



8th meeting of Expertise and Skill Acquisition Network

St Mary's University, Twickenham, London

Abstracts

Wednesday 1st May, 2019

Symposium 1: Challenging culturally resilient beliefs in skill acquisition

Presentation 1: Oliver Logan (British Swimming)

Moving away from joystick coaching in swimming skill development: Challenging culturally resilient coaching practices

The presentation will focus on the development of the skills of starts and turns in swimming particularly dolphin kicking which is referred to as the “fifth stroke”. Traditionally coaches in swimming have provided explicit technical instruction supported by high volume of repetition to support the prescribed movement pattern. This presentation will focus on two case studies of alternative approaches to skill development in swimming, incorporating constraints led approach, peer to peer learning and increasing functional variability, via a multi-disciplinary approach. The presentation will also focus on the feedback from coaches and athletes during this process along with biomechanical measurements detailing how the skill changed. Finally the presentation will reflect on the outcomes of the case studies and provide advice for coaches and practitioners looking to take similar approaches.

Presentation 2: Darren Warner (Welsh Judo Association, University of Hertfordshire)

Co-authors: Phil Kearney (University of Limerick) & Mike Callan (University of Hertfordshire)

Start with the end in mind: Creating Britain's first judo World number 1 using a Constraints-led Approach and the implications for pathway coaches

This presentation will begin with an overview of the factors underpinning success in Olympic/World Championship level judo. These factors will be referenced when

unpacking an exemplar training programme for a world-class performer, with specific focus on the periodization of constraints within an athlete-centred approach, and preparation to deliver within a high pressure context. Finally, the presentation will offer a reflection on the implications for club coaches to align their practices with elite judoka development pathways.

Presentation 3: Edward Coughlan (Cork Institute of Technology)

Co-author: Alan Dunton (Cork Institute of Technology)

Have we seen the last of drills?

This presentation will look at the development and progression of the original Karl Newell model for constraints from 1986 and how it has been adapted and adopted by the coaching fraternity in line with a more ecological approach to skill development. Research will be presented that predates the model to create a timeline of the concept and how it links to current evidence within the dynamical systems domain for athlete development. Applied examples will be discussed in relation to how movement and complex perceptual motor skills are best trained through the application of the original model by creating representative tasks within which athletes are encouraged to identify an appropriate action for the problem they perceive.

Oral presentations 1

Presentation 1: Germano Gallicchio (Loughborough University)

Co-author: Christopher Ring (University of Birmingham)

The advantage of a quiet eye: Visual processing or postural stability?

The quiet eye phenomenon describes the performance advantage conferred by a steady ocular fixation on the critical target of an action (e.g., the ball in golf putting) immediately prior to and during movement execution. Remarkably, the mechanisms underlying the quiet eye-performance association are still the subject of debate. This study adopts a novel multi-measure psychophysiological approach to shed light on the mechanisms behind the quiet eye phenomenon. We tested key predictions of two competing mechanisms: that longer quiet eye is associated with enhanced visual processing (visual hypothesis) or with greater postural-kinematic stability (postural-kinematic hypothesis). Thirty-two recreational golfers putted 20 balls to a 2-m distant target on a flat surface. We examined quiet eye durations using electrooculography, visual processing using electroencephalography, and swing duration using kinematic sensors. Occipital alpha power, an inverse neural marker of visual processing, increased prior to and during swing execution, suggesting decreased visual processing compared to a pre-putt baseline. Importantly, quiet eye duration was strongly and positively correlated with swing duration. Our findings refute the claim for enhanced visual processing in the final moments of

closed-loop aiming tasks and support the postural-kinematic account that the duration of the quiet eye is associated with a slow movement execution.

Presentation 2: Viktor Gredin (Brunel University)*

Co-authors: David P. Broadbent (Brunel University), A. Mark Williams (University of Utah), & Daniel T. Bishop (Brunel University)

Judgement utility modulates the use of explicit contextual priors and visual information during anticipation in soccer

Expert athletes integrate contextual priors and evolving visual information to inform anticipation. However, the extent to which the potential costs and rewards associated with their decisions (i.e., judgement utility) impact this process is yet to be explored. Using video simulations, we examined the impact of judgement utility on the integration of explicit contextual priors and visual information as expert soccer players predicted the direction (left or right) of an opponent's actions. Anticipatory judgements and verbal reports of thoughts were compared across three conditions. In two of the conditions, contextual priors pertaining to the opponent's action tendencies (dribble = 70%; pass = 30%) were explicitly provided. In one of those conditions, the players were told that an incorrect 'right' response would result in conceding a goal, which created imbalance in the utility associated with the possible judgements (left = high utility; right = low utility). In the third condition, no contextual priors or additional instructions were provided. It was found that explicit contextual priors changed processing priorities and biased anticipatory judgments in accordance with the opponent's action tendencies. However, imbalance in judgement utility suppressed these effects, and the players became more inclined to opt for the outcome with the higher utility.

Presentation 3: Marie Simonet (University of Lausanne)*

Co-authors: Hadj Boumediene Meziane (University of Lausanne), Oliver Runswick (University of Chichester), Jamie North (St Mary's University), A. Mark Williams (University of Utah), Jérôme Barral (University of Lausanne), & Andre Roca (St Mary's University)

An EEG investigation of the processing of kinematic and contextual information when anticipating cricket batting

Anticipation is the ability to accurately predict the outcome of an opponent's actions ahead of the act itself. This ability relies on at least two sources of information: kinematic and contextual information (Runswick et al., 2018). No data exists to demonstrate how neural activity supports the use of these two information sources. We recorded the electroencephalographic (EEG) activity in 12 skilled and 15 novice cricket players when anticipating deliveries from bowlers with footages including video-based simulations of kinematic information only, contextual information only, and kinematic and contextual information combined. Differences in anticipation accuracy were assessed with a Group (Skilled; Novice) x Condition (kinematic cues only; context only; both combined) mixed

ANOVA. The spectral changes of the EEG signal were evaluated with Event Related Spectral Perturbation analyses. Behaviourally, results are in line with previous studies showing that skilled players showed better anticipation accuracy than novices when contextual and/or kinematic information are displayed. Electrophysiologically, the skilled group presented stronger alpha event-related desynchronisation, namely a decrease in amplitude, compared to novices over frontal and occipital sites in the contextual condition. Findings have implications for those interested in identifying and enhancing the neural mechanisms involved in anticipation.

