Journal of Motor Learning and Development, 2025, 13, S1–S36
https://doi.org/10.1123/jmld.2025-0131

Human Kinetics
CONFERENCE ABSTRACTS

Australasian Skill Acquisition Network 2025

ASAN 2025
Singapore, Singapore
November 26–28, 2025

Conference Chairs and Committees

Organisation Committee

Chairs

Prof. Chris Button, University of Otago, New Zealand
Associate Professor Jia Yi Chow, Nanyang Technological University, Singapore
Associate Professor John Komar, Nanyang Technological University, Singapore

Members

Associate Professor Kee Ying Hwa, Nanyang Technological University, Singapore
Dr. Richard Shuttleworth, Sport Singapore, Singapore
Mr. Chua Yong Joo, Sport Singapore, Singapore
Dr. Tommy Ng, Nanyang Technological University, Singapore
Mr. Max Jing Xun Tan, Nanyang Technological University, Singapore

Scientific Committee

Associate Professor John Komar, Nanyang Technological University, Singapore
Dr. Jonathan Leo Ng, Victoria University, Australia
Associate Professor Gert-Jan Pepping, Australian Catholic University, Australia
Associate Professor Claire MacMahon, La Trobe University, Australia
Associate Professor Lyndell Bruce, Deakin University, Australia
Associate Professor Sarah Kate-Millar, University of Canterbury, Christchurch
Dr. Daniel Chalkley, Australian Catholic University, Australia
Dr. Kyle Bennett, Southern Cross University, Australia

Keynotes

K1 – Applying Ecological Dynamics Theory in Sport: From the Lab to the Field

Assoc. Prof. Rob Gray, Arizona State University & The Chicago Cubs, United States of America

In this presentation, I reflect on some of my experiences as one of the first Skill Acquisition Specialists (Otte et al, 2024) in professional sports. What are the major challenges and opportunities in applying Ecological Dynamics? How can we best translate research findings and theory into effective practice design (e.g., "practicing the wrong way", Gray 2025)? I will discuss some of the "hard lessons" I have learned including: (i) Choose your battles and consider constraints on the coach, (ii) Don't oversell yourself. Be realistic about your impact, (iii) Make sure to "close the loop" with players, (iv) Jump on any opportunities to talk and build relationships with players and coaches, and (v) Be present, available, and follow through with coaches. I then present some of the methods I have developed for: tracking and measuring progress, scaling constraints to stay near the optimal challenge level in practice, coaching to invariants/attractors and integrating performance analytics and other data. Finally, I will consider how the application efforts can inform research: what do coaches really want to know?

Gray, R. (2025). The Value of Practicing the "Wrong" Way: Skill Development and Affordance Perception Through Broad Exploration of the Solution Space. *Journal of Motor Learning and Development*, *13*(1), 120–145.

Otte, F., Yearby, T., & Myszka, S. (2024). The role of skill acquisition specialists within sports – why every high-performance sports organization needs these experts. *Journal of Expertise*, *7*, 1–14.

K2 – Mapping the Brain in Motion: Neurophysiological Approaches to Motor Performance

Assist. Prof. Alicia Goodwill, Nanyang Technological University, Singapore

Advances in non-invasive brain imaging and modulation are transforming our understanding into the neurophysiological mechanisms underpinning motor learning and performance. These tools allow the quantification of resting-state, and "real-time" task-related brain activity, can capture acute responses to exercise, and track chronic training-related adaptations in neural pathways. Together, such approaches can contribute to the comprehensive picture of how training shapes brain-behaviour relationships. Research applying functional and physiological measures of brain activity across different contexts has demonstrated these effects. For example, we have shown that resting-state functional magnetic resonance imaging (RS-fMRI) markers of fractional amplitude of low-frequency fluctuations (fALFF) and regional homogeneity (ReHo), which correlate with metabolic markers (e.g., blood flow, oxygen, glucose) in the brain, can be used to compare athletes and novices, and have detected physiological differences within key brain areas associated with cognitive-motor expertise. In addition to fMRI, functional near-infrared spectroscopy (fNIRS) can offer an ecological alternative to assess

task-related changes in cortical activity related to various modes of exercise/training. Whilst still an emerging technique, the application and reliability of fNIRS in ecological movement-based settings is also being tested. Lastly, brain-stimulation approaches such as transcranial magnetic stimulation (TMS) can provide mechanistic insight into corticospinal plasticity and neuromodulation of movement related neural pathways. For example, earlier work has demonstrated training-induced adaptations in excitability and inhibition within the motor cortex, highlighting the capacity of practice to reorganise neural control of movement. In summary, converging evidence from neuroimaging and brain stimulation may help us understand the brain's role in motor skill learning and exercise-induced plasticity. However, key methodological challenges, including the reliability and validity of measures in naturalistic settings, the impact of noise and motion artefacts, remain considerations for the exercise neuroscience field to address in order to effectively translate laboratory-based findings into real-world practice. Addressing these challenges is essential for developing more individualised, evidence-informed strategies in coaching and sport science.

Panel Discussions

P1 – Teaching/Education of Skill Acquisition Content at Different Institutions/Countries

This panel brings together educators who teach motor learning and skill acquisition in diverse contexts to share their approaches and experiences. The discussion covered both the learners and their specific environment or context, from undergraduates to practicing professionals. The panel then explored the key concepts and theories that shape their teaching, as well as consider which ideas are left aside and why. Finally, the panel highlighted specific techniques and strategies that have proven effective in bridging theory and practice, offering insights that participants can adapt to their own teaching environments.

- **Prof. Chris Button** (University of Otago, New Zealand)
- **Dr. Jonathan Leo** (Victoria University, Australia)
- **Mr. Andrew Hailey** (Aquatics Coordinator, Singapore American School, Singapore)
- **Prof. Yeou-Teh Liu** (National Taiwan Normal University, Taiwan)
- **Prof. Rob Gray** (Arizona State University, USA)
- **Prof. Chow Jia Yi** (National institute of Education,

P2 – Coaching Within an Ecological Dynamics Framework: Perspectives from National Coaches

This panel brings together a panel of international coaches who are at the intersection between applying the theory into practice as well as theorising the practices that work (or don't work) in their applications. The discussions started with the panel members sharing how they use theory into their coaching practices,

but also when and where limitations appear when the theory is confronted to practical issues of practice. The discussed was engaged into how coaches can interact with researchers to co-create a practical framework for applying theory into practice, offering insights into fruitful collaboration between research and practice.

- **Shayne Bannan** (High Performance Director at Singapore Cycling Federation)
- **Hasney Aljofree** (Head of Coaching for Football Association Singapore)
- **Paul Tietjens** (National Head Coach Rugby 7s)
- **Anastasia Goutseva** (Performance Director for Artistic Swimming)
- **Dr. Richard Shuttleworth** (Assistant Director, CoachSG, Sport Singapore)

Oral and Poster Presentations

1 – The Effects of Cluster Training on Strength and Power in Collegiate Basketball Players

Hongyi An, The University of Sydney

This study investigated the comparative effects of cluster training (CT) and traditional training (TT) on lower-limb strength, explosive performance, fatigue regulation, and metabolic response in collegiate basketball players during the endurance-to-power transition phase. The endurance-to-power stage is a critical period where athletes must adapt from high-volume endurance loads to high-intensity explosive tasks, yet few empirical studies have addressed optimal training structures in this context. Twenty-four male athletes from Wuhan Sports University were randomly assigned to CT ($n = 12$) or TT ($n = 12$). Both groups performed back squats at 70% of 1RM, 5×12 repetitions, twice weekly for four weeks, with equal total load and rest time. The CT group incorporated intra-set rests of 30 seconds plus 60 seconds between sets, whereas the TT group used continuous repetitions with 90 seconds between sets. Pre- and post-tests assessed maximal squat strength, sprint and vertical jump performance, kinematic variables measured by the Tendo Unit, ratings of perceived exertion (RPE), repetitions in reserve (RIR), and post-exercise blood lactate concentration. Both groups significantly im- proved maximal strength, but no between-group differences were observed. In contrast, CT produced superior gains in explosive outcomes, including faster sprint times (–0.20 s vs –0.10 s, $p < 0.05$) and greater vertical reach (+5.7% vs +2.3%). Kinematic data showed that CT better maintained peak power and velocity, while TT exhibited declines in later sets. CT participants reported lower RPE and higher RIR, suggesting reduced fatigue and more sustainable training quality. Blood lactate concentration was significantly lower in CT (12.9 vs 15.4 mmol/L, $p = 0.011$), indicating greater metabolic efficiency. In conclusion, both methods enhanced strength and explosiveness, but CT demonstrated additional advantages in explosive performance, fatigue control, and metabolic adaptation. These findings highlight cluster training as a safer and more effective resistance training strategy for collegiate basketball players in transitional phases. Importantly, the study provides further evidence that modifying training structure, even without altering total load, can optimize adaptation

and reduce injury risk. By emphasizing rhythm and recovery, CT may inform future program design, promote long-term adherence, and enhance the translation of physical gains into sport-specific performance.

Keywords: Cluster Training, Circuit Training, Inter, Set Rest Intervals, Strength and Conditioning, Youth Basketball Players

2 – An Ecological Dynamics Framework Integrated with Advanced Training Theory for Elite Fast Bowler Development

Harvey Anderson, Sheffield Hallam University

This paper demonstrates how an ecological dynamics perspective on skill acquisition can be integrated with advanced training theory to construct a cohesive and context-sensitive model for developing elite fast bowlers. Rooted in principles of perception–action coupling, representative learning design, and constraints-led coaching, the framework offers a non-linear, athlete- environment-centred approach to skill development. Drawing on established theories including Bernstein's concept of motor abundance and the role of affordances in self-organising be- haviour, the system places variability, exploration, and adaptive problem-solving at the heart of performance preparation. In parallel, the model incorporates key methodologies from high- performance physical training-Triphasic Training, Block Periodisation, Conjugate Sequencing, and Velocity-Based Training-to align neuromuscular development with the demands of the skill acquisition process. Each training phase-accumulation, transmutation, realization, and restoration-is structured to balance physical stimulus with perceptual-motor learning opportunities. Integrated sprint mechanics, med ball power work, and special developmental exercises (SDEs) enhance force expression specific to the bowling action, while carefully manipulated task constraints and scenario-based sessions develop decision-making and robustness under pressure. Influenced in part by applied practitioner research (e.g. Anderson, 2024), the system emphasises the coach's evolving role as a learning designer who shapes information landscapes rather than prescribes ideal movement templates. Outcomes observed in early implementations include improved performance consistency, adaptability, and injury resilience among developing fast bowlers. This presentation proposes a blueprint for performance preparation that transcends traditional dichotomies between physical and technical training, offering coaches and practitioners a unified, evidence-informed approach to fostering expert movement behaviour in high-speed, high-variability sporting contexts.

