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Keynote Speakers

Dr Andrew Cooke

Andy is a member of the Institute for the Psychology of Elite Performance at Bangor University. He has a BSc in Sport Science (Bangor University, 2004-2007) and a PhD in Psychophysiology (University of Birmingham, 2007-2010). Andy worked as an ESRC Postdoctoral Research Fellow at the University of Birmingham (2010-2012), before returning to Bangor University as a Lecturer in the School of Sport, Health and Exercise Sciences (2013-Present). His research employs a multi-measure approach (e.g., brain, eyes, heart and muscles) to investigate: a) the psychophysiological mechanisms underpinning human performance; and b) psychophysiological interventions to enhance performance (e.g., neurofeedback training). It covers a range of performance domains including sport (e.g., preparatory cortical activity distinguishes successful from unsuccessful golf putts), health (e.g., effects of neurofeedback on the motor symptoms of Parkinson's disease), and transportation (e.g., effects of gaze-training on driving), and has been supported by a variety of funders (e.g., ESRC, NHS, AXA insurance, England and Wales Cricket Board). Outside of work, Andy enjoys watching and participating in sport, where he tries to employ the performance-optimization techniques that he researches.



Dr Stafford Murray

Since January 2017 Stafford has been Head of Innovation at High Performance Sport New Zealand. Prior to that he was the Head of Performance Analysis, Biomechanics and Skill Acquisition at the English Institute of Sport from 2002. Stafford took the disciplines from 0 to 40+ staff members over that time; overseeing the provision and development of interventions to all key Olympic, Paralympic and Commonwealth Sports. As a practitioner, Stafford delivered Performance Analysis services to numerous elite sports over a 20-year period (Including South African Cricket, Welsh Rugby and Football, England Squash, McLaren F1 racing and numerous Olympic and Paralympic Sports) at some 23 World Championships, 5 Commonwealth Games and 3 Olympic Games. He has also consulted to Qatar Aspire, ECB, Shell Oil and Cisco Communications.



During that tenure, Stafford was also seconded as Team Leader for the England Squash Team in Delhi CWG's 2010, Head of the Team GB analysis service at London 2012 Games, one of the team leaders in the Lion's Den for Team England at the Glasgow 2014 Games, Head of Team GB Analysis at Rio 2016 and held the role of Performance Lead to 5 Olympic and Paralympic Sports (quality assuring and managing all sports science service provision to these sports).

Stafford holds a PhD and 3 further postgraduate qualifications, publishing extensively in the area of Coaching Science and Analysis of sport (20+ peer reviewed papers, 21 book chapters, 2 books and multiple sports science / coaching magazine features), mainly in the areas of analytical profiling in elite sport, feedback science and the search for individual differences amongst elite sporting performers.

Dr Clare MacMahon

Clare is a Senior Lecturer at La Trobe University, with expertise in motor learning and skilled performance. Her research examines the reciprocal effects between movement and cognition. In particular, Clare's research has focused on expertise in judgment and decision making in sport, exploring the development of sports officials and characteristics of their training and performance, methods to train and influence choices (e.g., above real time decision training; biases in officiating decisions), and talent identification and development in the Australian context. Current work examines the influence of cognitive fatigue on physical performance, which she applies to her own struggles in physical performance (or lack thereof) as an academic.



Graeme Robson

Graeme Robson is a former national athlete and coach. He is also a former physiologist but moved from the "dark side" into coach support in the early 2000s. He is passionate about the role of skill acquisition in coaching and is an enthusiastic promoter of the use of evidenced based protocols in assisting coaches develop their athletes. Part of his role at High Performance Sport New Zealand is to promote better use of skill coaching. Graeme facilitated development of the New Zealand Skill learning Framework.



Keynote Presentations

Under the hood: What are the cortical correlates of motor skill acquisition, and how can the brain be trained?

Andrew Cooke, PhD¹

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What determines optimal motor performance? One way to address this question involves the measurement of brain activity during motor performance, using electroencephalography (EEG). Research adopting this approach has revealed that alpha waves (brainwaves that oscillate at a frequency of 8-12 Hz and are involved with neuronal inhibition) may play a key role. In the first part of this talk I will present EEG alpha data from experiments comparing experts and novices, and experiments charting how brainwaves change with practice, to demonstrate that the inhibition of movement-unrelated regions of the brain (e.g., temporal and occipital) and the gating of activation towards movement-related regions (central) is important for success. This research sheds light on the mechanisms underpinning motor proficiency. In the second part of this talk, I will present some recent applied work aimed at teaching athletes to recreate the brainwaves for optimal performance at will. Using a form of brain training called neurofeedback, golfers were able to volitionally shape their brainwaves during their pre-putt routine, while untrained cyclists were able to boost their time to exhaustion by 30%. The implications of these findings, and recommendations for future skill acquisition research, will be discussed.