Presentation 4: Laurence Warren-West (Loughborough University)*

Co-authors: Robin C. Jackson (Loughborough University) & Michael J. Hiley (Loughborough University)

Wait! Does earlier detection of deceptive intent facilitate skilled suppression of incorrect motor responses to rugby sidesteps?

Researchers have suggested that expert performers wait longer before initiating movement responses so that they can obtain more information to inform their decisions (Brault, Bideau, Kulpa & Craig, 2012, PLoS ONE, 7(6): e37494). The aim of the present study is to establish how movement kinematics and kinetics relate to observed effects, response biases and discriminability. We placed high-skilled and low-skilled rugby players (19 per group) in a semi-immersive CAREN Lab and asked them to respond to life-size test footage of an opponent 'cutting' left or right, with or without a deceptive sidestep. Participants were instructed to respond by moving in a way that would allow them to intercept the running line of the player and put them in a position to make a 'tackle'. Three-dimensional motion capture cameras and force plates measured mediolateral displacement and velocity of the responses, alongside the ground reaction forces responsible for movement initiation. Our research has shown that performers are equally susceptible to deception but that high-skilled players identify deceptive intent earlier in the action sequence. In this presentation, we examine how this affects the kinematic and kinetic measures and argue that earlier perceptual recognition is crucial to facilitating suppression of an incorrect motor response.

Presentation 5: David Alder (Leeds Beckett University)

Co-authors: Jamie Poolton (Leeds Beckett University) & David P. Broadbent (Brunel University)

The impact of physiological load on anticipation skills in badminton: From testing to training

Research remains unclear on the impact of physiological load on perceptual-cognitive skills in sport. Moreover, no study has examined the training of perceptual-cognitive skills under physiological load. The current study comprised two phases. Firstly, we examined the impact of badminton-specific physiological load on anticipatory skills in expert

badminton players (n = 13), including key underlying mechanisms, such as gaze behaviour. Under high physiological load, participants displayed less efficient visual search behaviour and showed a reduction in response accuracy. Secondly, we examined the effects of combining perceptual-cognitive simulation training with high physiological load. Ten of the expert badminton players were assigned to a Combined Training group (CT), where the simulation training and the physiological load intervention occurred simultaneously, or an Independent Training group (IT), whereby the two components were completed independently. The CT group showed a positive change in the efficiency of their visual search behaviours compared to the IT group, but no significant performance improvements were found. Overall, findings demonstrate that high physiological load is detrimental to experts' anticipatory skills. However, combining perceptual-cognitive simulation training with high physiological load can potentially negate these debilitating effects.

Oral presentations 2

Presentation 1: Gavin Lawrence (Bangor University)

Co-authors: Ben Jones (Bangor University) & Lew Hardy (Bangor University)

Assessing expertise in cricket using non-linear pattern recognition (machine learning) techniques

Expertise research typically examines a narrow pool of features hypothesized as predictive, such as birthdate, or practice quantity. These features are analysed in isolation, using linear analysis techniques, and the results are generalised to produce theories of expertise development e.g., deliberate practice. However, emerging research has demonstrated that deliberate practice does not sufficiently explain the attainment of expertise. Such inconsistencies suggest the development of expertise is multifaceted, requiring a holistically-driven research approach. The present study adopted non-linear pattern recognition (machine learning) techniques to examine a multitude of features, across theoretical frameworks, and model the development experiences of super-elite performers. We tested the underlying assumptions of existing theory relating to practice quantity, as well as unexplored domains, including the nature and structure of practice, in a comparison of super-elite and elite cricket batsmen. We identify a subset of 18 features, from 658, that discriminate between the super-elite and elite batsmen with 96.25% classification accuracy. Results demonstrate that prospective super-elite batsmen undertake a greater volume of skills-based practice that is both more randomly sequenced and more varied in nature, aged 16. They subsequently adapt to, and transition across, levels of senior competition quicker. Thus optimising challenge at both a psychological and technical level relatively early, is a catalyst for the development of super-elite expertise. Application of this holistically-driven, non-linear, methodological approach to other domains of expertise would prove productive.

Presentation 2: Katherine Victoria Sparks (University of Birmingham)*

Co-author: Christopher Ring (University of Birmingham)

The effects of sport-specific conscious processing on competitive performance under pressure

This study aimed to develop a sport-specific (Rowing-Specific) Conscious Motor Processing (RS-CMP) scale and examine its validity, reliability and prediction of performance in comparison to the Movement-Specific CMP (MS-CMP). Furthermore, it investigated CMP differences as a function of rower's years of experience and whether a major rowing choke could be characterised by higher than average RS-CMP scores. 127 rowers completed a survey post competitive race. The survey included the MS-CMP, RS-CMP, a perceived performance rating scale, demographic and race information to identify and record the rower's actual race performance. Additionally, 'crabbing' instances were observed and recorded. Results from the research, demonstrated that RS-CMP had overall good reliability, construct and criterion validity. The RS-CMP predicted performance better than MS-CMP. RS-CMP scores were lowest for the least experienced rowers and increased with experience, but plateaued at 10+ years. Lastly, the crabbing cases possessed RS-CMP scores above or slightly below the average confidence levels. Therefore, this study overall demonstrates the importance of sport-specific scales, with RS-CMP better predicting performance over MS-CMP. Additionally, the study reveals that conscious motor processing might aid competitive performance in highly experienced athletes.

Presentation 3: Jamie Poolton (Leeds Beckett University)

Co-authors: Mitchell Joiner (Leeds Beckett University), Andrew Manley (Leeds Beckett University), Paul Parker (Defence Medical Service, University College Cork), Adrian Mellor (Defence Medical Services, Leeds Beckett University), & John O'Hara (Leeds Beckett University)

Hypoxia impairs the performance of tasks designed to reproduce the in-situ demands placed on military medical response personnel

Military medical response teams are expected to execute complex medical tasks at altitudes often exceeding 10,000ft during disaster-relief and conflict scenarios. High altitude may create a hypoxic state that prevents adept execution of important medical tasks. Therefore, it is crucial to better understand the influence hypoxia has on medical proficiency. Thirteen non-medically trained participants performed a battery of perceptual, cognitive and motor tasks at sea level and at a simulated altitude of 12,000ft (i.e., in a hypoxic state). Four perceptual-cognitive tasks were designed to test temporary information storage, time estimation, risk aversion and logical reasoning. These tasks were performed alone and alongside a perceptual-motor task designed to simulate a surgical skills training activity. At 12,000ft, participants reported heightened anxiety and felt that the task demands had increased. The hypoxic state impaired temporary information storage and influenced logical reasoning. Furthermore, hypoxia compromised perceptual-motor performance, but only when participants also needed to attend to certain perceptual-

cognitive tasks. Findings suggest that hypoxia negatively influences processing efficiency and performance effectiveness of tasks designed to reproduce the in-situ demands commonly placed on medical response teams. The next step is to provide context by testing medical personnel completion of simulated medical response problems at high altitude.