Keywords: Fast bowling, cricket, ecological dynamics, skill, training theory, integrative approaches

3 – Apperception in Skill Acquisition: Integrating Meaning, Memory, and Movement for Embodied Coaching Practice

Harvey Anderson, Sheffield Hallam University

This paper repositions apperception-the interpretive process through which new experiences are assimilated via prior knowledge-as a central mechanism in sport skill

acquisition and coaching practice. Drawing from Margaret K. Smith's seminal 1895 article and expanded through contemporary ecological, existential, and phenomenological theory, apperception is framed not merely as refined perception, but as the mental synthesis of past and present in context. Un- like conventional models that treat perception as sensory registration, apperception involves the recognition, integration, and meaningful evaluation of environmental information through embodied experience. Through this lens, skill development is not about refining reaction to stimuli but enhancing one's ability to perceive significance. Drawing from Gibson's ecological psychology and the constraints-led approach (CLA), this paper argues that athletes become skilful not by internalising motor patterns but by learning to apperceive affordances-possibilities for action-via guided exploration and reflective engagement. Ingold's concept of enskilment is reinterpreted here as the growth of apperceptive capability: the cultivation of attention, movement, and memory within meaningful activity. Moreover, existentialist insights-particularly from Merleau-Ponty-locate apperception at the core of self-formation: to apperceive is to be- come. Coaching thus shifts from prescribing behaviours to enabling athletes to perceive what matters, using learning environments rich in constraints, variability, and narrative feedback. Smith's distinction between lower (concrete) and higher (abstract) apperception further sup- ports the developmental progression from game sense to tactical intelligence and personal ex- pression. This reconceptualisation aligns learning not with mechanical repetition, but with the emergence of embodied understanding and adaptive judgment. Ultimately, apperception offers a unified framework for coaching that honours the interplay of perception, memory, and meaning. It encourages a pedagogy that supports not just the skilled body, but the reflective, intentional, and contextually attuned athlete, leading to self-development alongside skill adaptation.

Keywords: Apperception, perception, existential, meaning, skill, phenomenology

4 – Do Skill Acquisition Scientists Change a Coach's Perspective On learning? A Practical Workshop

Georgia Askew, Queensland University of Technology; Scotty Russell, Australian Catholic University

There is increasing interest in applying an ecological dynamics rationale to guide practice design in sport and physical education. Skill acquisition scientists (SAS's) present a possible avenue for supporting coach learning of learning design principles. Little is known about how valuable SAS's can be to coach learning, potentially due to research design challenges in capturing and conceptualising their contribution to changes in coaching perspectives and/or practice. Adopting an ecological grounded theory methodology (Russell et al., 2025), this study explored how coaches' perspectives about skill learning and their application of learning design principles evolved using an Innovative Approach (see Askew et al., 2024) emergent intervention working closely with an SAS over 10-months. Data collection included semi-structured interviews with three Paralympic coaches before and after the intervention period. Our analysis highlighted that coaches experienced a reorganisation of their metatheoretical foundations, with comprehensive changes emerging in relation to the structure, function, and relationship of coaches' beliefs, views, and assumptions about learning and coaching that underpinned their design and delivery of learning

environments. Facilitated through the emergent intervention, three specific sub-processes promoted the reorganisation: (1.1) re-evaluation of beliefs about skill learning, (1.2) re-centring of views about the role of the coach, and (1.3) re-examination of assumptions about structuring learning environments. The findings of this study demonstrate that implementing an Innovative Approach to support coach learning facilitates coaches to align their coaching practices with an ecological dynamics rationale. Implications of this work highlight the importance of conceptualising coach learning as a dynamic and individualised process that is ongoing. Practical applications include support for using SAS as critical agents to destabilise entrenched long-term coaching practice and changes in views of learning, rather than simple adoption of tools for coaching (e.g., manipulating constraints).

Keywords: Ecological dynamics, ecological grounded theory, coach development, metatheoretical perspective

5 – Task Constraints and Intentions: How Representative Practice Shapes the Kinematics of the Full Swing in Golf

Cavan Aulton, Sheffield Hallam University; Ben Strafford, Sheffield Hallam University; Keith Davids, Sheffield Hallam University; Chuang-Yuan Chiu, Sheffield Hallam University

The constraints-led approach suggests an athlete's technique develops most effectively through interaction within a representative performance environment. Golf coaches often use drills performed without a ball to facilitate technical changes, but this less representative task may affect a golfer's technique. Therefore, this study aimed to determine how manipulating a key task constraint (i.e., adding a ball) affects swing kinematics, and investigated whether these changes are influenced by skill level. Participants were 7 male golfers (age range: 20-55 years; stature: 182.3 ± 5.9 cm; body mass: 85.3 ± 9.7 kg), categorised by handicap (Low (LH): n=2, 0-10; Medium (MH): n=3, 10-25; High (HH): n=2, 25+). Participants completed two blocks of ten swings whilst a 3D motion capture system captured joint rotation and velocity of the torso, pelvis, wrist and club head (CH). The first block involved swinging without a ball, with participants instructed to: "swing as you normally would trying to hit the ball as far as possible." The second involved hitting a ball into a net with the same instructions. Paired sample t-tests were used to determine significant differences in kinematic variables between the two task constraints. All participants demonstrated greater CH velocity at ball contact (BC) in the more representative task. This increase emerged in all skill groups: MH golfers also showed increased pelvis velocity, whilst 7 participants increased torso velocity, and both LH and HH groups exhibited greater wrist velocity. Interestingly, while high handicappers showed a reduced torso rotation at the top of their backswing (TOBS) in the representative task, no other significant differences were observed in key rotational metrics at BC or TOBS between the two conditions. With most rotational metrics unchanged, coupled with increased velocities (CH, torso, pelvis, and wrist) between conditions, these findings suggest that representative task design constrains skill adaptations through changing participants' intentions. Findings also indicate golfers across all skill levels swing with greater velocity under more representative task constraints. Therefore, coaches should be aware that practice swings without a ball do not accurately replicate

swing velocities when striking. Rather, goal-directed, ball striking tasks may be fine-tuned to develop golfers' intentionality.

Keywords: Constraints, led approach, Representative task design, Golf swing kinematics, Ecological Dynamics

6 – The Development of a Tablet-Based 360° Situation Awareness Test for Cyclists

David Broadbent, Deakin University; Thuong Hoang, Deakin University; Aden Kittel, Deakin University; Lyndell Bruce, Deakin University; Anna Timperio, *Deakin University*; William McCalman, *Deakin University*

Poor situation awareness is a key contributor to road traffic crashes. While validated tools exist to assess situation awareness and hazard perception in drivers, beginner cyclists lack accessible resources capturing the unique aspects of cycling, such as the requirement for safe and effective head-turn behaviours. Immersive tools that utilise 360-degree footage offer a promising method to assess and improve cyclists' situation awareness in safe environments, but the need for specialist and expensive equipment limits their accessibility and scalability, which is fundamental for impacting road safety at a community level. This project aimed to develop a tablet-based, 360-degree video Situation Awareness Test for cyclists. Three tests were designed based on driver hazard perception literature and Endsley's three-level model of situation awareness: (1) Perception Test - participants click on hazards in dynamic footage; (2) Comprehension Test – participants answer multiple-choice questions about road rules and safe behaviours; and (3) Projection Test - participants indicate when they would brake in response to emerging hazards. To pilot the usability of this resource, 15 adult participants (6 male, 9 female) with varying cycling experience completed the tests and rated them using the System Usability Survey (SUS), along with open-ended feedback. Quantitatively, results showed that all tests were appropriately challenging, avoiding floor or ceiling effects: Perception ($M = 65\%$, $SD = 11\%$), Comprehension ($M = 61\%$, $SD = 15\%$), and Projection ($M = 55\%$, $SD = 20\%$). However, usability ratings varied, with the Perception Test receiving lower scores due to its 'complexity' and 'awkwardness'. Qualitatively, participants found the resource engaging and realistic and believed it could benefit beginner cyclists. Yet, they reported difficulties with implementing head turn behaviours on a tablet and suggested that more contextual information before each video would improve the realism and clarity of the situation awareness demands. Based on this feedback, revisions were made to the resource. A validity study of the updated tests is underway, and preliminary findings, along with future directions for using extended reality technologies to enhance road safety, will also be presented.

Keywords: Situational Awareness, Road safety, Hazard Perception, Gaze Behaviour

7 – Modelling the Discrete Jab and Cross in Boxing as Constraint-Based NLODEs

Szu-Hung Cheng, National Taiwan Normal University; Yeou-Teh Liu, National Taiwan Normal University

In boxing, the jab and the cross are two fundamental straight punches. The former is used for quick probing, while the latter is thrown for a powerful strike. Previous research suggested that the dynamics of continuous straight-punch combinations could be modelled with nonlinear ordinary differential equations (NLODEs). We expanded this approach to analyze the discrete jab and cross punches performed by a national-level boxer. Three synchronized cameras recorded six trials (three jabs and three crosses), and we tracked the 3D positions of the boxer's head, fist, and the target. The state variables were defined as the target–fist distance x and its time derivatives. The fist–head distance l was used as a practical proxy for the limb-length constraint, and the target–head distance p approximated distance perception for gating the countermovement through the unit step function u. Guided by the force–length relationship, we modelled the nonlinear stiffness with a quadratic polynomial in x. Regression analyses were implemented based on the NLODE with the limb-length constraint, perception-gated function u, and nonlinear stiffness: x''=(c 1+c 2*l max/(l max-l+ϵ))*x'+(k 1+k 2*x+k 3*x^2)*x+a 1*u(p 0-p). The results showed high coefficients of determination ($R2 = .91–.98$) across all trials. The perception-gated function u was significant ($ps < .05$) in all jab trials and in one of the cross trials, suggesting that the countermovement dynamics of crosses and jabs may differ due to distinct purposes. Contact between the fist and target occurred at about 0.63 l max in jab trials and 0.91 in cross trials. Because of their different purposes, this may reflect a trade-off the boxer makes between the limb-length damper and the force accumulated along the force–length relationship, resulting in strikes at different lengths. Only one of the crosses exceeded full extension (1.11 l max) because the boxer's head retreated, seeming to reflect a compensatory response to insufficient countermovement for powerful strikes. In summary, these results extend the modelling approach from continuous punches to discrete jabs and crosses using constraint-based NLODEs. For broader application, further work will focus on testing more participants and refining the arm-length constraints and countermovement based on more comprehensive hypotheses.

Keywords: nonlinear dynamics, human movement mechanism, perception action coupling, affordance

8 – Where to Look? Examining Visual Focus in the Initiation of Volleyball Blocking

Chih-Hsuan Chang, National Taiwan Normal University; Yeou-Teh Liu, National Taiwan Normal University

Volleyball players' ability to observe the setter's movements and predict the set's direction and tactics is critical for improving blocking success. A previous study showed that high-level volleyball players, when presented with point-light displays of the setter's body joints, achieve higher recognition rates of setting tactics compared to lower-level players. This suggests that skilled players are better at extracting action-related cues. However, when asked which specific area they focus on for blocking judgments, highly skilled players often give inconsistent or unclear answers. The present study examined the effect of observing different regions of the setting movement on blocking initiation performance. Six female club-level volleyball players with blocking experience participated. Three observation regions (the ball, the hands, and the upper body) and four offensive plays (quick attack in front of the setter, outside attack from position 2, outside attack from position 4, and back-row

attack from position 6) were combined to create twelve randomized scenarios. Blocking initiation times were recorded to evaluate performance differences across conditions. A linear mixed model was used for analysis, with significance set at $\alpha = .05$. Results showed that the observation region significantly influenced blocking initiation time, $F(2, 75) = 5.05$, $p = .009$. Specifically, participants initiated blocking faster when observing the upper body than when observing the ball or the hands. Further analysis indicated that during outside attacks from positions 2 and position 4, initiation times were shorter when observing the upper body. In contrast, no significant differences were found among the three observation regions during quick attacks and back-row attacks from position 6. Since all participants were club-level amateur players, their lesser familiarity and experience with quick attacks in real games may explain the lack of differences in those scenarios. Future research will focus on high level players to further explore how observing different regions of the setting movement influences blocking performance.

