice, limiting time and space in defensive areas and therefore promoting passes into forward areas. These findings explain how constraining pitch shape may help coaches create practice conditions that afford the development of intended emergent behaviours.

Investigating the frequency of bilateral skill use and comparing the success between the dominant and non-dominant limbs in the performance of skills in male and female Gaelic football teams.

K. Dillon, I. Sherwin, P. E. Kearney

Bilateral skill in sport refers to an individual's ability to successfully perform sporting actions with both sides of the body. Two scarcely researched areas in relation to bilateral skills are the effects of opposition proximity on skill execution and bilateral skill in high-performance female athletes. All skill executions (hand pass, kick pass,

hop, solo and shot) during 121 games (76 male, 45 female) were coded using Nacsport, with the participants including male and female Tier 1 (n = 181, 134) and Tier 2 (n = 238, 115) adult, high performance Gaelic Football players. Findings reflect previous research with Gaelic football players following the trends of other sports by predominantly relying on their dominant side for the majority of skill executions. Whilst male players were more bilateral than female players, there were clear

patterns between the four tiers, with MT1 using the dominant side less than the other three tiers, and MT2 using the dominant side less than FT1 and FT2. In general, MT1 had higher success percentages than the other three tiers, with shots and kick passes needing further discussion. These findings illustrate the demands of Gaelic football in relation to bilateral skill, providing guidance for coaches' session design.