Presentation 4: Sam Vine (Exeter University)

Virtual reality for sport: A reality, or virtually impossible?

The aim of this talk is to address the growing interest in Virtual Reality (VR) technology for sports research and training. The adoption of head mounted VR is increasing, as a number of commercial companies market devices to coaches, athletes, and researchers. But the evidence base underpinning the use of this technology in sport is limited. As such this talk will briefly review the available empirical evidence; explore the potential for further research and development; and generate debate and discussion about the efficacy of VR as a training tool and research paradigm. More specifically, empirical evidence of VRs efficacy as a learning, rehabilitation and tactical tool will be discussed, and contrasted with industries in which VR is already successfully widely adopted. Flaws in the perceptual-cognitive fidelity of VR, and the subsequent effects on perception-action coupling will be proposed. Finally, the potential for VR as an experimental tool, to enable manipulation of perceptual, cognitive, and emotional factors associated with expertise, will be highlighted.

End of Day Presentation

Ludovic Seifert (University of Rouen)

The functional role of movement coordination variability: How ‘degenerate’ neurobiological systems are able to exploit system stability and flexibility in their movement coordination?

The aim of this talk is to discuss the functional role of movement coordination pattern variability. To achieve performance goals in competitive sport there is a need to strike a delicate balance between movement pattern stability and variability because, although athletes need to achieve consistent outcomes, they also need to be able to successfully adapt their movements to changes in the performance environment. My talk will emphasise that movement coordination variability should not necessarily be construed as noise, detrimental to performance, nor should it always be viewed as error, or a deviation from a putative expert model, which should be constantly corrected in learners. A key idea is that movement coordination pattern variability can be viewed as a functional property of skilled performers to help them adapt their movement behaviours to changing task constraints (e.g., when switching from a single to joint action, or when switching from constant to variable practice). In particular, I will discuss how a neurobiological system property, degeneracy (i.e., many coordinative structures to achieve one function), can help

us understand how skilled individuals functionally adapt perception and action to interacting constraints during performance.

Thursday 2nd May, 2019

Keynote presentation: Naturalistic Decision Making (NDM) and expertise

Dr. Julie Gore (University of Bath)

Naturalistic Decision Making (NDM) research has developed over the past three decades to become a mainstream applied research paradigm. NDM models, tools and techniques have been utilised in domains as diverse as aviation and aerospace, banking, sport, music, energy production and distribution, defence, ground transportation, nuclear, manufacturing, maritime, medicine, oil and gas, and rail. This self organising community of practice which includes NDM scholars and practitioners, examine ill-structured problems; uncertain dynamic environments; shifting, ill-defined or competing goals; action/feedback loops; time stress; high stakes; multiple players, constrained by organizational goals and norms. Using examples from a range of professional groups, this presentation will contend that an understanding of NDM theory and methods may be helpful to practitioners and academics working with professionals' cognition and decision making under uncertainty. Evidence from field studies show that experts engage in adaptive, flexible sensemaking and research has utilized novel methodologies for examining and eliciting the processes of this expert tacit knowledge. This presentation will review these methodologies and the emerging evidence that NDM offers a *post* Kahneman framework to increasing our understanding of positive professional expert heuristics.

Symposium 2: An Ecological Dynamics framework for practitioners

The aim of this symposium is to provide an overview of ecological dynamics to facilitate understanding of skilled performance, movement variability, affordances, creativity, and representative practice design. A key aspect of skill acquisition involves the discovery of affordances and shared affordances in social coordination by attuning to information that specifies these affordances (i.e., the education of attention). Indeed, through exploration, performers learn to pick up informational variables that support behavioural adaptations relative to variations in the context of performance. Furthermore, interacting constraints in the surrounding environment can shape emerging behaviours of performers, and key information should be sampled from performance environments to be represented in practice tasks. The identification of key interacting constraints that shape emerging behaviours can be informed by empirical research and experiential knowledge of coaches and performers. The symposium will highlight theoretical concepts, research findings, and case studies to provide applications and implications for practitioners.

Presentation 1: Ludovic Seifert (University of Rouen)

Exploration, affordances & creativity: Contribution of the Ecological Dynamics framework

Depriving or restricting participants in their exploration might hinder affordance perception and recalibration. For example, not allowing participants to move degrades their capacity to judge the maximum distance they could reach; not allowing participants to see degrades their capacity to judge an object they could grasp. In the short term, exploratory actions often lead to task failure and might be observed in novices. However, research following ecological dynamics framework suggested that exploration could also support creative actions as it reflects the exploitation of 'degeneracy' property in neurobiological system. A key aspect of acquiring skill involves the discovery of affordances by attuning to information that specifies these affordances (i.e., the education of attention). Indeed, through exploration, performers learn to pick up informational variables that support behavioral adaptations relative to variations in the context of performance. My talk discusses how exploration could reflect creative actions, i.e. novel and functional actions adapted by the individual in response to problems, which exist both in novices and experts.