Reciprocal effects between movement and cognition

Clare MacMahon, PhD¹

¹*La Trobe University, Australia*

There are numerous examples of how our body states influence our thinking. For example, making a fist increases men's self-esteem (Shubert & Koole 2009), and mimicking a genuine smile results in less stress and faster physiological recovery from a stressful task (Kraft & Pressman, 2012). A rapidly expanding area of research examines how our cognition influences our movements. A particular focus is understanding the effects of cognitive fatigue on physical performance. In multiple studies, engaging in demanding cognitive tasks is associated with a decrement in performance on a subsequent physical task (e.g., MacMahon, Schücker, Hagemann & Strauss, 2014). This is not always the case, however, with studies finding that endurance performance and physical skills with greater relative reliance on perceptual-cognitive skills seem to decline following the completion of a cognitive task, while anaerobic performance tasks can be maintained despite cognitive fatigue (e.g., Pageaux, Marcora, Rozand, & Lepers, 2015). The complexity of the area is evident in that the research has used a variety of cognitive tasks to induce fatigue, and tested the effects on a variety of physical tasks (e.g., handgrip,

cycle time to exhaustion, running 3 km time trial, soccer shooting skills tests). To make sense of the findings, Aitken and MacMahon (2019) propose that a key variable in the relationship between performing a cognitive task and the impact on subsequent physical performance is whether the two tasks share central executive function demands. Going beyond this proposal, this talk will present our lab group's adaptation of Newell's (1986) constraints framework to this area of research to provide a research roadmap to explore the multiple factors, mediators, and moderators, that may influence the relationship. This framework is presented to highlight the next stages of the research.

Questioning the status quo of analysis and innovation in sport

Stafford Murray, PhD¹

¹*Innovation Manager, High Performance Sport New Zealand*

Innovation in sport is now commonplace amongst the best sporting nations across the globe. Where sporting performances are ever improving and margins of victory ever decreasing, it is essential that our practise as sports scientists, sports engineers, coaches and athletes is constantly changing and challenging the status quo. Predictive analyses suggest that a successful performance in the 2016 Rio Olympic and Paralympic games is unlikely to produce a podium finish in the upcoming Tokyo Games in 2020.

Innovation is a vastly used word in modern sport. But what is innovation in sport? By definition, innovation is something novel, bespoke, or customized. However, within elite sport if a 'new' idea or intervention has no impact on performance then it is purely an idea. In sport, innovation is frequently associated with technology (hardware and software development), which often it is. One of the largest areas of innovation in sport is the creation of novel wearable technologies (on humans or equipment) that capture huge amounts of data. The enduring question for sports scientists and coaches is why are we capturing these huge amounts of data (are we performance question or technology led?) and more importantly how can we optimally analyse the data (data analytics, statistical processes, computer vision, AI, etc) and subsequently feed it back (data visualisation, feedback science, learning preferences, etc) to our athletes/coaches in an efficacious manner?

Critics say that elite sport has become an 'arms race' and that 'technological doping' is creating an unlevel playing field. However, innovation in sport is not solely a new piece of technology it is any novel intervention, process or model that induces a performance change. In this presentation I will explore all types of sporting innovations, subsequently analysing how we can better apply these within the elite sporting landscape.

The New Zealand Skill Acquisition Framework

Graeme Robson¹

¹*High Performance Sport New Zealand*

The provision of support services (e.g., strength & conditioning, performance analysis, physiotherapy etc.) for coaches and athletes has shown great development over the last 20 to 30 years or so in high performance sport in New Zealand. But one area that has remained relatively dormant is that of skill acquisition – this has largely been left to the coach, based on the premise that skill acquisition is in fact “coaching”. However, much of the progress seen in skill acquisition/motor learning research over this time period has not necessarily been reflected in the practice of coaches. Three

years ago a project was implemented to design a framework to help inform coaches of best practice when coaching skill – a key component of this was to use evidence based research in its design. The framework was constructed by 3 academics with input and critique from 8 applied practitioners who support high performance coaches across a range of sports. The framework is constructed on 3 levels – an adaptive approach to skill learning (the constraints led approach), recognition of the factors that impact on how learning occurs in a sporting context and the issues that coaches need to consider around movement when athletes execute a skill. The framework will be presented along with feedback from coaches who have seen it over the last couple of years.

Oral Presentations

Effects of blue light on postural control in older adults

Beaven, C.M.¹, Uiga, L.¹, Hébert-Losier, K.¹

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Falls are a major economic burden and risk factor for mortality in older adults. Over half of all ACC claims by people 65+ are a consequence of falling, costing an estimated ~\$1,700 million in 2010. Blue light interventions can improve cognitive function and performance in fine motor tasks, but the potential impact on postural control with relevance to falling is unknown. Sixteen older adults [age 74 ± 8.1 y (65 to 82)] participated in four randomised and counter-balanced sessions with light delivered visually (Luminette®) and/or aurally (Human Charger®) for 12 minutes. Postural control, reaction time, and cognitive function were assessed before and after the light intervention. Force plate-derived centre of pressure data [95th percentile ellipse (95%E)] differentiated participants that reported falling in the past 12 months from non-fallers when balance assessed for 60 s with eyes closed ($p < 0.01$). Overall, visual exposure to blue-enriched light clearly decreased 95%E [Effect size (ES) = 0.26 ± 0.37], whereas the aural exposure was ineffective (ES = 0.01 ± 0.26). Reaction times (RT) also tended to discriminate fallers from non-fallers, who displayed faster RT in response to the congruent stimulus of a flanker selective attention task ($p = 0.12$). Overall, the aural intervention clearly decreased RT from 538 to 504 ms (ES = 0.42 ± 0.37). The brief light interventions were capable of altering measures associated with prior fall history in older adults. Novel light interventions may provide a potential countermeasure to decrease the financial and human costs of falls.