Keywords: Visual Perceptual, Motor control, volleyball setting

9 – Tactical Patterns in 3×3 Basketball: An Analysis of Sequence Length and Ending Methods in a Possession

Chi-Yun Chen, National Taiwan Normal University; Yeou-Teh Liu, National Taiwan Normal University

In basketball, ball handlers direct ball movements based on the positions of teammates and defenders. The sequence of these ball movements forms the foundation for basketball tactics. This study examined the tactical features of 3-on-3 basketball by analyzing ball movement sequences, providing reference criteria for developing performance indicators and training strategies. Forty games from the FIBA 3×3 U23 Women's World Cup were analyzed. Simi Scout software was used to record the outcomes of defensive actions for each ball movement (turnover, effective defensive positioning, defensive failure, and opponent foul). The number of ball movements in a possession was defined as the sequence length, and the shot attempt, turnover, and opponent foul were recorded to determine the end of a possession. Independent samples t-tests were used to compare the differences in possession length and possession-ending methods between winning and losing teams. The most frequent sequence consisted of three movements, followed by two-movement sequence. Winning and losing teams exhibited different methods for ending possessions at various sequence lengths. Losing teams had significantly more possessions that ended after 1 or 2 movements compared to winning teams ($ps < .05$). Regarding possession ending methods, losing teams more frequently ended possessions with a shot attempt ($p < .05$) at 1 movement and with a turnover ($p < .001$) at 2 movements. The winning teams had more possessions with sequence lengths between 4 and 6, often ending with a shot attempt ($ps < .05$). Possessions lasting 1 or 2 movements were more likely to end in a turnover than those lasting 3 or more movements, indicating that shorter possessions may reflect poorer decision-making. In contrast, when sequence length increased to 3 or more, the possessions of winning teams often ended with a shot attempt, suggesting that, after proper organization, winning teams tend to create more effective scoring opportunities. Future research could examine whether certain ball movement sequences are

preferred by different teams and if specific sequences of ball movements result in particular performance outcomes.

Keywords: performance analysis, performance indicator, decision making

10 – Effectiveness of Constraints-Led Approach with Auditory Feedback on Jab Performance and Body Rotation in Boxing Novices

Chun-Yu Chen, National Taitung University; Cheng-Chang Jeng, National Taitung University; Kuo-Liang Chuang, National Taitung University

The jab is a fundamental boxing technique for beginners, with power generation being crucial in boxing performance. Previous research using accelerometers on punching bags with random auditory augmented feedback improved learners' power output but lacked essential body rotation principles for beginners and may increase injury risk. The constraints-led approach (CLA), grounded in ecological dynamics theory, facilitates learners to explore optimal movement strategies through task constraints rather than explicit instruction, enabling better skill acquisition and transfer. This study investigated whether combining CLA with auditory feedback allows boxing novices to enhance striking effectiveness while learning body rotation principles for force generation. Eighteen participants with no prior boxing experience were randomly divided into auditory feedback and constraints-led groups. The auditory feedback group received traditional verbal instruction and random auditory feedback according to existing literature. The constraints-led group had a white line placed one forearm's length from the punching bag, in structed only that their front foot should not cross the line, plus random auditory feedback. The experimental protocol included warm-up (10 strikes), pre-test (20 strikes), five practice rounds (20 strikes each), and post-test (20 strikes). Nine-axis accelerometers (IMU) were installed on the punching bag and participants' non-dominant shoulder with 25Hz sampling frequency. During the five practice rounds only, random auditory feedback was provided 10 times within each 20-strike round at 80 decibels, increasing 10% for every 0.1g acceleration improvement above pre-test average. Data analysis used two-way mixed ANOVA examining X-Y plane acceleration changes across groups and test phases, with significance set at $p < .05$ and effect sizes calculated. Results showed both groups increased punching bag acceleration from pre- to post-test. However, shoulder rotation acceleration demonstrated significant interaction effects ($F(1, 16) = 5.504$, $p < .05$, $\eta 2 = 0.090$), with only the constraints-led group showing significant post-test increases. These findings demonstrate that task constraints effectively guide motor exploration for body rotation mechanisms, proving superior to repetitive verbal instruction for developing proper striking biomechanics while maintaining power improvement.

Keywords: Constraints, led approach, Boxing, Body rotation

11 – When Holistic Attention Misaligns: Neural and Kinematic Evidence from Expert Archers

Yin-Hua Chen, National Taiwan Sport University Taiwan; Ya-Ling Chen, National Taiwan Sport University Taiwan; Szu-Yuan Chen, National Taiwan

Sport University Taiwan; Wen-Jui Kuo, National Yang Ming Chiao Tung University

The role of holistic attention in motor control and learning remains underexplored. This study examined whether skilled archers' subjective holistic feeling of shot execution reflects their actual performance, assessed through kinematic and neural measures. Eight skilled collegiate recurve archers completed 12 simulated competition sessions, each involving 12 ends of 6 arrows. Brain activity was recorded with a 32-channel wireless EEG system. After each shot, archers rated the holistic feel of their shot execution (1–10), a procedure designed to direct attention toward overall shot quality rather than isolated technical elements or bodily kinematics. Kinematic measures included phase durations (setup, drawing, aiming, clicker reaction), and aiming trajectory (X and Y axes, 0.5 s before clicker fall and to arrow release). Two generalized estimating equation (GEE) models tested predictors of actual arrow scores and perceived holistic feeling, and EEG activity was analyzed using generalized linear models (GLMs). Behaviorally, actual arrow scores were negatively predicted by longer drawing times and vertical aiming trajectory, whereas holistic feeling was only reduced by longer aiming duration. At the neural level, poor performance was associated with increased activity in sensorimotor (C3/Cz/C4/CP1/CP2) and parietal (P3/Pz) regions, while higher scores were linked to auditory (T7, CP5) and visual cortices (O1/Oz/O2). In contrast, holistic feeling was negatively related to activity in F3, C3, and CP2, but positively associated with Pz, T7, and CP5-partially overlapping with regions predicting performance. These findings reveal a dissociation between holistic attention and motor execution: archers' subjective sense of shot quality primarily reflected temporal control but not fine-grained kinematic or widespread neural dynamics. This divergence suggests that the holistic attention captures only a limited portion of the complexity underlying expert motor performance.

Keywords: focus of attention, drawing time, aiming duration, aiming trajectory, sensorimotor control

12 – How Softball Batters Adjust Batting Movements?

Yun-Ting Chen, National Taiwan Normal University; Yeou-Teh Liu, National Taiwan Normal University

Batting is the key scoring skill in fastpitch softball. Skilled batters combine visual information, such as the pitcher's movements and ball trajectory, with whole-body coordination to generate maximum power through the bat. This study explored how collegiate female softball batters adjust their batting movements to inform training practices. Six participants each hit 10 fast pitches and 10 slow pitches, delivered in random order by two pitchers. Their pitching and batting movements were recorded using two high-speed cameras, and key timing variables were extracted using the SimiMotion system: pitcher's movement start, ball release, batter's step and land, swing initiation, and bat–ball contact (or ball–bat crossing for missed swings). Because five of six batters planted their front foot before ball release, analyses focused on the following intervals: landing- to -swing initiation, ball release- to- swing initiation, swing initiation- to- ball- bat contact, and release- to- ball- bat contact. Fast pitches ranged from 81–88 km/h, clearly

faster than slow pitches, which ranged from 61–74 km/h. Linear mixed-model analysis showed that all intervals-landing- to- swing initiation, swing initiation- to-contact, release- to- swing initiation, and release- to- contact-were significantly shorter for fast pitches compared to slow pitches. Pearson correlations revealed strong negative relationships between release- to- swing initiation and swing initiation- to-contact for both fast ($r(58) = -.802$, $p < .001$) and slow ($r(58) = -.908$, $p < .001$) pitches. These findings suggest that front- foot movements serve as preparatory actions independent of pitching speed. Adjustments were only made in the swing actions after ball release. Batters seem to rely on early visual cues from the ball-flight to fine-tune swing initiation and swing time. The results emphasize the importance of training batters to quickly perceive and respond to post-release pitch information, focusing on swing adaptability rather than pre-release adjustments.

Keywords: Perception and action, Motor control, Fast pitch softball

13 – Assessing Skill Learning in Dynamic Environments, Possible But Difficult – A Water Safety Case Study

Kane Cocker, University of Otago; Tina Van Duijn, University of Otago, Swiss Lifesaving Federation (SLRG); Chris Button, University of Otago

Public learning about water safety remains a leading drowning prevention strategy such as through children's swimming lessons, or in public safety messaging. Traditional water safety education and assessment has been undertaken in indoor environments such as pools or school classrooms. In contrast, the vast majority of accidental drownings take place in open water settings. Our previous research has shown that it is possible to teach children water safety skills in open water environments with a high level of retention (Button et al., 2020) and that skill learning can be assessed in an open water environment (van Duijn et al., 2022). However, open water environments (i.e., oceans, rivers, lakes, ponds, etc.) are abundant and each has unique characteristics. As such it is vitally important to consider representative learning design and respect key perception-action couplings in water safety education. We have been unable to match the physiological demands of open water swimming in a flume simulation in experienced surf swimmers. We believe this is due to the task demands of the open environment not being matched by the in the simulation despite participants mirroring their own open water movements as closely as they could. Designing representative learning environments that reflect open environments is inherently logistically challenging. In this presentation we will discuss the benefits and challenges of assessing water safety skills in open water environments both from our own experiences (including cost, safety, and the unpredictable environment) and invite the audience to consider challenges they may face. Technological advances may soon help to overcome some of these challenges such as the use of virtual reality simulation-based assessment. While assessing learning is arguably important to assess the efficacy of interventions, we also discuss whether immediate testing following a program is necessary or if delayed retention testing may be more beneficial.

Keywords: Representative Design, Water Safety, Perception Action Coupling

14 – Variability-Based Learning Designs in Skilled Sporting Cohorts: A Scoping Review and Quality Assessment

Christopher Court Gold, Queensland University of Technology, Australian Institute of Sport; Michael Maloney, University of Canberra, Australian Institute of Sport; Peter Sondergeld, Queensland University of Technology; Adam Gorman, Queensland University of Technology

Although variability is often advocated for inclusion in practice for skilled learners, most of the evidence appears to arise from lab-based studies in controlled settings, often involving novice cohorts. Therefore, a scoping review was conducted to examine and assess the quantity and quality of research in the variability-based learning (e.g., practice variability, contextual interference, and differential learning) literature, focusing on a skilled cohort performing a sporting task. Twenty-two sources of evidence, comprising twenty-five studies meeting our inclusion criteria, were screened from eleven online databases. A custom quality assessment was developed by the research team, drawing on previous literature (Alfonso & Menayo, 2019; Christina, 1997; Davids et al., 2012; Ranganathan et al., 2020) to establish relevant quality questions for the field of variability-based learning. The distribution of the variability-based learning methods in the studies included differential learning (32%, n = 8), practice variability (28%, n = 7), contextual interference (20%, n = 5), or a combination of two methods (20%, n = 5). A considerable portion of studies relied solely on a retention test with no transfer test (42.86%, n = 9), a quarter did not include either a retention or transfer test (23.81%, n = 5), while another quarter employed both a retention and a transfer test (23.81%, n = 5). The quality assessment further revealed that transfer tests rarely represented competition (8%), multiple retention tests were rarely used (6%), competition statistics were infrequently recorded (6%), and individualised data was rarely reported (25%). Given that a key aim of using variability in training is to improve transfer and retention, the fact that many studies did not include both a retention and transfer test is concerning. Future research should consider how learning is best measured in a representative setting and consider adopting more athlete-specific, scaled variability-based learning methods. Doing so could deepen our understanding of variability-based learning methods in skilled sporting cohorts and enhance how variability is incorporated into practice for better skill development in high-level athletes.