Presentation 2: Ric Shuttleworth (Rugby Football Union)

Ecological Dynamics in sport: Experiential knowledge of elite performers and coaches on 'what is skilled performance behaviour'

In this presentation, we will discuss recent data that explores coaches' and players' experiential knowledge about skilled performance behaviour in elite rugby union to further our understanding of how to facilitate the design of more representative practice tasks. Insights from dynamical systems theory and ecological psychology frameworks were used to conceptualise athlete and team development, considered as complex adaptive systems. The purpose behind this thesis was to explore and challenge current thinking and understanding about skill acquisition in rugby union, particularly in light of empirical research that suggests skill acquisition is better framed as skill adaptability involving functional relationships with a performance environment. A series of studies were designed to explore experiential knowledge from some of the most skilled performers and elite coaches in international rugby union to gain a concise understanding of what actually is skilled performance behaviour, how it can be nurtured and developed and finally captured within a high performing system. Data revealed key concepts that guided coaches and players in the co-design of practice environments focused on: (i) the individual-environment relationship, (ii) self-organising behaviours, (iii) interacting constraints shaping behaviours and (iv), designing opportunities for action or affordances into landscapes for learning, intertwined in the physical, psychological, emotional and social dimensions of expertise acquisition. These ideas were evidenced in the practice and performance needs expressed by expert players to be able to perform skilfully and many of the components highlighted shared common beliefs and intentions between players and coaches such as promoting; co-design of practices, local to global self-organising tendencies, and enhanced functionality through co-adaptive interactions in training. Practice designs evolved through the co-adaptation of coach and player identifying the

importance of providing specifying information (highly functional information for regulating actions) through a purposefully and individually designed rich landscape of affordances. The findings had some clear implications for how researchers, coaches, players and practitioners could view: skill, talent development, learning design, athlete development, coaching, coach education (differences between performance and development coaching), and organisation of athlete development systems. A nonlinear pedagogical conceptual framework will be presented which has been used with professional coaches in rugby union and across a range of sports with varying skill levels to facilitate skill adaptation processes using representative task design and constraints manipulation appropriate to learner needs and capabilities.

Presentation 3: Chris Pocock (St Mary's University)

Using experiential knowledge to identify key constraints in competitive performance environments: Implications for representative practice environments

Symposium 3: The use of video feedback to develop tactical knowledge and game understanding

Performance analysis in sport is now more accessible to coaches, clubs, and organisations due to the rapid growth in technology over the last two decades and the development of enhanced analysis software. The integration of digital video footage and computer technology has led to cost-effective, easy to use performance analysis systems that are now an integral part of the coaching process in many sports (Hughes & Franks, 2007). Furthermore, coaches perceive video-based performance analysis to be beneficial to the coaching process as a support tool that facilitates learning (i.e. specifically anticipation and decision making more broadly 'game understanding') and develops a mutual understanding between the coach and player (Groom, Cushion, & Nelson, 2011). Wright, Atkins, and Jones (2012) reported that 84% of coaches surveyed had access to match footage and edited clips that they used to provide feedback to other coaches, support staff, and athletes. In addition, interactive video feedback and internet technology systems allow the engagement of athletes beyond the formal coach-led feedback session at times and locations that are convenient (Donoghue & Mayes, 2013). There are a number of anecdotal examples of performance analysis and its impact on performance, such as former Manchester United goalkeeper Ben Foster reviewing video footage of Tottenham Hotspur's penalty takers on an iPod ahead of the 2008–2009 Carling Cup shoot-out (Fifield, 2009). However, there is limited scientific evidence documenting how, or even whether, such interventions improve performance and/or learning. This shortcoming is particularly relevant when considering the paucity of research focussing on the potential role of metacognition in developing anticipation and decision making. The lack of data is somewhat understandable because unlike controlled laboratory studies, there are many variables that can impact on performance, so researchers have been discouraged from measuring the effectiveness of performance analysis support systems (Donoghue & Mayes, 2013). The aim of this symposium is to address these shortcomings by reviewing research and practice addressing the use of video feedback to develop tactical knowledge and game understanding in sports.

Presentation 1: Allistair McRobert (Liverpool John Moores University)

The use of video feedback to develop tactical knowledge and game understanding: A scientific perspective

In presentation 1, we will outline the role of performance analysis within the coaching process and highlight how video feedback is currently used as a tool to develop reflection and game intelligence. Second, we discuss the theoretical and conceptual underpinning to these interventions by reviewing research on metacognition and perceptual-cognitive adaptations that support the use and effectiveness of performance analysis in developing anticipation and decision making. Finally, we propose some suggestions for future research, so that we can enhance scientific understanding of the role and effectiveness of performance analysis in developing perceptual-cognitive skills.

Presentation 2: Alex Scanlon (The Football Association)

The use of video feedback to develop tactical knowledge and game understanding: A perspective from The Football Association

In presentation 2, we will introduce the current performance analysis services delivered across the development pathway with England Teams in soccer, discussing the change in the department's vision, mission and objectives over the course of the last three years. Second, we will provide practical examples of the use of video feedback in this setting to plan and review training sessions and games against the England DNA, playing principles and coaching philosophy. Finally, we will share some current work that aims to increase ownership, engagement and learning with the players off the pitch, and how this links in with practice design and coaching sessions that challenge understanding and adaptability.

Presentation 3: Pam Richards (Wrexham Glyndwr University)

Operationalisation of tactical shared mental models: Integrating off-field reflection with in-action, on-field training/competition to accelerating team decision-making

In presentation 3, we will examine the development of high-pressurised team decision-making in elite sport. Specifically, the presentation will explore how shared mental models relating to tactical play can be operationalised in high-pressurised elite competitive sport. The presentation will present a decision-making framework which integrates both 'off-field' slow deliberate reflective training environment (psychosocial) with rapid 'on-field' training/competitive settings (psychomotor). The emphasis will focus on how video can be used in 'off-field' training settings to enhance the development of shared mental models which are transferred and used to accelerate 'on-field', in-action, team decision-making. Practical examples will be explored using the sport of netball, football and hockey and suggestions for future work shared.

Posters

Kevin Smith (Cork Institute of Technology)

‘What are they coaching and how are they coaching it’: An analysis of coaching behaviours across different age grades of amateur rugby union

Coaching may be regarded as a complex interaction between a coach and an athlete. The behaviours that underpin this dynamic relationship are determined by the experiences of both coaches and players and the traditions of the sport (Partington & Cushion, 2013). Rather than an interplay between coach and athlete, coaching often follows a more didactic approach of prescriptive instruction. The purpose of this research was to examine coaching behaviours and bidirectional coach-athlete relationship across different grades of amateur rugby football union. Participants were coaches ($n = 3$) and players ($n = 75$) from three separate teams (child, adolescent, adult). Each teams coaching practice was audio and video recorded on three separate occasions and analysed retrospectively using the Coach Analysis and Intervention System (CAIS). Athlete’s perceptions of their coaches were measured using the Coaching Behaviour Scale for Sport (CBS-S) questionnaire while coach’s perception of their relationship with their athletes were measured using the Coach–Athlete Relationship Questionnaire (CART-Q). Preliminary data from the ongoing current research gleaned via the CAIS, CBS-S and CART-Q appears to indicate a trend towards didactic coaching, which may counter the expected positive questionnaire responses of perception from the athletes and coaches.