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The eyes have it – measuring the cognitive load of intuitive decision making strategies in elite athletes

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The ability to select and execute good decisions under extreme time pressures is an ability that has been demonstrated by elite athletes in many sports. However, what is lesser known about these decisions is the underlying processes that underpin them and in particular how athletes make good decisions under extreme time pressures. An approach that has begun to receive

some attention in the literature is the use of intuitive strategies. This study aims to understand the decision making process of elite athletes through the use of a common psychophysiological measure, pupil dilation.

Twelve elite field hockey athletes and 12 non-athletes will complete a series of video-based tasks (one hockey-specific decision making task and two non-sport specific tasks) to measure the underlying processes they adopt. In all of these tasks, the cognitive load of the participants will be measured using the pupil dilation recorded from a mobile eye tracking device.

Based on pilot study data, we hypothesise that in the non-domain specific tasks, there will be no differences in accuracy or cognitive load between groups. In the hockey-specific task, we anticipate that elite athletes will demonstrate a lower cognitive load compared to non-athletes. Given that intuitive decisions are characterised as requiring less cognitive processing compared to more deliberative decisions, the findings of this study will provide evidence of the intuitive strategies that elite athletes adopt.

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Defining tactical competency in Netball: Using the Delphi method to capture expert coach knowledge.

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Traditional methods for understanding change of possession (turnovers) in team-based invasion sports have not accounted for how the dynamic, interactive actions of multiple players contribute to turnovers. One approach is to access the expertise of highly skilled coaches to determine the important tactical behaviours that create turnovers. In this study, we synthesised expert opinion from 12 experienced netball coaches with a consensus-based method (the Delphi method). The expert group undertook one-on-one interviews followed by two rounds of questionnaires to develop a list of 18 tactical behaviour definitions developed into the Tactical Principles Guideline

(TPG). The tactical behaviours can be grouped thematically into four overarching tactical principles, including; space and movement, timing, support and reading play. Each of the four tactical principles is derived from interactions between multiple players highlighting that, in high level netball, turnovers typically result from the team dynamics rather than from individual player behaviours (i.e., a poorly executed pass). Therefore, when using game statistics to assess performance it is important to acknowledge that errors and successes are the result of the interactions of multiple players on court, and not solely a reflection of individual players' tactical ability. In this context, the (TPG) has been incorporated into a Netball NZ player profiling tool as it is seen to be the first step in enhancing the effectiveness of coach and player communication, tactical behaviour assessment, as well as informing selection processes.

Use of a brake power meter to quantify skill in mountain biking

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Power meters for measuring pedalling power have become widely used in the sport of cycling. Here, we use a similar technology to measure the power taken away from the bicycle through braking. We have developed and patented a brake power meter, which was subsequently validated by comparison to reductions in kinetic energy during braking events. The current research is designed to identify differences between skill levels in regards to braking.

Participants completed two laps of a mountain bike course at a "race pace". The brake power meter recorded instantaneous braking power. The downhill portions of the course were then analysed to find correlations between different braking variables and the time to complete the downhills. The highest correlations ($R^2=.93$) were found between time and a normalized brake power, where power was divided by the instantaneous kinetic energy of the rider and bicycle and then integrated over the downhill section.

The brake power meter is a valid method for measuring braking during mountain biking. Moreover, differences in skill levels and performance can be determined using the normalized brake power. This technology could be used in the future to provide feedback during training and competitions to improve descending performance.

(Thres)Hold my beer while I use executive functions as a talent identification tool in football

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Executive functions (EF), such as response inhibition, working memory updating, attention shifting and action planning, are higher-level cognitive functions for regulating attention, thoughts and action, which have previously been associated with performance in football (Vestberg et al., 2017). However, no study has investigated longitudinal changes in EF in a cohort of elite athletes to examine if increased exposure to high level training is related to superior EF performance. This study used 1-6 observations of EF in 304 German football players aged between 10-21 years. Individual and age-cohort specific segmented linear models were developed using a Bayesian approach to structural equation modelling to describe the 'breakpoints' associated with the development of domain-generic and domain-specific EF measured using a battery of five EF assessments.

The results revealed that the slopes for domain-generic and domain-specific EF decreased with increasing age (domain-generic: late childhood 29.4 (22.6-36.8), adolescence 24.8 (21.3-28.0), post adolescence 6.4 (2.9-9.9), adulthood 8.71 (5.1-12.0); domain-specific: late childhood 0.5 (0.1-0.9), adolescence 1.1 (0.9-1.3), post adolescence 0.1 (0.0-0.2), adulthood 0.1 (0.0-0.3) arbitrary units). Furthermore, no consistent influence of field position was observed, with only goalkeepers scoring worse than on-field players.