Keywords: Variability based learning: Practice variability: Contextual interference: Differential learning: Skilled sport

15 – The Reciprocity of Spatial and Temporal Errors in Discrete Aiming

Tsung-Yu Hsieh, Fu Jen Catholic University; Yeou-Teh Liu, National Taiwan Normal University

The classical formulation of Fitts' law treats movement time as a dependent variable influenced by spatial constraints, potentially overlooking reciprocal dynamics between temporal and spatial dimensions in discrete aiming movements. This study examined how temporal constraint manipulations affect spatial and temporal movement outcomes through two experimental paradigms: target time manipulation

and temporal bandwidth manipulation across different levels of temporal index of difficulty (IDT). Results revealed systematic adaptations in spatial characteristics as a function of temporal constraints. Target time manipulation resulted in increased movement amplitude and velocity with longer target times. In contrast, temporal bandwidth manipulation showed that shorter time windows at higher IDTs reduced movement velocity and produced correspondingly shorter movement amplitudes, demonstrating constraint-specific adaptations. Variability patterns differed between manipulation types, with target time increases producing greater spatial and temporal variability, while bandwidth constraints reduced temporal variability but increased amplitude variability as compensation. These findings challenge the sufficiency of traditional Fitts' law for time-constrained movements and support a broader framework wherein space and time function as co-regulated dimensions within a constraint-based motor control system, with movement velocity mediating reciprocal organization of discrete aiming movements.

Keywords: discrete movement, speed and accuracy trade, offs, temporal constraint

16 – Effects of Task Constraints on Learning the Three-Step Pitch

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

Softball pitching is a complex and specialized sport skill. The three-step pitch, which is similar but simpler than the softball one-step fastpitch, can serve as a foundation for coaches in talent identification. Developing a training strategy for the three-step pitch may provide coaches with more training and selection options and expand players' developmental possibilities. This study examined the effect of task constraints on learning the three-step pitch in fastpitch softball. Eight junior high school softball players without prior pitching experience participated in the study. Participants were randomly assigned to either the constraint group or the control group. The constraint group practiced pitching between two parallel practice nets about shoulder-width apart and a horizontal bar approximately 30 cm above the ground for pitchers to stride over. The control group practiced in an open field. Both groups performed 20 three-step pitches for the pre-test before starting their practice session, then practiced 50 three-step pitches daily for five consecutive days. The post-test and transfer test of one-step pitching were conducted two days after the last practice session. Pitching movement time and subjective ratings of the pitching form by three coaching experts were analyzed using a linear mixed model, comparing groups across tests. Results showed that the constraint group significantly improved their movement forms in the transfer test compared to pre-test ($p < .001$). The control group showed no significant change ($p > .05$). The constraint group became faster in the post-test ($p = .037$), while the control group was slower ($p < .001$). Both groups improved in pitching accuracy, though the control group showed a larger increase. In conclusion, the constraint group demonstrated more effective movement patterns, better transfer to one-step pitching, and reduced movement time. Although the control group appeared to have greater improvement in pitching accuracy, the lack of ball speed and trajectory data limited assessment of ball quality. Future research will extend

training duration and include ball speed measurements to thoroughly examine the impact of the constraint-led approach on fastpitch softball pitching skill learning.

Keywords: Fastpitch Softball Pitching Motor Learning Transfer

17 – Effects of Visual Constraints on Learning Full-Turn Jumps

Jing-Yao Hwang, National Taiwan Normal University; Yeou-Teh Liu, National Taiwan Normal University

Gymnasts use "spotting" during jumps and spins, and show early head movement returning and a stabilized gaze before landing to gather information about rotation and balance throughout the process. However, it remains unclear whether external static and dynamic visual information help in learning jump-turn skills. Therefore, the purpose of this study was to explore how different visual information affects learning full-turn jumps. Twenty-three young adults who exercised regularly but lacked jump-turn training experience were randomly assigned to one of three visual information groups: Blank Screen Group (BG, n=8), Static Dot Group (DG, n=8), and Dynamic Number Group (NG, n=7), where different numbers were displayed every 200ms. A two-week training program was implemented to achieve full-turn jumps in 400ms. Data were recorded and analyzed using a 1-meter-diameter disc protractor, a force plate, and a high-speed automatic tracking system. A linear mixed model examined group differences in rotational angle and displacement from the starting point between pre- and post-tests, as well as differences in head velocity and acceleration in the post-test. Regarding performance outcomes, significant interactions were found in the average rotational angle and the absolute error of the rotational angle, with NG showing significantly greater improvements after training than BG. The average distance also showed a significant interaction, with DG performing worse in the post-test compared to the pre-test. Furthermore, higher head peak velocity observed during the post-test indicated a trend toward better performance with the order NG > DG > BG. The high complexity of the task made it highly susceptible to individual differences, and all three groups experienced some form of visual constraints, differing only in the degree of restriction. The findings suggest that the constraints applied in the NG may serve as a potential training strategy. Future research should include subjective evaluations of movement performance to supplement objective metrics and offer a more complete understanding of movement quality.

Keywords: full turn jump, visual information, constraints

18 – Mixed Outcomes, Evolving Demands: NFL Combine Testing and Performance Trajectories in Defensive Linemen and Ends

Maarten Immink, Flinders University

Scouting combines, grounded in the assumption that standardized testing predicts on-field success, have long been central to athlete evaluation. However, the predictive value of physical performance testing remains mixed across

sports, including professional American football. This question is particularly relevant for defensive linemen and ends, whose roles are evolving with the rise of pass-heavy NFL offenses that increasingly demand speed and agility alongside power from these positions. Despite these shifting demands, limited research has examined how NFL combine tests forecast success in defensive front positions. Addressing this gap is critical for talent identification and informing skill acquisition strategies for the modern defensive front. Analysis of publicly available 2014–2024 NFL combine, draft, and season data, revealed increased annual combine participation among defensive linemen and ends. Trend analysis showed significant gains in height and improvements in broad jump, three-cone, and 40-yard performance for defensive line/tackle (DL/DT) positions, while defensive end/Edge (DE/E) positions demonstrated only significant improvements in 40-yard times. After adjusting for height and weight, strong correlation was observed only between the three-cone and 20-yard shuttle; other associations were small to moderate. Logistic regression identified weight as the sole significant predictor of draft likelihood, limited to DL/DT. On-field performance prediction also varied by position. DE/E per-game tackle rates correlated positively with weight at combine, while DL/DT per game quarterback sacks and pressures correlated positively with most combine metrics except the bench press. These findings reinforce the mixed predictive utility of combine testing for NFL defensive front positions, consistent with broader literature reporting mixed links between physical tests and professional performance. Annual improvements in height, speed, power, and agility reflect both evolving positional requirements and the broader progression of NFL athlete performance capacities. Practically, the results highlight the need to interpret combine data within positional and longitudinal contexts rather than relying on static predictive models.

Keywords: Abilities, Talent Prediction, Testing, Professional Performance, Strength and Conditioning, Skill Acquisition, Football

19 – Acute Neuromuscular Responses During Repeated Sprint Exercise in Track and Field Sprinters

Gaku Kakehata, Waseda University; Naoya Takei, University of Tokyo

Repeated sprint exercise (RSE), involving maximal-intensity efforts with short recovery intervals until exhaustion, is a widely used and effective training method among athletes. However, the characteristics of neuromuscular behavior involvement during RSE remain unclear. To investigate neuromuscular fatigue during RSE from the perspective of neuromuscular responses in track and field sprinters. The task was a set of repeated 30-m maximal sprints. Nine male track and field athletes participated to this study. Each continued until their sprint time declined by 10% compared with the first trial, with 20 s of rest between runs. Surface electromyography (EMG) was recorded from eight muscles of one lower limb (gluteus maximus, rectus femoris, biceps femoris, semitendinosus, vastus lateralis, tibialis anterior, soleus, gastrocnemius lateralis). Spatiotemporal variables were measured using a high-speed camera and timing gates. The running cycle was divided into four phases (contact, early-

swing, mid-swing, and late-swing), and integrated EMG (iEMG) was calculated for each phase. Three sprints were analyzed: the first trial, the trial at 5% speed reduction, and the trial at 10% reduction. As fatigue progressed, running speed and step frequency significantly decreased. Significant interactions were observed for EMG in the rectus femoris and gluteus maximus. In particular, rectus femoris activity decreased during early and mid-swing, while gluteus maximus activity decreased during stance, mid-swing, and late-swing. An important finding was that neuromuscular activity of the hip muscles was selectively attenuated as fatigue progressed during RSE. These muscles are critical in the acceleration phase of sprinting, responsible for generating ground reaction force through hip extension and recovering the swing leg forward. Thus, they are indispensable for achieving faster running speed. The results of this study suggest that, in repeated sprint exercise, fatigue does not occur uniformly across all muscles, but rather selectively, indicating the presence of muscle-specific differences.

Keywords: Repeated sprint exercise, Sprint running, EMG

20 – Talent Development Factors and Skills for Sport Officiating

Aden Kittel, Deakin University; Ian Cunningham, Edinburgh Napier University (ENU); Nathan Elsworthy, Central Queensland University; Paul Larkin, Victoria University

Research has typically explored the key attributes of officiating in isolation, such as soccer, rugby league or Australian football. Although these studies provide deep insight into the factors and attributes relevant to officials in a particular sport at elite level, these are very homogenous samples. However, officials represent a heterogenous group (different sports, different performance levels), and much of the research, including talent/skill development, is considered transferable within this broad domain. Therefore, the aim of this study is to identify the most important factors for skill development and attributes for sport officiating, and determine how these differ between sports, performance level, and gender of officials. 369 active sport officials (mainly from soccer, cricket, rugby union, hockey) representing a range of skill levels (professional, semi-professional, talent, community) consented to participate in this study which is part of a broader project on recruitment, retention and development of sport officials. Only 272 (male n=239; female n=33) completed the online survey in its entirety and therefore included in the final analysis. A list of a) talent development factors and b) attributes were presented to participants to rank from most to least important. These factors and attributes were developed based on previous research conducted, and in consultation with industry officiating coaches. The most important talent development factors were 1) Amount of games umpired/refereed, 2) Formal training, and 3) Amount of time interacting with other umpires/referees in group meetings and training. The most important skill attributes were 1) Making accurate decisions under pressure, 2) Communication skills, and 3) Knowledge of the rules. Key differences between sport officiated, performance level, and gender will be presented. To our knowledge, this is the

first study exploring talent development factors and skill attributes for sport officiating across a range of sports and performance levels. This study identified several similarities between different sports, which is important given much of the research is considered transferable between officiating populations. Findings indicate factors contributing to positive development of sport officials, and some attributes required to succeed. It is anticipated this will lead to stronger talent identification and skill development within sport officiating.