Paul Dancy (St Mary's University)

The effect of equipment modification on novice cricket players’ batting performance

Equipment modification research has confirmed that the constraints associated with scaled compared to standardized (adult) equipment afford junior athletes more effective technique and facilitate higher levels of performance (e.g., Buszard, Farrow, Reid & Masters, 2014). However, it is possible that increasing the surface area available to junior athletes to make bat-ball contact could increase performance success and the underlying technique, over and beyond the benefits associated with traditional scaling. Therefore, this study investigated the effect of modified junior cricket equipment (wider bats and oversized balls) on batting performance and technique when compared to traditionally scaled junior cricket equipment. Forty-three children ($\text{Mage} = 5.2 \pm 0.8$ years) participated in the study. Each participant batted in four conditions with modified and traditionally scaled bat and ball equipment. Both the number of successful bat-ball contacts and shot accuracy were higher in oversized ball compared to traditionally scaled ball conditions ($p < .05$). Moreover, technique scores were higher in modified (wider) bat compared to traditionally scaled bat conditions ($p < .05$). Our findings support and extend previous research recommending the use of modified equipment for skill acquisition in junior sports programmes.

Emma Jane McLoughlin (Brunel University)

Characteristics of expert decision making in Gaelic football: A focus group study

Research examining expert decision-making in sport predominantly uses experimental approaches, however, this fails to provide an understanding of how experts make decisions and the pertinent sources of information that they use. The current study utilised a focus group methodology to provide a more in-depth understanding of the characteristics of expert decision-making in Gaelic Football. Five focus groups were conducted: two with senior elite players (n=5; n=6), two with U17 academy players (n=5; n=6), and one with elite coaches (n=4). Participants watched video clips of All-Ireland senior football championship games, where action was paused at key moments. Participants individually wrote down what they thought the player in possession would do at the key moment and also what they perceived to be the best option for the player in possession. Following this, the group shared their recorded responses and views, including the information sources they used to make their decision, and then saw the remaining action in the clip. The focus groups lasted 60-120 mins. Participants also completed the Decision-Specific Reinvestment Scale, the Risk Propensity Scale, and the Attentional and Interpersonal Style questionnaire; median splits of the data derived from these measures were used to make between-group comparisons. Thematic coding and analysis were used to identify and categorise emergent concepts. The findings will be discussed in relation to skill acquisition and talent development in invasive team sports.

Sam Jermyn (Cork Institute of Technology)

An investigation into the impact of training with a weighted football on kicking distance in Gaelic football

Training protocols incorporating weighted equipment have been shown to increase distance following an acute loading period in sports such as baseball and shot put. This study explored the acute effects of training with a weighted football on kick distance in Gaelic football. Participants were assigned to either a Standard Ball (480g) or Weighted Ball (600g) group. On Day 1, baseline testing assessed kick distance with a standard Gaelic football from 5 maximal efforts off a 3cm kicking tee with the preferred kicking leg. Distance was measured from where the ball landed within a graded grid and subsequently cross-referenced with video footage. A wind threshold of 2m/s was applied to all test trials. On Day 2, both groups executed 10 kicks. The standard ball group kicked 10 standard footballs, while the weighted ball group kicked 5 weighted footballs followed by 5 standard footballs. The mean of the final 5 trials of each participant was measured and compared to the mean baseline distance. It is hypothesised that kicking with a weighted football immediately prior to kicking a standard football will result in greater kick distance.

Thomas Simpson (Edge Hill University)

A systematic review of motivational and attentional variables to children's fundamental motor skill development: The OPTIMAL Theory

An external focus of attention, enhanced expectancies and autonomy support are key independent and interactive characteristics which enhance motor learning. These OPTIMAL characteristics have proven supportive of adult's motor learning yet, their effect on children's motor learning is comparatively under- explored. Thirty-seven studies were systematically reviewed to outline the impact of OPTIMAL variables on children's motor learning, specifically fundamental movement skills (FMS). Twenty-one studies examined an external focus of attention, whereas relatively few addressed enhanced expectancies (n = 9) and autonomy support (n = 7). Only 2 explored the interaction between OPTIMAL variables. Results show emerging evidence that OPTIMAL variables contribute to children's effective motor learning, however the motivational underpinnings require further research (e.g. self-efficacy and perceived competence). Moreover, an external focus of attention was generally more effective for motor performance, but the benefits for learning are less clear. Individual differences are also highlighted. Despite this initial support a paucity of research regarding the impact of OPTIMAL variables across the full FMS range (i.e. a skewness towards object manipulation skills). Additionally, there is a need for future combinatory research addressing OPTIMAL variables in children (e.g. enhanced expectancies with autonomy support). These results have implications for movement specialists working with children.

Paul Ellison (Edge Hill University)

Visual search strategies in gymnastics coaching: Exploring the effects of skill complexity and coach experience

Gymnastics movements are complex and temporally challenging for coaches to observe. Ascertaining coaches' visual behaviour during skill observation may identify the information informing coaching decisions and feedback. This study aimed to explore whether differences in coaches' visual search strategies across skills of varying complexity were related to experience and qualification. Twenty female gymnastics coaches (age: 21.75 ± 4.5 yrs; coaching experience: 4.7 ± 4.6 yrs; and qualification level: L1=9; L2=6; L3=5) viewed 24 videos of under 16yrs. gymnasts performing a variety of skills in four clusters (Acrobatics; Floor; Rolls; Jumps). Coaches identified the primary correction required in each video, whilst a Tobii Pro X2-60 screen based eye tracker recorded scan path, visual fixations and durations in Areas of Interest. We will present the major areas of the body focused upon by coaches, the sequence of fixations, and how the complexity of the skill and the expertise level of the coach influenced these variables. These results suggest that gymnastics coach development may benefit from including bespoke training to educate coaches visual strategies during the observation of performances. Differences within visual search patterns between coaching levels is dependent on the skill being performed and its complexity.