Despite previous research showing a positive relationship between EF and sporting expertise (i.e., the higher the EF the more expert the performer, Sakamoto et al., 2018), this study showed that in elite populations, just like in a general population, improved EF are likely a result of the maturation of the central nervous system (Zelazo et al., 2004), rather than a result of increased exposure to high level sport. Additionally, EF likely adhere to the 'threshold hypothesis', where increases in EF are only related to performance below a certain EF threshold. Therefore, their use as a prognostic tool in talent identification and development in high level athletes is questionable.

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Propensity for conscious control of movement is unrelated to hypermobility or injury-risk scores

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The Movement Specific Reinvestment Scale (MSRS) measures the propensity for conscious control of movement. Conscious control can inhibit automated movement processes, potentially causing movement disruption or injury. Hypermobility individuals present with poor movement control or clumsiness, and high injury risk individuals make more movement errors during jump-landing tasks. Consequently, we examined propensity for movement specific reinvestment in hypermobile and high injury risk participants.

Sixty volunteers (35 males, 25 females) were tested using the MSRS, Beighton hypermobility scale, and Landing Error Scoring System (LESS). Spearman rank correlation coefficients were computed between MSRS, Beighton, and LESS scores. Furthermore, MSRS scores were compared between non-hypermobility and hypermobility, as well as high (LESS ≥ 5) and low (LESS < 5) injury risk participants.

MSRS was not significantly related to Beighton ($\rho = 0.09$, $p = 0.481$) or LESS ($\rho = 0.06$, $p = 0.625$) scores. MSRS scores between non-hypermobility and hypermobility (37.55 ± 9.10 vs 38.59 ± 6.86 , $p = 0.619$), and low and high injury risk (37.81 ± 7.84 vs 38.00 ± 8.64 , $p = 0.931$) participants were comparable.

The origin of poor movement control in hypermobile individuals stems from genetic alterations in connective tissue and proprioceptive deficits, with propensity for movement specific reinvestment not appearing to be a relevant factor. Based on our results, there is also no evidence that movement specific reinvestment contributes to injury risk, which might be due to the phylogenetic and dynamic nature of the LESS jump-landing task.

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Innate injury risk scores change with knowledge of the grading criteria

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Clinicians examine movement patterns during dynamic tasks to identify athletes at high risk of injury. The Landing Error Scoring System (LESS) is one clinical tool used for this purpose. In less dynamic movement screen assessments than the LESS,

individuals with knowledge of scoring criteria are able to alter their innate movement patterns during testing to 'better' their score. We compared LESS scores and risk categorisation before and after providing scoring criteria and information on performance to thirty volunteers. Participants performed 3 x 30-cm drop-jumps for LESS scoring at Baseline and one week later under two conditions: Pre and Post knowledge of scoring criteria and performance. Baseline and Pre errors were similar (6.2 ± 2.5 versus 6.6 ± 2.0 , $p = 0.186$), as was the percentage of individuals at high risk (90 vs 83%, $p = 0.688$). In contrast, LESS errors (4.7 ± 1.2 , $p < 0.001$) and percentage of individuals at high risk (33%, $p < 0.001$) were significantly lower after individuals were provided with scoring criteria compared to Baseline and Pre. The clinical utility of LESS to identify high injury-risk biomechanics and athletes is compromised with prior knowledge of scoring criteria and performance.

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Action deception in combat sports – the case of muay thai

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This paper examines deceptive actions in combat sports. The research uses a cognitive ethnographic approach to address questions on the nature of deceptive actions and the coregulative interaction processes that underlie behavioural dynamics in unique performance settings. I make my key points through ethnographic research on specialised martial arts practices that I have conducted throughout the last six months and particularly zoom in on a decisive moment at the *Yokkao muay thai* fight event 2019 in Sydney. In this moment *muay thai* fighter Singpayak skilfully feints and badly cuts his opponent Lloyd Dean on the forehead and close to settles the fight. I use this example to look into the strategies that fighters employ to make skilful decisions in temporally narrow and constrained settings. I will explore and investigate: 1) philosophical and socio-psychological definitions of deceptive actions including the feint; 2) the semiotics or “grammar” that

fighters rely on during competitive fighting in *muay thai*; 3) entrainment and pattern detection as tools in deceptive actions; and 4) the breaking of those patterns in the pivotal moment of the feint.

The effect of pre-performance unilateral hand contraction protocols on verbal-analytical engagement in motor planning

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Previous studies have shown that left-hand contractions prior to performance reduce the effects of pressure on performance compared to right-hand contractions. Left-hand contractions potentially lessen pressure-driven verbal-analytical control of performance by reducing left hemisphere activity. In this study, we examined the influence of pre-performance unilateral hand contractions on neural markers of verbal-analytical engagement in motor planning. Twenty-eight participants performed pre-performance hand contraction protocols for 45 sec in a randomised order: left-hand, right-hand, control (no hand). Each protocol was followed by 25 golf putts. Electroencephalography connectivity between the verbal-analytical left hemisphere region (T7) and the motor planning frontal region (Fz) was analysed for the 3 seconds prior to the movement, to assess verbal-analytical engagement in motor planning. Putting performance was analysed as well. The left-hand contractions led to significantly lower T7-Fz connectivity before movement initiation compared to the right-hand and no hand contractions, whereas, right-hand contractions led to higher T7-Fz connectivity compared to the other protocols. No significant differences in performance were revealed; higher cognitive demands are possibly required to show effects on performance. Our findings suggest that hand contractions may influence neural activity associated with verbal-analytical engagement in motor performance, by affecting brain asymmetry. This study increases understanding of the cognitive processes potentially responsible for stable performance under pressure after a left-hand contraction protocol.