Keywords: Officiating, Referee, Umpire, Skill development, Talent

21 – Biomechanics-Informed 3D Animation for Teaching Throwing in Primary School Physical Education Lessons

Pui Wah Kong, Nanyang Technological University; Kyaw Thu Aung Ba, Nanyang Technological University; Allan Fu, University of Sydney; Yiyu Cai, Nanyang Technological University; Shern Meng Tan, Nanyang Technological University; John Komar, Nanyang Technological University

In Singapore, the primary school Physical Education (PE) curriculum places strong emphasis on the acquisition of fundamental movement skills (FMS), which are essential for children's holistic development and lifelong participation in physical activity. Currently, there are limited scientifically grounded visual tools to effectively demonstrate correct FMS performance. To address this gap, we developed a 3D animation tool of overarm throwing techniques derived from whole-body biomechanical data and established teaching guidelines. Designed for cultural and contextual relevance, the avatars wear Singapore primary school PE uniforms and can be customised to reflect different genders and races (Chinese, Indian, Malay, Caucasian). The animations allow students to view skill execution from multiple perspectives and at varied speeds, making complex movement patterns easier to understand. These animations were integrated into a web-based application optimised for iPads, facilitating convenient use in school environments. This new teaching resource delivers accurate, mechanically correct demonstrations of overarm throwing movement that are independent of a PE teacher's own skill proficiency. By enabling students to choose their preferred avatar characteristics and interact with features on iPads, the tool has the potential to enhance engagement and motivation to learn physical skills. The next stage of this project will be to implement the 3D animation tool in Singapore primary schools to evaluate its effectiveness in improving children's overarm throwing performance. Since FMS acquisition in childhood is fundamental to more complex sports skills and can positively influence active lifestyle, this project holds important long-term implications for the well-being and physical development of children into their adolescent and adult years.

Keywords: Physical Education, sport, fundamental movement skills, throwing, animation, iPads

22 – Who Decides What Is Worth Knowing? Joining With the Conversation as a Sport Scientist in Learning Design

Alex Lascu, Queensland Academy of Sport, Victoria University

The growing emergence of sport scientists in skill acquisition and learning design has reinvigorated research into how coaches, athletes and scientists regard knowledge, (co)design and collaboration. Learning Design within the Australian high performance sport system is defined as "*the optimisation of skilled performance by designing practice environments and experiences that are intentional, individualised, imaginative and evidence-informed, through the integration of principles from skill acquisition, coaching science, pedagogy and other specialist domains*" (AIS, 2025). As such, the nature of how sport scientists interact with and support coaches-athletes includes joining with their everyday practices and sharing knowledge from various specialist domains to evolve training design, and by extension, coaching practice. But who decides what knowledge is shared, and thus, what is worth knowing in each context? Existing coach education centres on ready-made curricula and knowledge, but this static view makes it difficult to reconcile with the dynamic, unfolding world that coaches, athletes and scientists experience daily. Viewing knowledge as ecological emphasises that coaches-athletes-scientists are entangled, active participants primarily experiencing the world as it is coming-into-being (Woods et al., 2022). This presentation will explore how joining with the conversation as a sport scientist can manifest in different ways, where 'what is worth knowing' is guided by three factors inspired by Woods and colleagues (2022): "*curiosity sees us continually attending to what sparks our interest; care sees us skillfully responding to what we find; and hope that together, we carry the correspondence on*". A series of inflection points between coach-athlete-scientist will be discussed, exemplifying how what is worth knowing (concepts, theories, frameworks etc) can be "*constructed and negotiated in real time by the contributions of those engaged in the learning process*" (Cormier, 2008, p 3). Such cases are not presented as a definitive way of how sports scientist should work, but rather aims to spark a conversation that overflows into other ways of doing and being in this space.

Keywords: learning design, skill acquisition, sport scientist, joining with the conversation, knowledge as ecological

23 – From Theory to Practice: Implementing the 5Es Framework to Enhance Movement Skill Learning in Preschoolers

Miriam Chang Yi Lee, Sport Singapore; Farah Syirin, Sport Singapore

Movement skill acquisition is an emergent process shaped by dynamic interactions between the child and their environment, occurring across varied contexts such as classrooms, playgrounds, and peer interactions. These interactions create nonlinear pathways to learning, challenging traditional prescriptive approaches and reinforcing the relevance of learner-centred pedagogies such as Nonlinear Pedagogy, which embrace variability and adaptability in practice. In line with these principles, Sport Singapore developed the 5Es Framework to guide educators in facilitating meaningful and positive movement opportunities for preschoolers through child-centred, facilitator-led approaches. The 5Es framework consist of five aspects: Learning Environment, Movement Experiences, Exploration, Engagement, Encouragement. This presentation will illustrate the practical application of the 5Es Framework through two case studies conducted in Singapore

preschools. The first case study features the Nurture Kids programme, an eight-week in-school initiative designed to increase preschoolers' physical activity through outdoor play and varied movement experiences incorporating neighbourhood playgrounds, storytelling, and music. The second case study examines a fundamental movement skill-based basketball pilot programme, which involved ball exploration activities and game-based play to develop motor skills and an interest in basketball. The presentation will include photos, short videos, observational notes, and data from surveys and interviews with educators and coaches, offering insights into how movement learning occurred and the benefits of such approaches for children's engagement, adaptability, and skill development. The findings highlight the pedagogical value of creating enriched, flexible learning environments that prioritise exploration and intrinsic motivation, offering practical implications for early childhood educators and coaches seeking to translate ecological dynamics and Nonlinear Pedagogy into practice. This presentation aims to demonstrate how theoretical concepts can inform programme design and practice in preschool settings, contributing to the discourse on learner-centred frameworks in early movement education.

Keywords: Fundamental Movement Skill, Preschool, Nonlinear Pedagogy, Mixed Method Approach

24 – Practice Effects on Movement Dynamics of Discrete Timing Tasks

Yeou-Teh Liu, National Taiwan Normal University; Szu-Hung Cheng, National Taiwan Normal University; Karl Newell, University of Georgia [USA]

Discrete aiming tasks have been widely used to analyze the spatial and temporal features of movement. A general "Bell-shaped" velocity profile has been proposed to describe the dynamics of the discrete aiming task. The purpose of the study was to examine how practice conditions influence movement dynamics in a discrete line drawing task. Forty-eight self-reported right-handed young adults were randomly assigned to one of four practice groups. The target task involved drawing a 30 cm line on a desktop digital tablet from the midline of the body to the right in 600 ms. All participants completed 50 trials of the target task for both the pre-test on the first day and the post-test on the sixth day. Participants practiced drawing a 30 cm line daily for 400 trials under different time constraints across four consecutive days. The practice goals were to pass 7.5cm at 150 ms (short), 15cm at 300 ms (mid), 22. 5 cm at 450 ms (long), and reach 30cm in 600 ms (end, the target task). The horizontal trajectory of each trial was normalized to 199 time points. FisherEM clustering in RStudio was used to analyze 4800 trials from both pre- and post-tests, as well as from the practice trials. Three clusters- early, late, and intermediate acceleration- were identified within each group for both the pre- and post-tests. The four groups showed similar cluster distributions in the pre-test. The proportion of the intermediate acceleration cluster increased in the post-tests for the mid, long, and end groups, while the end group also exhibited a significant reduction in the early acceleration cluster. Four clusters emerged from the practice trials. Although each practice group displayed different cluster distributions, a decrease was observed only for the

early acceleration cluster, and an increase was observed in the late and intermediate acceleration clusters over the four days. The observed changes in movement dynamics during practice indicate that the movement system adapted to a more efficient strategy.

Keywords: movement dynamic, discrete timing task, motor learning

25 – Rethinking Assessment: Aligning Practices with the Principles of Nonlinear Pedagogy (NLP) in PE

Ho Louis, National Institute of Education; Jia Yi Chow, National Institute of Education; Kah Loong Chue, National Institute of Education

Assessment has always been integral to teaching and learning, and pivotal in shaping classroom practices. Through assessment, data on student learning can be collected and used for decision-making to enhance teaching and learning. In the context of PE, assessment has predominantly focused on standards-based assessment and product-oriented assessment practices, such as fitness testing and skills testing in a decontextualised learning environment that offers little transfer in real-world contexts. Moreover, assessment in a closed environment may not fully account for the rich learning that takes place in the dynamic and complex environment for games and sports in PE. In recent years, there has been a pedagogical shift toward game-based approaches that account for the dynamic and complex nature of the learning environment that PE offers. There is also an increased interest in Nonlinear Pedagogy (NLP). With NLP's theoretical roots in Ecological Dynamics, which emphasises the interaction between the learner and the environment, learning is recognised as nonlinear and complex, reflecting the dynamic learning environment in PE. The gap lies in how assessment can effectively support the emergence of NLP as a pedagogical approach to nurture exploratory learning and adaptive learners. Thus, there is a need to examine the role of assessment within the pedagogical principles of NLP. This work seeks to rethink assessment in NLP for PE by exploring and conceptualising a framework for assessment in NLP-based PE lessons, potentially providing insights into developing assessment approaches that are more meaningful and effective.

Keywords: assessment, nonlinear pedagogy

26 – Complex Acrobatic Skill Development Approaches in Artistic Gymnastics: Systematic Observations of Short-Term Training Environments

Nathan Lynch, University of Canberra; Brad Clark, University of Canberra; Nick Ball, University of Canberra; Michael Maloney, University of Canberra, Australian Institute of Sport

Artistic gymnastics coaches continually develop their gymnasts' abilities to perform complex acrobatic skills to improve both difficulty and execution scores in routines. Previous interview studies in artistic gymnastics have highlighted that coaches utilise task decomposition approaches to progress skills towards a specific technical model. More recently, interviews in other acrobatic sports have shown the application of task simplification through multiple modified environments to support skill transfer. However, there is little empirical evidence of what happens

in practice to develop complex acrobatic skills. This study was an exploratory investigation of how women's artistic gymnastics coaches design and structure practice of complex acrobatic skills in short-term training environments. Ten advanced or expert coaches, each attending a minimum of one women's artistic gymnastics training camp, participated in the study. The study specifically focussed on the development of complex acrobatic tumbling skills on the floor apparatus. Systematic observations were conducted by video- recording all tumbling practices. For each practice task, the following variables were recorded: task duration, repetitions, surface, number of complex skills, mat height, skill difficulty, and task design (decomposed, simplified, part-routine, full-routine, other). Additionally, brief in-situ interviews were performed to capture factors influencing coaches' task design decisions. Results indicated that, in preparation for competition, practice tasks became more representative of competition demands, with gymnasts performing more connected skills (simplified, part-routine, full-routine) primarily on the floor surface (81.9% ±15.7%). Conversely, during general training, tasks focused more on part-practice (decomposed: 39% ± 11.9%; simplified: 57.7% ± 14%) and were performed mostly on alternate surfaces (89.7% across rod floor, trampoline, tumble track) compared to the floor surface (10.3% ± 7.9%). Furthermore, the in-situ interviews identified two main themes influencing coaches' decision making of gymnasts' session designs: (1) approaches for skill development and progression, and (2) factors that influence coaches designs. These findings demonstrate that in coaching the application of whole or part-practice is not as straightforward as using one method for complex skill development. Rather, these practice methods are applied on a continuum, influenced by multiple interacting factors, with coaches continually deciding the most appropriate approach to develop complex acrobatic skills.

Keywords: Complex Skill Development, Whole and Part Practice, Skill Acquisition, Artistic Gymnastics

27 – "Berjaya, Singapura": How Do We Perceive Success in Youth and Senior Sport?