Adam Kelly (Birmingham City University/Exeter City FC)

Relative age effect reversal in an English professional football club

The relative age effect (RAE) refers to the bias influence of birth date distribution, with athletes born later in the selection year being under-represented in youth talent

development systems. However, a ‘relative age effect reversal’ (RAER) has also shown that younger birth quarter (BQ) athletes are then over-represented among those who successfully transition from youth development systems to senior professional status in sport. Accordingly, the purpose of this study was twofold; 1) to provide a further test of the RAE (n=192), and 2) to examine the existence of the RAER in an English professional football club academy (n=364). Significantly skewed ($P<0.001$) birth date distributions were found for both current (BQ1 n=79; BQ2 n=60; BQ3 n=34; BQ4 n=19), and retrospective (BQ1 n=145; BQ2 n=108; BQ3 n=54; BQ4 n=57) player data. The distribution for retrospective data was also significantly skewed for professional contracts awarded ($P<0.001$), with BQ4 over-represented (n=8) compared to other BQs (BQ1 n=5; BQ2 n=8; BQ3 n=6). These findings suggest that the RAE continues to manifest within an academy setting. Interestingly, however, the RAER shows BQ4s were four times more likely to achieve senior professional status compared to BQ1s. Implications for talent identification and development in football are discussed.

Martyn Rothwell (Sheffield Hallam University)

Exploring forms of life in player development pathways: The case of British rugby league

Social, cultural and historical constraints, categorized as a form of life, guide the complex interactions that underpin learning and development of athletes. A form of life in sport organisations is exemplified by the specific pedagogical approaches, organisational settings, and structural mechanisms which underpin athlete development (Henriksen, Stambulova, & Roessler, 2010a). An important challenge is to identify how a form of life in athlete development programs will help practitioners understand how socio-cultural and historical constraints influence the type of practice environments that coaches design to enhance athlete performance (Rothwell, Davids & Stone, in press). Although a form of life can influence how sports organisations implement athlete development programs, research exploring this relationship is limited (Uehara, Button, Falcous & Davids, 2016). To generate research in this area, this study adopted an ethnographic methodology to conduct a season long intervention of a professional British Super League clubs academy. Findings identified beliefs towards practice and player learning, competing paradigms of learning and developing, and masculine values and control as the constraints that influence athlete learning. These insights imply that coaches and performance managers should consider the form of life when designing athlete development programmes to enhance athlete potential.

Nicholas Kalakoutis (Oxford Brookes University)

Comparing the effects opposed and unopposed practices have on skill acquisition and transfer to the competitive environment

Research examining performance solely during practice phases may not necessarily reproduce action fidelity or transfer, (Maloney et al., 2018). The fidelity of athlete behaviour in learning tasks can be impacted when practitioners remove key ecological constraints to create non-representative practice conditions, (Shim et al., 2005). Understanding what action-specifying information sources must be preserved within a

practice to maintain its representative nature is paramount. This study aims to contribute to research replicating typical sports training programmes that can be applied to real world settings and used by sport practitioners. An 8-week data collection period consisting of filming competitive matches and training sessions, kinematic testing, and a 5-week training intervention will be completed using a university men's football team. The 5-week intervention will consist of opposed/unopposed training groups, both practising non-dominant foot kicking for 25 minutes over 10 training sessions. A kinematic analysis will be completed pre/post training intervention examining changes in kicking kinematics. Insight into the effect each practice may have on transfer of non-dominant foot kicking will be measured by analysing footage focusing on success rate/usage rate of participants' non-dominant foot in competitive matches. In light of this, this poster will illustrate the provisional emergent findings from this ongoing project.

Phil Birch (Chichester University)

Smart phone video analysis during practice affects focus of attention and performance in skilled golfers

Focus of attention (FOA) has been shown to affect motor learning in novice learners, predominantly using artificial manipulations in lab tasks. However, little consideration has been given to FOA in skilled practice environments in which personal video analysis is commonplace. We aimed to investigate the effect of video analysis on skilled golfers' FOA and practice and competition performance. 19 golfers (handicap: $M = 5.79$, $SD = 5.80$) were assigned to a practice only or practice with video group. Range based pre-tests were completed prior to a four week practice intervention during which the video group recorded and analysed their own swings. Practice diaries were completed to measure FOA. Range based post-test were completed and participants provided competition scores pre and post intervention to assess retention and transfer. The video group reported a more internal FOA than the practice only group. There was significant time \times group interaction for on range performance in which the practice only group improved during the intervention whereas the video group performance declined. There was no significant change in competition scores. Personal video analysis can induce internal FOA and future research should incorporate skilled samples and transfer tests to establish if FOA effects extend to competition.

Zoe Wimshurst (AECC University College)

Visual skills of elite athletes: A screening study

A comprehensive visual screening could be used to help identify if there are differences in the visual abilities of athletes compared to novices, as well as athletes from different sports. The findings of such a study could then be used to design and monitor training programmes to enhance such visual skills. The hypothesis of the current study was that differences in visual skills would be seen in athletes of different abilities and from different sports. Two hundred and sixty-five athletes representing 23 different sports (plus a control group of 35) each took part in 13 different visual tests. Of the athletes who took part 130 were senior internationals, 117 played and the top club level within their sport and

18 were junior internationals. Following a Principle Component Analysis, ANOVA results showed that there were significant differences between males and females ($p < .001$), between athletes of different abilities ($p < .001$) and between athletes of different sports ($p < .001$). The results suggest that different visual skills are important across different sports and that elite athletes may require better visual skills than athletes of a lower level.

Oliver Runswick (Chichester University)

The effect of match play context on cognitive effort and perceptual-motor performance in golf putting

Sport-specific context, such as the score of the game or opponents action tendencies, has been shown to affect processes such as anticipation and decision-making. However, little work has investigated whether context affects cognitive load, gaze behaviour, and performance in closed skills such as golf putting. We test predictions of Cognitive Load Theory (CLT; Sweller, 1988) to investigate the effect of task specific context on cognitive load, quiet eye duration, and performance in novice learners. Altogether, 21 novice participants completed golf putts in three different conditions that manipulated context using match play scenarios (putts to win, half, or practice) while pupil dilation, quiet eye duration, and radial error were measured. Results show a main effect of context on performance with decreased radial error in putts to win compared to practice. Participants also engaged in significantly longer quiet eye durations in putts to win and half compared to practice. There was no effect of context on pupil dilation. This suggests that context can be added to learning environments for novices to enhance practice performance and specificity without overloading cognitive resources. Furthermore, context should be incorporated in applied research designs that aim to investigate perceptual-motor processes, such as quiet eye, in a realistic environment.