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Pre-performance routines in cricket bowling

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Pre-performance routines (PPR) have been shown to be beneficial for performance under pressure. Given the limited research on PPRs in cricket bowlers, this study examined the effects of a novel PPR (i.e., centering and self-talk) on bowling performance under pressure.

Participants were six male university cricket team members with average competitive bowling experience of 7.38 yrs (range: 1-17 yrs). Participants bowled two overs in low and high pressure conditions using their own PPR. On a separate day, participants bowled two overs in low and high pressure conditions with the novel routine. State anxiety measures were collected and performance accuracy was recorded. Participants were interviewed about their existing PPRs and their views on the novel routine.

Results showed that the most experienced bowlers (M = 15 yrs experience) performed better under high pressure than low pressure when bowling with their own PPR and similar results were observed with the novel PPR. Interviews revealed that PPRs improved concentration and performance consistency for experienced bowlers. The less experienced bowlers (M = 2.63 yrs experience) did not maintain performance levels under high pressure. The less experienced players rated the novel pre-performance routine as less favourable (M = 5.5/10) than the more experienced players (M = 6.5/10).

Overall, the findings suggest that bowlers' experience should be taken into consideration when introducing novel PPRs specifically designed as a coping mechanism for performance under pressure.

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The role of task constraints in shaping gait regulation in long jump run-ups

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The run-up in sport provides a practical example of a locomotor pointing task in a dynamic performance environment. However, as most of the empirical research on long jumping has taken place outside of the performance environment there is minimal understanding of how competition constraints impact on visual regulation of footfall during long jump competitive performance. This omission is important as recent research has highlighted how performance is shaped by individuals (e.g., athlete intentionality), performance environments (e.g., wind strength and direction) and tasks (e.g., requirement for take-off foot to be behind foul line). This initial investigation will examine how the critical task constraint of placing the take-off foot behind the foul line at take-off in order for a legal jump to be recorded, constrains the emergent coordination tendencies of long jumpers' run-up patterns.

A total of 294 competition jumps (Legal Jumps = 200; Foul Jumps = 94) will be used for the analysis following methodologies which record gait variables during the entire run-up. If athletes are successful in meeting these sport specific demands, it is expected that more functional gait regulation will emerge, with smaller, more systematic adjustments in stride length throughout the run-up compared to when an athlete is unsuccessful. In highlighting these critical differences, coaches and practitioners will be provided with valuable information to ensure that practice design includes the requirement of placing the foot behind that take-off line to ensure athletes are exploring functional movement solutions transferable to performance environments.

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Visual exploratory action variables that contribute to improved passing performance among U13 and U23 football players

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The visual exploratory actions (i.e., scanning head movements) used by football players to perceive their surrounding environment have recently gained increased interest, as the use of inertial sensor technology has enabled efficient data

collection in match-play environments. While this advancement has resulted in important findings relating to visual exploration during natural match-play, these study designs lack the experimental control of laboratory-based experimental settings. Here, we endeavoured to strike a balance between experimental control and representative design. We aimed to understand which visual exploratory action variables best explained passing performance in high level U13 and U23 players.

Fourteen U13 and 13 U23 football players from a Bundesliga club completed a standardised 32-trial sequence in the Footbonaut. Exploratory head movements were recorded with a head worn inertial sensor, from which various exploration variables were extracted. The moment of ball reception and disposal were coded for each trial, and performance was operationalised as the time taken to complete each trial. Across all players, the variables that best explained faster performance were 1) a higher number of head turns before receiving the ball, 2) a lower number of head turns when in possession of the ball, and 3) being an U23 player. However, different combinations of variables explained performance for U13 and U23 players.

Together, the findings demonstrate the value of scanning before receiving the ball in order to prospectively control passing actions, however, further research investigating the development of movement solutions that differentiate younger and older players is needed.

Nonverbal behaviour and its effect on visual anticipation in soccer penalty situations

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Nonverbal behaviour expressed by athletes in key performance situations conveys important information related to success and has been shown to significantly influence impression formation and outcome expectancies in observers. In a recently published study, we aimed to (i) replicate and offer more insight into impression formation effects seen in soccer penalty situations; and (ii) provide initial evidence that penalty-takers' expression of dominance or submissiveness may affect goalkeepers' visual anticipation performance.

In our study, we report three experiments confirming that participants (n = 54; n = 68; and n = 72) form more positive impressions (about player quality) and have less confidence in saving penalty kicks against dominant penalty-takers than submissive penalty-takers (Experiment 1-3; all p's < .001). In addition, using a classic visual anticipation paradigm, we demonstrate that participants' anticipation of kick direction is influenced by penalty-takers' body language, with participants performing significantly worse against dominant than submissive penalty-takers (Experiment 3; p = .034).