Nur Adilah Masismadi, La Trobe University, High Performance Sport Institute; Matthew Wylde, La Trobe University; Esther Chia, High Performance Sport Institute; Paul B. Gastin, La Trobe University; Minh Huynh, Monash University; Haresh T. Suppiah, La Trobe University

Success in sport is often assumed to have a shared meaning, yet definitions vary across cultural, developmental, and individual perspectives. This study examined how stakeholders in Singapore perceive sporting success in both youth and senior contexts, and the implications for athlete development. A total of 103 respondents-36 athletes, 18 coaches, 20 parents, and 29 sport administrators/scientists-completed an anonymous online survey, piloted with 10 participants. The survey asked respondents to identify the most successful sporting nation, rate its success (0–100), rate Singapore's sporting success on the same scale, justify their choices, and indicate important components of success (checkbox and 5-point scale). The United States (41.7%, rating 87.8 ± 12.7), China (35.9%, 91.2 ± 8.0), Australia (5.8%, 88.3 ± 11.3), and Japan (3.9%, 96.8 ± 5.3) were most frequently identified as the most successful nations,

consistently cited across all stakeholder groups. Respondents justified these choices by citing international achievements, well-developed sport systems, and supportive cultures. Comparatively, Singapore received an average rating of 32.7 ± 22.3. Perceived successes included isolated standout competitive performances and community/recreational sport initiatives, whereas perceived shortcomings were linked to inconsistent high-level achievements, underdeveloped elite pathways, lower prioritisation of sport, and limited systemic or public support. Perceptions of success also differed across developmental stages. In youth sport, training commitment (M = 4.74 ± 0.56) and training experience (M = 4.65 ± 0.59) were endorsed as important by 81.6% and 80.6% of respondents, respectively, whereas medal attainment (M = 3.70 ± 0.86) was endorsed by only 35.9%. For senior sport, competitive level (M = 4.51 ± 0.60), national representation (M = 4.42 ± 0.73), and medal attainment (M = 4.11 ± 0.81) were endorsed as important by 76.7%, 68.9%, and 68.0% of respondents, respectively. These findings highlight that definitions of sporting success are both context- and development-specific. For Singapore, this suggests that youth pathways may benefit from emphasising long-term training commitment over early medal attainment, while senior pathways may require stronger systems to sustain international competitiveness. Although the modest sample size warrants caution in interpretation, aligning athlete development strategies with stakeholder expectations may strengthen both elite and community sport outcomes.

Keywords: Singapore, survey, athletes, coaches, parents, administrators, scientists

28 – Assessing Situation Awareness in Cycling

William Mccalman, Deakin University, Southern Cross University; Lyndell Bruce, Deakin University; Aden Kittel, Deakin University; Thuong Hoang, Deakin University; Anna Timperio, Deakin University; David Broadbent, Deakin University

Safe cycling involves having well-developed situation awareness, including a cyclist's perception of the environment, comprehension of how they should respond, and projection of what they or other road users should or will do in dangerous situations. However, there remains a limited understanding of the methodological approaches to assess these situation awareness levels in cycling. This research addressed this gap by systematically reviewing the situation awareness research on cycling. Six electronic databases (PubMed, Web of Science, Academic Search Complete, APA PsycArticles, APA PsycInfo and SportDiscus) were searched, resulting in 56 peer-reviewed studies, where information regarding the sample and methodological characteristics was presented. Male cyclists represented most (66%) of the sample compared to females (31%), and those not reported (3%). Most studies were quantitative (91%) compared to qualitative (9%), with the majority using lab-based (48%) or in-situ (45%) designs. Based on an initial analysis of these studies, the predominant situational awareness measures were of cyclists' perception (45%), followed by their comprehension (42%), and projection (13%). Most studies examined situational awareness variables together (64%), including cyclists' perception and comprehension (38%), followed by their perception, comprehension, and projection (27%). The most frequently used measures were eye-tracking glasses (64%), followed by surveys incorporating

multiple-choice, open- and closed-ended questions (30%), and instrumented bicycles (18%). Based on these findings, recommendations are for future research to explore the holistic nature of situation awareness requirements. These findings can provide guidelines on current best practice approaches to evaluating cyclists' situational awareness and areas requiring further research. Specifically, future researchers and/or practitioners may seek guidance on the most appropriate measurement tool. Furthermore, this research will inform evidence-based resource development aimed at enhancing cyclists' safety when riding. In the future, researchers can examine the validity and reliability of these tools so they can be integrated into cycling safety programs in schools and communities.

Keywords: Road User, Bike, Safety, Hazard Perception, Decision Making, Gaze Behaviour

29 – Literacy Benefits From Embedded Physical Education in Primary Schools

Sarah-Kate Millar, University of Canterbury; Susannah Smith, University of Canterbury; Brigid McNeill, University of Canterbury; Jen Smith, University of Canterbury

This research aimed to determine whether the Better Start Literacy Approach (BSLA) can be enhanced by including physical education teaching that directly links to the books and words being shared in the literacy approach. Researchers were interested in finding out whether having this combined literacy and movement focus will be more beneficial to children's literacy learning. They were also interested in tracking the impact of this teaching on children's movement skills. The literacy assessments included phoneme awareness (child's ability to hear sounds in words) and non-word reading and spelling. The movement measures included timing the children as they complete a small circuit moving around various objects (e.g., moving around a cone, going under a barrier) and a perception task where they will be asked to select a picture which most closely resembles how they feel about engaging in movement activities. In addition, classroom behaviour was systematically recorded to see if there was a difference before or after physical activity. The study ran for 10 weeks in 5 rural primary schools in Northland in NZ with year one and two children. Results showed an increase in literacy and movement measures, including perceived competence, as well as differences in classroom behavior. The result from this study is hoped to help design lessons that can improve the movement and learning skills of young children in New Zealand.

Keywords: Literacy, Primary school, PE, Teacher support, Perceived competence

30 – Guiding Human Skill Learning using AI-curated Virtual Environments

Patrick Nalepka, Macquarie University

Skill acquisition is facilitated by social interaction, whereby coaches, teachers, and peers structure environments and form curricula to guide attention and shape

the learning of adaptive behaviours. From a constraints-led perspective, learning is a self-organizing process in which skill development emerges from the interplay of individual-, environment-, and task-relevant constraints. Instructors, whether human or artificial, play a critical role in identifying and manipulating these constraints to guide the self-organization of adaptive behaviour. This can be done during the task's design, or dynamically through the interactions of social agents embedded in the learning context. My research investigated how social interactivity functions as an enabling constraint in a social virtual reality problem-solving game with a latent solution that, once discovered, yields superior performance. Participants who discovered and exploited this solution exhibited greater perceptual-motor coupling during the pre-discovery phase than those who did not. I also demonstrated that AI agents embodying the decision policies of pre-discoverers could, when paired with novice human participants, scaffold learning environments that increased the likelihood of solution discovery. These findings demonstrate the potential for human-compatible AI agents to act as adaptive peer instructors that dynamically shape constraints through interaction to support skill acquisition. Building on this work, I will conclude the talk by outlining the next stage of my research in AI-assisted skill learning and interaction, with a focus on personalised curriculum design. Drawing inspiration from Automatic Curriculum Learning (ACL), a machine learning approach for training AI agents, I propose adapting these methods for human skill learning. This approach involves developing AI systems that design effective learning environments through interaction with AI agents embodying generative models of human behaviour, informed by motor control research on Dynamical Motor Primitives (DMPs). These models will enable curricula to be designed, tested, and optimised in high-speed simulation, producing personalised training environments that respect the dynamics of human behaviour.

Keywords: social interaction, human AI interaction, interpersonal coordination, AI assisted skill acquisition, virtual reality

31 – Effect of Environmental and Task Constraints on Shot Kinematics and Task Accuracy During Tennis Forehands

Busuttil Nicholas, Victoria University; Alexandra Roberts, LaTrobe University, Queensland Academy of Sport; Marcus Dunn, Heriot-Watt University; Kane Middleton, LaTrobe University

The sports-performance environment is dynamic and unpredictable, which requires individuals to be adaptable under multiple scenarios (Araújo et al., 2013). To equip athletes to perform well in these dynamic environments, coaches use multiple training tools to develop skills (Busuttil et al., 2024). Two types of tools used in tennis are ball projection machines and grip-specific tools, which have been demonstrated to affect upper-limb kinematics (Busuttil et al., 2023; 2025) and task accuracy (Carboch et al., 2014). This study aimed to understand the effects of grip task constraints on task accuracy and shot kinematics under different ball delivery modalities and shot directions. A convenience sample of 13 right-handed semi-professional tennis players (Mean ± SD; age: 17.2 ± 2.2 years; height: 1.8 ± 0.7 m; mass: 66.7 ± 2.2 kg) participated in the study. Each participant was required to

perform ten successful lateral moving tennis forehands, aiming for two 3 x 3-m target zones (Crosscourt and down the line), under two ball delivery (ball machine & racket fed) and grip (normal & gripfixer) conditions. The protocol included a total of eight conditions that were counterbalanced. Performance measures of task accuracy (% in zone) and peak horizontal and vertical racket linear velocity were measured. Three-way ANOVAs were used to assess the main effects of, and interaction between, ball delivery, grip type, and shot direction. There was a significant main effect for ball delivery on task accuracy ($p = .039$, $\eta 2p = 0.045$), whereby the racket-delivered condition was ˜5% greater in accuracy compared with the machine-delivered condition (SE = 2.46%). There was also a significant main effect of hitting direction for peak horizontal racket linear velocity ($p = .008$, $\eta 2p = 0.077$), whereby the crosscourt condition had greater velocity (1 m/s; SE: 0.319 m/s) compared with the down-the-line condition. There were no significant main effects of grip type ($p < .05$). These findings detail the importance of manipulating ball delivery and shot direction, regardless of grip type, as they affect accuracy and racket velocity. Understanding these effects is critical for designing representative training that fosters adaptable and transferable tennis skills.

Keywords: Constraints, tennis, ball machine, training tools

32 – Different Brain Regions are Involved In Intra- and Inter-Individual Variability in Reaction Time During the Real-World Sprint Start

Atsushi Oshima, The University of Tokyo; Gaku Kakehata, Waseda University; Naotsugu Kaneko, The University of Tokyo; Yume Mashiki, The University of Tokyo; Daiki Yamasaki, The University of Tokyo; Hiroki Arakawa, The University of Tokyo; Mayu Dohata, The University of Tokyo; Taishi Okegawa, The University of Tokyo; Hikaru Yokoyama, Tokyo University of Agriculture and Technology; Kimitaka Nakazawa, The University of Tokyo

Preparatory brain activity that precedes movement is known to correlate with subsequent reaction time (RT). However, this knowledge is based on studies in controlled laboratory settings. Therefore, even when individuals who have maximized their response abilities through long-term training perform in near-natural settings, it is unclear whether there is a correlation between preparatory brain activities and RT. We focused on a sprint start, which requires particularly rapid responses, even within the context of sports. Thus, this study aimed to clarify the relationship between preparatory brain activity just before a sprint cue and the subsequent RT. Seventeen sprinters (aged 19–27 years) performed 30 sprint starts. An electroencephalogram (EEG) was recorded using a 63-channel portable system. RT was calculated from ground reaction force data. In the EEG analysis, after preprocessing such as independent component analysis, source estimation and cluster analysis were performed. Then, event-related spectrum perturbations from "Set" to the start cue were computed for each trial and participant, and the mean alpha, beta, and gamma power were calculated. We conducted two types of correlation analyses. First, to assess the intra-individual relationship, we used a repeated measures correlation analysis using EEG power

and RT in each trial. Second, to determine the inter-individual relationship, we performed a correlation analysis using the mean EEG power and mean RT across all trials. For all analyses, the significance level was set at $p < 0.05$. Focusing on the intra-individual relationship, we observed significant negative correlations in the alpha and beta bands of the anterior cingulate cortex, as well as a significant positive correlation in the alpha band of the right sensorimotor cortex (all $p < 0.05$). For the inter-individual relationship, significant positive correlations were shown in the alpha, beta, and gamma bands in the right temporal lobe (all $p < 0.05$). These results suggest that trial-by-trial RT variability was associated with activity in the anterior cingulate and right sensorimotor cortices. In contrast, inter-individual RT variability was related to activity in the right temporal lobe. Thus, different brain regions may contribute to intra- and inter-individual RT variability in the sprint start.