Harry Ramsey (Portsmouth University)

An exploratory analysis of variability in the visual control and coordination of basketball free-throw shooting

Shooting analysis of variability between and within individuals can reveal important information regarding skilled performers information-movement strategies. The present study aimed to: i) determine inter and intra individual differences in gaze behaviour across 5 skilled performers in the basketball free-throw; and ii) use novel, exploratory analysis to relate gaze behaviour and movement coordination in a case study of a skilled performer. Gaze data were recorded using a portable eye tracking system (Tobii Pro Glasses 2) and coordination data was recorded using a motion capture system (Qualisys, Sweden) while participants performed free-throws until 10 successful and unsuccessful shots were made. Observation of QE duration at the individual level revealed large variations between individuals and large intertrial variation for each performer. Additionally, coordination data revealed elbow angle at ball release, and the coupling between elbow angle and velocity through the movement, to be important variables for success in the free throw. There was no clear trend between QE duration and elbow angle at ball release with respect to performance outcome. These findings emphasise the need to consider inter and intra

individual analysis in future studies and the need to develop new approaches to integrating gaze and coordination data.

David Harris (Exeter University)

Assessing the effect of virtual reality training on quiet eye durations and golf putting performance

The increasing capabilities and accessibility of virtual reality (VR) technology has led to growing interest in the use of VR for training sporting skills. Currently, however, it is unclear to what extent virtual training holds benefits for real-world performance. Additionally, for VR to be an effective training tool it must develop psychological factors, such as control of attention, in a manner akin to the real world. There is, however, limited understanding of how VR training might impact variables such as quiet eye - a functional gaze behaviour characteristic of expertise in target and aiming tasks. In this study, putting performance was assessed at baseline on both a virtual (using HTC Vive head-mounted display) and real-world putting task. Participants were then assigned to either real or virtual putting practice and returned to the lab for a retention test. Quiet eye was assessed during real-world putting using head mounted eye tracking. These findings will indicate whether virtual training is likely to transfer to real-world performance and whether perceptual-cognitive skills can develop in VR in the same way as in the real world.

Kirsty Brock (Winchester University/ AECC University College)

A simple dual task improves novel skill learning

Dual-tasks have been shown to improve novel skill learning in discrete movement tasks, however, it is unknown whether this transfers to continuous movement tasks. Therefore, the purpose of this study was to determine whether dual-tasks aid learning of a novel, continuous movement task. Forty-five participants (25 male, 20 female; age: 22.50 ± 5.63 years) were divided into three groups; control (Con), simple response (SR) and choice response (CR). The novel task involved 42 training trials of an Xbox Kinect bowling game which involved no secondary task (Con), responding to a simple audio cue by saying now each time the cue was played (SR) or a choice audio response task which involved determining whether a cue was high or low pitch (CR). Baseline measures were taken before the start of training and a retention test was performed at the end of training. Greater improvement was observed in the dual task conditions than the Control condition (SR: 97.67%, $p = 0.86$; CR: 64.49%; $p = 0.937$). Results indicated that training in a simple dual-task condition provides the greatest benefits to novel skill learning. These findings have important implications for skill acquisition.

Laurence Warren-West (Loughborough University)

Sidesteps and signal detection: Deceptive actions bias responses and impair discriminability

When using the temporal occlusion paradigm, researchers have traditionally studied responses to deceptive actions. Examining the time window where players resolve deception, improving from low to high response accuracy (e.g., Brault, Bideau, Kulpa and Craig, 2012, PLoS ONE, 7(6): e37494). Remarkably, the period where players become deceived has yet to be examined. The present study addresses this by examining both susceptibility to, and detection of, deception in rugby union players using signal detection analyses. High-skilled and low-skilled participants (19 per group) responded to 168 trials, showing a player 'cutting' left or right, with or without a deceptive sidestep. Trials were occluded at seven time points relative to the footfall after the initial (genuine or fake) reorientation (deception window: -600ms to -300ms; resolution window: -300ms to 0ms). High-skilled ($M=0.40$) and low-skilled players ($M=0.39$) were equally susceptible to deceptive intent ($P=.62$, $\eta_p^2=.01$) but high-skilled players were significantly better at resolving deception ($P=.004$, $\eta_p^2=.21$), indicated by better discriminability ($P=.001$, $\eta_p^2=.25$), reduced bias toward judging actions to be genuine ($P=.02$, $\eta_p^2=.14$), and earlier improvements in both these indices ($P=.01$, $\eta_p^2=.12$). We conclude that experts are highly susceptible to deception but can respond more effectively than lesser-skilled players through earlier detection of deceptive intent.

Matt Shaw (Chichester University/Inner Drive)

An in-situ investigation into cognitive processes of professional and amateur golfers when green reading

When performing in high-level sport, decision-making is key to success. The ability to make superior decisions has been explained through Long-Term Working Memory Theory, which predicts that experts are better able to retrieve information from long-term memory to interpret stimuli. Within golf, making decisions about the pace and line of a putt is of vital importance. However, there is a paucity of research examining the processes that underpin green reading. Here 12 professional tour golfers and 6 amateur golfers (\geq Category 2) took part in an in-situ task that involved walking from tee to green on a par three hole and executing different length putts while thinking aloud. We predicted that professional golfers would identify key features on the green and verbalise more statements related to prediction, and planning the upcoming putt. Findings showed a significant interaction between group and statement time ($p < 0.05$) during the walk to the green and when on the green prior to a putt. Professional golfers verbalised more about gathering information whilst walking from tee to green and more about planning and prediction when on the green prior to the putt. Findings support LTWM and have implications for coaching of green reading in golf.

Francesco Dimundo (Birmingham City University/Worcester Warriors RFC)

Talent identification and development in male rugby union: A systematic review

Both the identification of talent and the development of expertise among young athletes remains a contemporary challenge. The aim of this systematic review was to synthesise the body of literature addressing the talent identification (TID) and talent development (TD) processes exclusively in rugby union (RU). Searches using combinations of relevant

keywords were conducted in five databases using the PRISMA procedure. After the initial search returned 382 records, 34 studies met the inclusion criteria; 1) English language, 2) male participants, 3) original and peer-reviewed data, and 4) RU data specifically researching TID and TD. A cumulative 46,069 participants were measured across a combined total of seven major factors. The ecological dynamics framework was applied to collate factors from the one-dimensional (OD) and multidimensional (MD) findings; 1) *Task constraints* (OD=0, MD=2): (a) participation history (OD=0, MD=2); 2) *Performer constraints* (OD=9, MD=45): (a) psychological (OD=1, MD=0), (b) technical and tactical (OD=2, MD=8), (c) anthropometrics (OD=3, MD=18), and (d) physiological (OD=3, MD=19); 3) *Environmental constraints* (OD=3, MD=8): (a) relative age effect (OD=3, MD=4) and (b) socio-cultural (OD=0, MD=4). Results suggest there appears to be a predisposition towards anthropometrics and physiological performer constraints research, with limited inclusion for task constraints, psychological factors, and socio-cultural influences.