Findings of our study fully replicate Furley et al. (2012) and provide initial evidence that nonverbal behaviour of soccer

penalty-takers may effectively influence performance in observing goalkeepers. A currently ongoing follow-up study aims to extend findings to experienced goalkeepers (and field players) and examines changes in gaze behavior as a potential mediator of the observed performance effect. Preliminary data from this study – indicating that nonverbal expressions of dominance may indeed affect task-relevant visual attention – will be presented.

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Tactical measures of performance in elite rugby union

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Performance analysis in rugby union is often limited to simplistic summaries of physical and technical characteristics. Furthermore, research has typically analysed single teams despite understanding that collective behaviour is complex and influenced by numerous contextual factors e.g. opposing team's tactics. Such performance analysis may not capture appropriate complexities, thereby limiting generalisability and interpretability. This study determined the relationships between collective tactical and physical characteristics on performance in elite rugby union by aggregating data from attacking and defending teams. 629 possessions were analysed across four teams and 13 Super Rugby matches. Global Positioning Systems were used to measure physical (e.g. average velocity and acceleration) and tactical characteristics (e.g. longitudinal and lateral synchronisation, surface area coverage, average depth and width of players). Linear mixed effects models were constructed with "distance gained" as the dependent variable, physical and tactical measures as independent variables, and team as a random effect. The best model (conditional $R^2 = 0.33$; AIC = 4861.5 [null model AIC = 5074.2]) identified that the attacking team gained more distance by retaining the ball for longer, moving with less lateral synchrony, attacking Forwards (positions 1-8) occupying smaller surface area, and attacking Backs (positions 9-15) moving with greater velocity and surface area. The defending

team mitigated attacking distance when the defending Forwards moved with less surface area and less longitudinal synchrony, and the defending Backs moved with less lateral synchrony. Greater synchrony was typically unfavourable for attacking and defending. These tactical measures provide new insight, although the generalisability should be investigated further.

Piloting a motor analogy for improving landing from unexpected falls

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Previous work suggests that motor analogies can be used to promote safer landing from self-initiated falls. Regardless of the direction of the fall, the analogy condition resulted in significantly longer free-fall duration (s), and lower impact duration (s), maximum acceleration (g), and jerk (g/s) than a control condition. However, 'real' falls are not normally self-initiated; rather, they occur unexpectedly. The aim of this study was to investigate the efficacy of a motor analogy when landing after an unexpected fall. Thirty young adults were randomly allocated to an analogy or control condition. Inertial Measurement Unit (IMU) sensors were attached to the participants, who were subsequently propelled onto a padded surface in an unexpected direction (backward, forward, leftward, rightward; randomised) by a nudge to the shoulder by the experimenter. Participants in the analogy condition were instructed to "land like a feather", whereas participants in the control condition were instructed to "land safely on the ground". The results indicated that participants in the analogy condition displayed significantly lower maximum acceleration (g) and jerk (g/s) in their left and right wrist (IMU), compared to the control condition (p 's < 0.05). A significant condition \times fall direction interaction was not evident (p > 0.05). These findings shed more light on the effects of motor analogies on biomechanical variables associated with fall landing. Considerable further research is needed to establish the efficacy of this approach for reducing severity of fall-related injuries in the older adult population.

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The effect of colour in sport

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Studies suggest that competing against an opponent wearing red clothing can lead to poor performance outcomes. Red is associated with dominance and threat, which can elicit avoidance motivation in the viewer. However, there is a lack of consistent results to consolidate this finding. This presentation will provide a brief overview of colour research in sport and will describe an experiment that tests whether the colour red elicits avoidance behaviour during football penalty shoot-outs. We adopted an off-center goalkeeper paradigm to create an

easier (larger) side to kick to and a harder (smaller) side to kick to. Kicks to the easy side were deemed to represent avoidance behaviour. Experienced (N = 22) and less experienced (N = 17) football players completed a series of indoor football penalty-shootouts either against a background of spectators wearing red or blue. The results revealed that less experienced football players chose the easier option more often when viewing a background of blue spectators, suggesting that blue (not red) evoked avoidance behaviour ($p = 0.028$). An alternative explanation is that viewing a background of red spectators evoked approach behaviour, which decreased choice of the easier option. The current experiment was conducted in an attempt to clarify colour research in sport. Further considerations and future directions for research will be discussed.

Affordances for exploration and the regulation of action in sport, exercise and healthy ageing

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For prospective guidance of action in complex environments, knowledge about future opportunities for action is imperative. In terms of affordances, this knowledge is expressed relative to an individual as the future individual-environment relationships. In social situations, such relationships give rise to the emergence and dissipation of social synergies that drive (transitions between) individual- and social-action. Agency and ongoing action, therefore, can be understood as emerging from the competition between affordances when multiple actions are afforded simultaneously. In this context, exploratory action, as movement aimed at revealing information about (future) affordances, is of vital importance in driving individual-environment interactions. Here, I will argue that exploration, as an activity, is a manifestation of affordance competition. As an example, I will discuss exploration in team sport, in which athletes are presented with many affordances related to, for instance, the ball, teammates, opponents, and space. Analysing exploration as the manifestation of affordance competition assists in the formalisation and optimisation of exploratory activity and exploration needs for health and sport science support. In the context of our ongoing studies in team sport, exercise, and healthy ageing, I will present the development of a number of novel collective exploration variables.