Keywords: EEG, Sprint start, Motor preparation

33 – Exploring Kinetic Strategy in the Rear-Foot-Elevated Split Squat Using Clustering Analysis on Waveforms

Ignas Palamarcukas, Nanyang Technological University; Violet Man-Chi Ko, Nanyang Technological University; Veni Pui Wah Kong, Nanyang Technological University

The rear-foot-elevated split squat (RFESS) is mainly a unilateral lower-body resistance training exercise often used for enhancing physical performance or assessing athletes. As a resistance training exercise, RFESS is generally performed with the focus on maximising concentric velocity at a specified external load. Mathematically, velocity is determined by the area under the curve of the vertical ground reaction force (vGRF). The constraints of the exercise, such as the range of motion of the joints, the non-ballistic nature, and the individual's force production capacity relative to the system weight, limit the magnitude and the temporal duration of the vGRF curve. Importantly, however, the shape or pattern of the vGRF curve itself is free to vary and can be interpreted as a kinetic strategy. To date, few studies have explicitly aimed to identify different kinetic strategies in resistance training exercises. As such, twelve males and four females (27.0 ± 4.4 years, 1.72 ± 0.06 m, 70.1 ± 8.7 kg) performed RFESS at 40%, 60%, and 80% of their one-repetition maximum loads for two sets of five repetitions with both left and right legs as the lead leg. Kistler force platforms (one under each leg), sampling at 1000 Hz, were used to capture kinetic data. To account for individual differences in system weight and strength, force data were both magnitude- and time-normalised. Functional data analysis methods were used to represent vGRF using B-spline basis expansion, with a k-means clustering approach to identify different vGRF patterns. After the classification, further analysis was done to examine whether each participant's kinetic strategy varied across the three external loads. The k-means clustering method successfully identified different kinetic strategies at the level of vGRF. Future research should further investigate associations of each vGRF pattern with individual characteristics (e.g., strength of different muscles), RFESS performance (e.g., peak force, power, and velocity), as well as other athletic abilities (e.g., vertical jump prowess).

Keywords: functional data analysis, clustering, biomechanics

34 – Sports as Tool-Use: Implications for Skill Acquisition

Robert Rein, Institute of Training Science and Sports Informatics

Many sports disciplines rely on the use of specific implements. For example, tennis athletes use a racket to hit a ball, golf players use a club to drive the ball, and fencers use a foil. Conceptually, in all these instances the athlete uses an object to interact with the environment, which follows the definition of tool use as the control of a freely manipulable external object with the goal of altering the physical properties of the actor. Thus, a large number of sports disciplines fall into the domain of tool use. This raises the question of whether actions involving tools are somehow distinct from those lacking tools. Surprisingly, this question has received very little attention in sports skill acquisition research. In contrast, fields such as medicine and neuroscience have accumulated over a century's worth of research findings specifically addressing tool use. Results from these domains in particular underscore the distinctiveness between actions involving tools and those lacking them. During execution, tool use depends on the appropriate perception of the tool's properties, as movement control and coordination must be scaled accordingly. For example, during a long-line drive in tennis, the necessary striking force depends on the string tension of the racket. Moreover, in cases of movement errors, responsibility can be assigned to either a misperception of the tool's properties or the selection of an incorrect movement. From a predictive processing perspective, this corresponds to a misspecified generative model, resulting in erroneous sensory predictions. This is particularly important during the initial stages of skill acquisition, when athletes are neither well attuned to the tool nor to the required actions. To shed some light on this phenomenon, results from two experimental campaigns are presented. First, results from badminton, table tennis, and tennis show that experienced athletes demonstrate better perceptual performance with respect to tool properties compared to novices. Second, based on an ongoing investigation, preliminary findings reveal how task difficulty interacts with tool perception in a golf-putting task. Potential avenues for future research on skill acquisition in sports tool use are outlined and discussed.

Keywords: motor learning, motor control

35 – Influence of Game-Representativeness and Individual Factors on Perceived Challenge

Green Sarah, Deakin University

The Challenge-Point Framework and Periodisation of Skill Training (PoST) Framework have been developed as methods of classifying training based on the 'challenge' of a task. This 'challenge' refers to both the informational complexity and functional (perceived) task difficulty of the task. These frameworks propose a theoretical system for optimising training environments for outcomes such as learning, adaptability, and performance. This study examined the relationship between perceived challenge and objective measures of game-representativeness, focusing on individual differences within a team. 23 professional Australian Football players completed nine training drills with various skill training intentions. The training drills had various intentions – ranging from position-specific craft to large game-based activities – which

resulted in different degrees of game-representativeness being produced through their drill design. Immediately after each drill, participants provided responses for the Rating of Perceived Challenge and Rating of Perceived Exertion. Notational analysis was used to describe the training environment and player behaviour in each drill. Linear Mixed Effects Models will be used to evaluate differences in player behaviour and perceived challenge across different drill types. Further analysis will then be conducted to determine whether individual factors such as playing position and years of elite experience influence perceived challenge. The findings of this study will provide theoretical insight into how challenge may be evaluated holistically in team sport training. Findings will support the use of existing skill training frameworks – such as PoST – in which both objective and subjective measures of challenge are used to create optimal training conditions for different skill training outcomes. From a practical perspective, methods used in this study may be used by coaches to understand how their athletes perceive training drills and align their drill design with these perceptions. Findings will also highlight considerations for coaches when designing training aimed at specific skill outcomes for groups with varying ability levels.

Keywords: Challenge, team, sport, perceived challenge, representativeness, PoST

36 – Does Nonlinear Pedagogy Favour Functional Collective Behaviour and Performance in Rugby and Basketball?

Ludovic Seifert, Université de Rouen Normandie, Institut Universitaire de France; Guillaume Hacques, Le Mans Université; Quentin Bourgeais, Université Rouen Normandie; Raphaël Coté, Université Rouen Normandie; Pierre Vauclin, Université Rouen Normandie; Mickaël Campo, Université de Bourgogne

Nonlinear pedagogy has been emphasized to develop functional behavioural variability, notably adaptability as the subtle blend between stability to perturbation and flexibility to interacting constraints. The aim of our study was to check this theoretical rationale by comparing NLP and linear pedagogy (LP) in small side games in rugby (6v6) and basketball (4v4). 120 rugby U18-U21 players were split into LP and NLP groups; each group played 12 possessions in 3 scenarios of defence (gap between defenders; gap behind the defenders; gap between the wing defender and the side line). In LP, the coach instructed and prescribed the players movement and action on the field, whereas in NLP, only 3 principles of collective play were given (go in the gap, play in free space, give support to ball carrier) to focus attention of players on shared affordances. 70 basketball U18 players performed 16 possessions in 3 pedagogy conditions (LP in which task goal, i.e. 2pt vs 3pt shot, and game system were predefined by the coach; NLP1 with free play and free task goal; NLP2 with predefined task goal but flexible game system). Results in rugby showed that NLP did not lead to higher tries nor greater distance covered by the ball carrier than in LP; however, longer possession, more passes and more players were involved in NLP, suggesting more collective involvement and interaction between players. Results in basketball showed that NLP1 promotes ball circulation (= players hold the ball less and pass it more often) and generates

shorter possessions, while LP favoured possessions with more passes, likely linked to the requirement of carrying out the full game system. LP was very effective in enforcing a 2pt scoring intention (and it reduces the occurrence of a player holding the ball for too long) in comparison to NLP2. NLP1 led to the highest score per possession, notably thanks to a greater number of 2pt attempts and fewer turnovers. Moreover, the rate of success was maximized for 2pt in NLP1 and was maximized for 3pt in LP. Taken together these results emphasised the functional role of NLP by favouring more interaction between players.

Keywords: nonlinear pedagogy, team sport, shared affordances

37 – The Impact of Coaches' Verbal Interventions on Players' Tactical Behaviour of Youth Football Players in a Competition Context

Ronélia Viana, Federal University of Amazonas; Alberto Lobato Góes Júnior, State University of Campinas; Lucas Leonardo, Federal University of Amazonas; Tathyane Krahenbühl, Federal University of Amazonas; Machado João Cláudio, Federal University of Amazonas

Youth competitions should be understood as an essential learning space. In this sense, the interventions of coaches in these formative spaces need to be considered in order to provide their players with learning opportunities. During the competition, coaches provide several verbal interventions to help their players achieve better performance during the game. To understand the impact of these interventions on the game's contextual dynamics, this study examined the effect of coaches' verbal interventions on the tactical behavior of football players in youth competitions. The study involved two coaches (A: 50 and B: 30 years) and 20 Under-11 players (10.21 ± 0.65 years). Using the Coach Analysis and Intervention System (CAIS), 51 verbal behaviors from the coaches (A= 43 and B= 8) were selected, transcribed, and synchronized with the players' positional data, obtained through the Wimu ProTM tracking system. This tracking system was also used to analyze players' and teams' tactical behavior, before and after the coaches' intervention episodes. It was observed that Coach A's interventions, during timeouts (in the 1st and 2nd halves) and at halftime, impacted the players' tactical behavior. These behaviors encouraged the players to lower their defensive line ($p< 0.001$), moving closer to their own goal. However, this resulted in a greater distance between the team's defensive and midfield lines ($p<0.001$). Regarding Coach B, it was found that his interventions during halftime encouraged his players to increase the distance from each other in length during the defensive phase ($p=0.006$). It was possible to conclude that the coaches' verbal interventions impact their players' tactical behavior; however, these can negatively affect the spatial organization of their teams. Therefore, the coach can directly impact the tactical behaviour of young footballers in competitive matches, and it becomes necessary for them to understand how best to convey information to their players to enhance their tactical behaviour and learning opportunities.