Matthew Andrew (Liverpool John Moores University)

Developmental activities of elite British rugby league players

Currently, literature has examined the development activities of athletes from a wide range of sports, but not rugby league. Therefore, we examined differences in the development pathways of elite British rugby league players who progressed to professional status in adulthood, compared to those who were released. Participants were elite rugby league players who had progressed to professional status (Professional; $n = 26$), been released (Ex-Academy; $n = 18$) and a control that had only played recreational rugby league (Recreational; $n = 14$). Participants completed a modified rugby league-specific Participation History Questionnaire (PHQ) containing milestone data and hours accumulated in rugby-specific activities (competition; practice; play). Though the PHQ revealed no differences in playing milestones (p 's > 0.05). Consistent with the early engagement pathway, players that progressed to professional status engaged in significantly ($p < 0.01$) higher total hours in rugby-specific play (6081 ± 3995) and practice (3071 ± 1630), compared to players who did not gain professional status (play = 3167 ± 1169 ; practice = 1974 ± 734) or had never played elite rugby (play = 1901 ± 670 ; practice = 998 ± 463). Findings from this study may inform future practice of talent development systems within rugby league in Britain.

Natalie Meder (Exeter University)

The effects of cognitive training on perceptual-cognitive performance under high and low pressure

Despite being heavily marketed, there is a lack of empirical research on screen-based cognitive training (CT) and its efficacy in real-world environments. The most critical aspect of CT, transfer to the real world, has some evidence, however, the findings from studies are inconsistent. Far transfer effects are typically tested using motor tasks performed in low anxiety environments, and as such, there is a paucity of research examining CT effects on perceptual-cognitive skills and performance under pressure.

Aiming to overcome these limitations, we examined the effects of 3D-Multiple Object Tracking training (NeuroTracker) on performance in a perceptual- cognitive task, in low and high anxiety conditions. Participants were allocated to one of five groups (Group 1: 5 training sessions over 10 days, Group 2: 10 training sessions over 5 weeks, Group 3: 27 training sessions over 9 weeks, Group 4: Active control, Group 5: Passive Control). All five groups were tested for working memory capacity, and perceptual-cognitive performance at baseline and post-training. Findings will contribute fundamentally to our understanding of CT regimes and their transfer to real-world performance. Furthermore, they will increase the understanding of the influence of general cognitive mechanisms on perceptual-cognitive tasks in sports in high- and low-pressure conditions.

Benjamin Franks (University Campus of Football Business/Oxford Brookes University)

Investigating the representative nature of perceptual research experiments: (Re)understanding football goalkeepers expertise

Amidst the continued theorising and objective epistemological approach to perceptual research (Michaels and Beek, 1995), there remains little clarity regarding what information athletes use to direct decision making in performance settings (Dicks et al, 2010). There is now a consensus that skilled performance is subject to an athletes ability to locate and interpret key specifying information (Vickers, 2006). However, experimental design often fails to represent the performance environment (Vaeyens, 2007; Williams and Grant, 1999). The Quiet Eye (QE) depicts the final fixation towards a specific location within 3* of visual angle for a minimum of 100ms (Vickers, 2016). It is reasonable to suggest that QE describes the variable to examine the relationship between perception and action (Panchuk and Vickers, 2006). Eye Tracking Glasses (SMI-ETG) were used to capture eye behaviour of professional goalkeepers. QE data will be collected in the traditional penalty kick design (Dicks et al, 2010; Piras and Vickers, 2011) and a novel dynamic task with a moving ball. 4 goalkeepers took part in both conditions over the course of a season. Using a vision-in-action method (modified from Klostermann et al, 2018) QE data was extracted and two tailed independent t-tests applied across the two trial conditions. Findings were significant across all QE measures (onset, offset, duration and location) and performance measures (number of saves). Implications exist for pursuing more representative experimental conditions to understand goalkeeping expertise. We also offer support for practitioners designing goalkeeper-training programmes.

Alan Dunton (Cork Institute of Technology)

An ecological approach to spatial occlusion during a control and passing task in football

In sport, skills such as anticipation and decision-making have been used to identify the difference between elite and sub-elite players. However, research is limited in the application of spatial occlusion for sport performance. This research uses an ecological and tri-phasic approach to assess the impact of training with spatial occlusion goggles on a control and passing task in football. Phase one is designed to assess participants' ability to

control a pass from a player who will move to a new location to receive the return pass. Phase two has an additional player who is a “decoy runner”, adding a level of difficulty, to force the receiver to scan for the original passer to complete the play. Phase three adds a further additional player to act as incoming opponent to decrease the scanning time of the receiver to complete the control and pass play. It is hypothesised that participants who complete an acquisition phase with the spatial occlusion goggles will improve pass response time and pass accuracy once full visual conditions are returned in the post-test. Note: Data collection is currently in progress with analysis to be completed before ESAN allowing for the presentation of results.

Danny Powell (British Swimming, Manchester Metropolitan University)*

Motor skill learning at British Para swimming: Current practices in relation to focus of attention and contextual interference

Experimental research in skill acquisition has demonstrated that motor skill learning is enhanced as a function of external (vs. internal) focus of attention instructions (Wulf, 2013), and of high levels of variability (contextual interference) during practice (Magill & Hall, 1990). Despite this, observational research in elite sport indicates that coaches typically adopt instructions which facilitate an internal focus (e.g., Diekfuss & Raisbeck, 2016; Guss-West & Wulf 2016), and conduct training sessions which involve low levels of contextual interference (Buszard et al., 2017). The current study sets out to assess coaching practices in relation to both focus of attention and contextual interference within the British Para swimming World Class Programme via three lines of analysis: (i) athlete surveys, (ii) coach surveys, and (iii) video recorded training sessions. Preliminary results from the athlete survey suggest coaches use instructions which include more internal (53%) than external (47%) focus cues, and more often conduct practice sessions under conditions of low contextual interference (44.5%), compared to sessions involving high levels of either within-skill (32.9%) or between-skill (22.6%) variability. These initial findings indicate that coaching practices at British Para swimming may be sub-optimal for skill learning.