Domain-general, perceptual-motor abilities underlying expertise in esports

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Esports involves individuals or teams of players who compete in video game competitions through human-computer interactions. Currently, there is limited research that assesses expertise in esports. The present study applied the expert performance approach to understand the domain-general, perceptual-motor abilities that discriminate skill level in esports. Seventy-five participants (age = 24.2 ± 4.2 y) from three skill levels (professional, recreational, and control) completed assessments to determine their manual dexterity, speed-accuracy trade-off, and processing ability. A significant multivariate effect was identified for skill level on players' domain-general, perceptual-motor abilities ($F(18,128) = 3.87, p < 0.001, \eta_p^2 = 0.35$). Univariate effects were evident for movement time ($F(2,72) = 26.48, p < 0.001, \eta_p^2 = 0.42$), two-choice response time ($F(2,72) = 3.43, p = 0.038, \eta_p^2 = 0.09$), congruent response time ($F(2,72) = 4.92, p = 0.010, \eta_p^2 = 0.12$) and incongruent response time ($F(2,72) = 3.20, p = 0.047, \eta_p^2 = 0.08$). Professional esports were less susceptible to a speed-accuracy trade-off than their lesser-skilled counterparts. Furthermore, professional esports players had a faster two-choice response time and were better at ignoring pre-cues when compared with the control group. Overall, these findings demonstrated that some perceptual-motor abilities underpin esports expertise.

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Skill transfer in the Women's AFL: Coach and player perspectives

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Talent transfer (TT) aims to recycle and fast-track talent from one sport to another. This is achieved via the detection of athletes with attributes likely to facilitate their transition and achieve similar or greater success in their transfer sport. Despite the increase in TT initiatives worldwide and the significant

investments made, very limited empirical research exists to guide and inform best practice.

Current and former coaches and players involved in the Women's Australian Football League (AFLW) competition will be invited to participate in a short online survey. Questions will be designed to gather information on i) coach and player backgrounds, including previous coaching/playing experiences across different sports, and ii) the perceptions of skill transfer from four of the AFLW's top donor sports; netball, basketball, soccer and Gaelic football.

It is anticipated that players will report engagement in a greater number of team invasion and/or interceptive sports throughout their developmental years, than individual sports. It is also anticipated that coach and player perceptions of a TT athlete's ability to execute the physical, technical and tactical capabilities necessary for Australian rules football will differ depending upon which sport/s players transfer from.

Findings from this study intend to inform talent identification, development and transfer processes in team invasion sports. Understanding how coaches and players perceive the transfer of expertise to facilitate (or constrain) an athlete's transition may provide insights on how practice can be best designed to address the unique needs of TT players.

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Physical fatigue and its effect on road crossing decisions

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Road crossing is an everyday task that requires integration of information (e.g., speed and distance of an oncoming vehicle) to effectively guide behaviour. The embodied perception perspective states that people's perception of environmental (task-relevant) stimuli is influenced by their psychophysiological state. Upon this premise, the current study examined whether acute physical fatigue influences visual perception and associated decision making in road crossing.

Using a between-subject design, 54 participants (healthy adults, aged 18-35 yrs) were divided into a fatigue and a no-fatigue group. To manipulate fatigue, participants either completed a repeated Wingate cycling protocol (fatigue group) or a low-resistance cycling protocol (no-fatigue group) prior to completing a video-based examination of road crossing decisions (cross vs. not cross; action-based) and verbal judgments of speed and distance, in relation to an oncoming vehicle. Analyses indicate that participants (i) were able to effectively distinguish between different speeds (30-50-70

km/h; $p < .001$) and distances (10-100m in 10m increments; $p < .001$) of the oncoming vehicle; and (ii) that both vehicle speed ($p < .001$) and vehicle distance ($p < .001$) significantly influenced road crossing decisions. However, no significant effects of fatigue was observed (all $ps > .26$).

This study demonstrated that individuals are sensitive to changes in vehicle speed and distance and respond to these changes in making road crossing decisions. Based on the current study, and in contrast to the embodied perception perspective, physical fatigue did not alter perceptual judgments of vehicle speed and distance nor did it influence road crossing decisions in a video-simulated road crossing environment.

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Light therapy: The solution to the "stormtrooper effect"?

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Sleep restriction has adverse effects on exercise performance and increases injury risk. While research into methods to alleviate the negative effects of insufficient sleep on athletes exists, research in the use of bright light therapy (BLT) is limited. This study aimed to determine the effect of BLT on shooting performance, daytime sleepiness and shooting consistency. The study adopted a randomized pre-post crossover design.