Keywords: Coaches' interventions, Players' tactical behavior, Youth competition

38 – More Golf or More Game? Examining the Predictive Influences on Virtual Reality Golf Performance

Luke Wilkins, La Trobe University; Kane Middleton, La Trobe University

The use of virtual reality (VR) technology within sport has rapidly expanded over the past decade. The technology enables the creation of environments that can be carefully manipulated, enabling controlled, repeatable assessments that enhance our understanding and evaluation of skilled performance. However, to ensure effectiveness and accuracy in drawing inferences about skilled performance, VR platforms must demonstrate adequate construct validity. This study aimed to examine: 1) the broad and fine construct validity of a commercially available VR golf game, and 2) the predictive value of real-world (RW) golf ability and videogame experience for VR golf performance. Thirty-three golfers and 32 non-golfers completed a 12-hole test (preceded by a five-hole familiarisation period), with their To Par score used as the performance measure. Self-reported best handicap, weekly golf hours, total videogame playing experience, and prior VR exposure were also recorded. An independent-samples Student's t test revealed that golfers significantly outperformed non-golfers on the VR golf game (golfers M = 12.5 ± 7.5; non-golfers M = 27.5 ± 15.9), confirming broad construct validity. However, VR golf performance did not correlate significantly with best handicap, weekly golf hours, videogame experience, or prior VR use, failing to find evidence for fine construct validity and rendering subsequent multiple regression to examine the predictive value of these variables unnecessary. Reduced motor correspondence (due to using a standard VR controller) and gamified features may explain the inability of the VR golf game to make fine-grained distinctions between golfers of varying abilities, whilst the minimal perception-action coupling afforded by videogames may account for the limited transfer of videogame experience to VR golf performance. Differentiating levels of expertise with high sensitivity – such as distinguishing golfers by precise handicap – may currently exceed the capabilities of commercially available VR platforms. Nevertheless, as the use of VR to understand skilled performance within sport and sport science research is unlikely to slow down, it is important that, at the very least, VR sports platforms exhibit broad construct validity before being integrated into athletes' training practices or used for assessment purposes.

Keywords: virtual reality, construct validity, skilled performance, expertise differences

39 – Comparing Baseball Hitting Decision-Making Between Virtual Reality and Real-World Conditions

Lachlan Winter, Deakin University; Danielle Trowell, Deakin University; Aaron Fox, Deakin University; Robert Crowther, University of New England; Lyndell Bruce, Deakin University

Hitting a baseball is a complex action requiring perception and action coupling. According to ecological dynamics, practice conditions should be representative of what is experienced in competition to achieve transfer between them. However, current baseball training methods such as soft toss batting practice, hitting with a ball machine and two-decision making paradigms do not mimic competition conditions. Virtual reality (VR), computer-generated imagery that

simulates real-world environments, is a tool that has the potential to better preserve the perception-action coupling experienced in baseball. Despite been sighted as a potential tool to aid pitch recognition performance, no study has addressed how pitch recognition performance in VR compared to real-world pitching. 15 Right-handed hitters, competing in Baseball Victoria competitions were recruited. Participants completed a VR condition in a biomechanics laboratory and real-world data collection session at an indoor hitting cage. In the VR conditions, participants wore a Meta Quest 3 (Menlo Park, California) head-mounted display (HMD), and used the WinReality software (WinReality, Austin, Texas). In both conditions, participants received 50 pitches, made up of 30 fastballs and 20 curveballs, with pitches matched between conditions to ensure consistency and allow for pitch-to-pitch comparison. Analysis will compare response accuracy between the two conditions as well as out of zone swing percentage and in-zone percentage.

Keywords: Virtual Reality, Baseball, Decision, making

40 – From Tasks to States? Rethinking Mental Fatigue Effects on Running Performance in Laboratory and Field Settings

Svenja Wirtz, La Trobe University; Yannik Guthardt, University of Münster; Ross Julian, University of Münster; Minh Huynh, La Trobe University; Kate Webster, La Trobe University; Clare Macmahon, La Trobe University

Research on the implications of mental fatigue (MF) for performance has shifted toward the use of more ecologically valid fatiguing tasks and the exploration of countermeasures. Despite the progress, important gaps remain. One underexplored area is how different task types influence MF and subsequent performance. Most studies have focused on comparing a fatigue-induced state to a control condition and drawn conclusions from group-level differences. However, there is an increasing recognition that MF is individual and that methodological approaches should account for within- and between-person variability. In line with this, our lab was unable to replicate traditional group-based differences and is challenging common practice by instead using individual responses to compare higher versus lower individual fatigue irrespective of the specific task used to induce MF, to then examine the impact on running performance. In a multi-site randomized counterbalanced study, participants either watched a documentary (information processing) or completed the Mackworth clock task (vigilance) for 30 minutes, followed by a self-paced 3km time trial run on either a treadmill or 200m indoor athletics track. Perceived MF pre and post cognitive tasks was recorded on a 100mm VAS scale and time to completion and split times of the run were recorded. Linear mixed models were used to analyse the data. Results showed that there were no significant ($p > .05$) differences in MF levels between the two cognitive tasks, and 3km times were on average 18.6 seconds slower after the Mackworth clock, though this did not reach significance ($p = .06$). Participants varied in which task was rated more fatiguing. Subsequent analysis thus grouped ratings by higher and lower levels regardless of task, and showed significant differences ($p < .001$). However, these differences did not translate into performance outcomes ($p > .05$),

with participants on average 8 seconds faster in the higher fatigue group. The findings indicate that MF perception alone does not drive performance impairments. There seems to be an interaction between the individual, the context, the cognitive task and subsequent physical task. All parts of the relationship should be considered to aid understanding of MF and its potential effects on performance.

Keywords: cognitive fatigue, individual differences, methodology

41 – Gait Adaptations to Environmental Uncertainty

Jaime Wong, Nanyang Technological University; John Komar, Nanyang Technological University; Alicia Goodwill, Nanyang Technological University

Uncertainty is inherent in many tasks and situations of walking in daily life. The ability to walk in varied and uncertain environments is thus crucial to an individual's ability to perform activities of daily living and contributes to overall quality of life. Uncertainty can be either expected or unexpected, and has been characterised as sensory uncertainty (not knowing the accuracy or exact causes of sensory information) and environmental uncertainty (not knowing how the environmental state will change). Previous studies have showed that healthy young adults are able to adapt their stepping strategies when there is uncertainty in sensory information. However, we do not know how healthy young adults proactively adapt their movement strategies when facing environmental uncertainty during walking, and whether their inter-limb coordinative strategies are affected. This pilot study investigates the impact of environmental uncertainty on inter-limb coordination and obstacle crossing performance in healthy young adults. We recorded participants walking towards a target on a walkway with projected obstacles using Qualisys motion capture. 3 baseline walking trials with no obstacles was recorded. Following this, obstacle appearance within 3 different experimental trial blocks was manipulated according to a probability distribution (10%, 50%, 100%). Participants were informed of the probability of an obstacle appearing, but they were uncertain of whether or not an obstacle would appear and when it might appear when they started each trial. Trials with higher probability of obstacle appearance were considered to be less uncertain and vice versa. The phase coordination index was used to quantify interlimb coordination, while gait variables such as approach speed, crossing speed, step length and overall time taken to complete the task were used to compare movement strategies/organisation between trials with different levels of uncertainty. Findings suggest that proactive adaptations are made in response to expected (or predicted) environmental uncertainties. Movement strategies were also different in the approach phase before obstacle appearance.

Keywords: Motor Control, Motor Variability, Uncertainty, Active Inference

42 – On the Task Constraints of Learning to Juggle Three Balls

Yi-Chin Wu, National Taiwan Normal University; Yeou-Teh Liu, National Taiwan Normal University

Three ball juggling is a complex motor skill. Studies have explored various factors that influence the acquisition and performance of this skill. Our previous

study involving 16 college athletes practicing while standing inside a 3-foot diameter hula hoop showed that after four days of daily 15-minutes practice sessions, some participants still could not catch six balls in a row. To develop an effective strategy to help learners acquire the 3-ball juggling skill, we recruited five learners from the previous study who had not yet mastered it. In this study, we used smaller juggling balls, and required participants to stand behind a table with two facing baffles about shoulder width apart. Each baffle had an upward-pointing arrow painted on it. Learners were instructed to follow the arrows with their hands when throwing the balls. After 10 pre-test trials on day1, participants practiced for 15 min daily over 4 consecutive days. The post- tests, consisting of 10 trials, was conducted on day5. The number of catches per trial during both pre- and post-tests was recorded for analysis. A linear mixed model compared the two sets of pre- and post-tests for the 5 participants, revealing significant differences for both main effects, with no interaction ($p_s < .05$). The five learners showed notable improvement after four days of practice with the added spatial constraints and smaller balls. They demonstrated clear performance improvements, with maximum consecutive catches observed at 9, 11, 33, 50, and 55, respectively. Future studies will focus on practice duration and the effect of task constraints on the acquisition of three-ball juggling.

Keywords: Motor skill, Cascade Juggling, Constraints led of Approach

43 – Replay. Reflect. Refine: Leveraging Live and Delayed Video Feedback to Enhance Skill Learning in Coaching Practice

Mei Teng Woo, Republic Polytechnic Singapore

Integrating live and delayed video replay is changing coaching by improving skill development and feedback. With the increasing availability of video analysis tools, coaches and educators are better positioned to deliver timely, visual feedback that supports athletes' learning processes, enhances tactical understanding, and facilitates performance improvement. When integrated effectively, video replay can enhance attentional focus, increase feedback specificity, and promote autonomy - all of which contribute to long-term skill development. Live replay offers immediate external feedback during training drills, while delayed replay sup- ports athlete-led reflection and self-regulation - both vital components of motor learning. Recent action research examined the impact of video feedback on understanding gameplay. Five-minute segments from pre- and post-intervention games were used to analyze player clusters (defined as more than 50% of players in a zone). The intervention group experienced a 60% reduction in spatial clustering, while the control group saw a modest decrease. These results indicate improvements in spatial awareness and decision-making potentially related to video-based learning. Student feedback supported these quantitative findings, noting increased self-reflection, improved comprehension of gameplay, greater awareness and confidence, and higher motivation and engagement. Several students reported that watching themselves helped them identify positioning errors, tactical decisions, and movement pat- terns. This session describes methods for utilising live and delayed replay in both individual and team environments. It outlines approaches to designing feedback systems that align

with learner-centred coaching principles, addressing aspects such as timing, focus, and autonomy in visual interventions. The session also includes guidance on implementing these strategies in team and individual sports using minimal equipment.

Keywords: Video replay, Reflect, Video Feedback

44 – Model How Historical, Political, Geographical and Socio-Economic Constraints Contribute to the Design of Physical Education Spaces, Using Bronfenbrenner's' Bioecological Theory of Human Development

James Banks, Sheffield Hallam University; Keith Davids, Sheffield Hallam University; Martyn Rothwell, The Constraints Collective; Ben W. Strafford, Sheffield Hallam University

Understanding the relational interaction between child and their environment is central to motor development. In physical education settings, it has been proposed that more open and diverse spaces may afford enrichment of interactions between the learner and environment by disregarding the explicitly tied, historical relationship between spaces, locations, and pedagogical approaches. In this position piece we explore how to design these pedological spaces, centring attention on the 'design process' (co-design) and the 'physical architectural content' (interchangeable modularity) through positioning innovative methodological and architectural alterations for indoor and outdoor education spaces. We propose a conceptual framework for practitioners to consider how to promote skilful movement, irrespective of the historical spaces, locations or expectations of how physical education should be taught. To do so, we utilise concepts such as co-design and socially democratic pedagogy, encompassed within an Dcological Dynamics framing, as means of outlining a theoretical framework for developing (physical) education environments. The impact of urbanisation and technological advancement on access to stimulating natural environments for students is explored, therein, opening discussion on how providing equal opportunity for those impacted by geographical -alongside additional factors- restrictions can pragmatically be approached, so that all students can capitalise on opportunities for action (termed affordances) in indoor and outdoor environments.

Keywords: Pedagogy, Ecological Dynamics, Co-design, Interchangeable Modularity, Environmental Constraints