Data of 14 elite youth shooters (age: 14.1 ± 0.8 years; pistol: $n=7$; rifle: $n=7$) were used. Participants underwent two experimental conditions - active and placebo light for 30 minutes on two separate sessions, one-week apart, before a 60-shot simulated competition. Subjective daytime sleepiness measures were obtained pre- and post- intervention. Magnitude-based decisions were used for analysis. There was a likely moderate beneficial effect of light therapy on shooting consistency (% change; $\pm 90\%$ confidence limits (CL), effect size; $\pm 90\%$ CL, probabilities ($3.2 \pm 2.9\%$, 0.64 ± 0.57 , 90/9/1), with a possibly small harmful effect on daytime sleepiness ($14.1 \pm 22.2\%$, 0.29 ± 0.42 , 64/34/3). A small inverse correlation was observed between total shot scores and daytime sleepiness in pistol shooters only ($r = -0.54$; $\pm 90\%$ CL 0.35).

Exposure to BLT may possibly aid in maintaining shooting consistency, but may not be useful in reducing daytime sleepiness. For pistol shooters, the stabilization of the pistol prior to shooting might require more attention focus, which might have been compromised by sleepiness. Whereas, the butt-plate provides added support for rifle shooters, potentially making the task less attention-demanding.

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The effect of altitude on concussion in university (American) football players

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Concussion causes varying degrees of brain damage in athletes, but factors affecting severity and damage to neuropsychological domains are complex and not well-understood. A potential contributing factor is altitude; current research is mixed on whether altitude acts as a risk or protective factor, but much of this research has not been done at altitudes high enough to cause physiological changes. This study seeks to clarify the role altitude plays in concussion symptoms and recovery. We collected data on concussions sustained at or around 1,966m among university football players. Thirteen American football players at New Mexico Highlands University (N = 13) consented to participate and were administered the 40-minute neuropsychological battery to examine domains affected by concussion like attention, working memory, verbal fluency, and depressive symptoms before and after the 2016 football season. In total, there were 5 concussed players and 8 non-concussed (control) players. All five concussed players had persistent neurological impairment at the post-season assessment, most notably increases in depression symptoms ($F = 6.335, p = .029$), declines in processing speed ($F = 7.073, p = .024$), and declines in verbal learning/memory ($F = 5.777, p = .037$). Additionally, two players (one who sustained a concussion and one who did not) were re-administered the battery within 7 days post-injury. The concussed player experienced acute deficits in most domains and demonstrated incomplete recovery on measures of depression, verbal learning/memory, and switching. These results indicate that concussions sustained at moderate altitudes may not fully recover within the frequently cited 10-day window.

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Examining movement quality and speed following analogy instruction in older people

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Motor analogies have been used as a learning technique across a range of tasks in sport, surgery, speech therapy, stroke and Parkinson's Disease. However, it remains unclear whether they can be processed faster and more efficiently than traditional, explicit instructions, which is a key aspect in life skills. Furthermore, it is not clear to what extent the method is useful for older people. We examined whether movement-related analogy instructions can be processed and executed as motor responses more efficiently than explicit instructions by older people. Sixty older participants practiced a motor task involving fast and accurate tying of a bowline knot after receiving analogy or explicit instructions, which they performed under simple and complex task conditions. Participants in the analogy condition were instructed via an existing "rabbit" analogy while participants in the control condition received explicit instructions. Reaction time and movement time were measured in each task condition. Qualitative ratings of performance based on video recordings (scores 1-10 of fluency, segmentation and overall impression) were performed by 2 independent, blind raters. After controlling for age and gender, no effect of instruction condition was found for either of the dependent variables (reaction times in simple and complex task, reaction time difference complex – simple task). Moderated regressions revealed no interaction of instruction condition by age. Qualitative ratings of video recordings of a sample matched by age and gender (n = 24) are being assessed at the moment. The findings of this experiment will allow better understanding of analogy instructions as a potential means for teaching important everyday life skills to older people.

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The reality of small-sided games in rugby union

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Small-sided games (SSGs) are prominent within the football codes' practice and sports science research. However, a lack of systematic approach to SSG research limits the ability to make definitive evidence-based recommendations in rugby. The purpose of this research was to investigate the use of SSGs in rugby union. An electronic survey was conducted to obtain a comprehensive view of SSG application in training practice.

Results showed that 32% of respondents coached at a semi-professional level or above. Most fulfilled the roles of head coach (52%), S&C coach (21%), and assistant coach (18%). Eighty-three percent of coaches used SSGs every 1-3 sessions. The most popular formats are 3v3, 5v5, and 7v7 sides. Technical skill development (26-28%) and fun (25-30%) were reported to be the main motivation for SSG application at the lower levels, whereas technical skills (21-29%) and physical conditioning (21-35%) were key for SSGs at the higher levels. Touch rules are favoured for higher-level athletes (47-64%) by assistant (50%) and head coaches (43%), whilst school (49%), local (47%), and S&C coaches (62%) prefer union rules. Three bouts (46%) of 1:1 to 5:1 work-rest ratio with backwards passing (71%) is most commonly used.

SSGs are widely implemented in practice, and thus relevant to rugby union. Professionals seem to adhere to the scientific evidence regarding conditioning more than amateurs. Differentiation between roles, levels, and athletes is key considering application clearly differs regarding playing level, function, experience, and target group. Evidence-based and contextual individualisation would optimise conditioning through SSGs.