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Article

Representative co-design: Utilising a source of experiential knowledge for athlete development and performance preparation

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Abstract

Contemporary models for athlete development and performance preparation in sport have advocated a role re-conceptualisation for coaches grounded as *learning environment designers*. Within this re-conceptualisation, expert practitioners are encouraged to draw upon their experiential knowledge to design representative and meaningful learning activities that place the performer-environment interaction at its core. However, we propose that currently, a critical source of experiential knowledge is often overlooked within the process of learning design – that of performers. Specifically, practitioner-performer interactions could enrich the design of learning environments by promoting the utilisation of soliciting affordances and encouraging the psychological engagement of performers. This position paper introduces the concept of *representative co-design* – a notion which builds on existing research by framing how the insights and experiences of performers can be negotiated within the design of practice tasks that seek to faithfully simulate interacting constraints of competition to enrich learning environments. We frame the notion of *representative co-design*, and contend its importance within more contemporary athlete development and performance preparation models, at two levels: (i) that of enriching physical education curricula to develop thought provoking, 'intelligent' child / adolescent learners, and (ii) that of enriching contemporary athlete preparation models in high-performance sport to enhance learning and engagement, and to develop 'next generation' coaches within current athletes. To bring this conceptualisation to life, we present two exemplars demonstrating the notion of *representative co-design*, while concurrently highlighting areas for future empirical research.

Key words: Ecological dynamics; Athlete development; Contemporary performance preparation; Experiential knowledge; Representative co-design

Introduction

Skilled movement behaviour evolves over timescales of performance, learning and development (Button, Seifert, Chow, Araújo, & Davids, 2020). In sport, practitioners such as psychologists, coaches, managers, trainers, analysts, and applied scientists are challenged to develop models that prepare athletes for the demands of both current and future competition. This ubiquitous challenge is addressed by contemporary models that facilitate behavioural change along two timescales: (i) at the micro-scale of practice (hourly, daily, weekly and monthly), and (ii) at the macro-scale of talent and expertise development (observed over annual periods) (Davids, Güllich, Araújo, & Shuttleworth, 2017). The challenge of addressing development and performance preparation is as important for athletes on the pathway, as it is for senior, experienced professionals at the height of their career. At the core of such contemporary models is the need to foster a functional, evolving relationship between each individual performer and the competitive performance environment.

In this position paper, we contend that contemporary models would be enhanced by a performer (e.g., athlete or student) being actively engaged with the learning process, not just passively receiving instruction and direction from an authoritative figure (such as a sports coach or teacher). More directly, we introduce the concept of *representative co-design* – a notion which builds on existing research, by framing how personal insights and experiences of sport performers (at all levels of development) can be negotiated within the design of practice tasks that seek to faithfully simulate interacting constraints of competition. We argue that this pedagogical approach could extend current and contemporary models of performance preparation by empowering individual performers to take greater ownership of their learning activity designs, promoting a deeper understanding of their expertise domain. In doing so, practitioners are affording a platform that encourages the performer to engage in greater thought provocation about his/her learning, which may ultimately function to support the performer's 'intelligence'. To conceptualise the notion of *representative co-design*, we feel it is important to first discuss the more salient features of contemporary performance preparation models in sport. Specifically, positioned within an ecological dynamics framework, the following sections detail the integration of experiential and empirical knowledge and the role that expert practitioners have in performance preparation.

Contemporary performance preparation models in sport

Situating an ecological dynamics framework

The work of Davids, Handford and Williams (1994) and Handford, Davids, Bennett and Button (1997) indicated the need for a bio-physical perspective on skill acquisition and movement development. These papers called for sport practitioners to appreciate the complex and entwined interactions between an individual performer, task and environmental systems on movement organisation (Newell, 1986). Over two decades later, these conceptual ideas have evolved into ecological dynamics (Araújo, Davids, & Hristovski, 2006), a contemporary theoretical framework on performance and learning that integrates concepts from ecological psychology (Gibson, 1979), constraints on dynamical systems (Newell, 1986), the complexity sciences (Edelman & Gally, 2001) and evolutionary science (Araújo, Davids, & Renshaw, 2020). An ecological dynamics rationale views perceptions, cognitions and actions as interacting and self-organised phenomena that emerge from the continuously dynamic interplay of a performer's action capabilities (defined as their *effectivities*) and the affordances (defined as *opportunities for action*; Gibson 1979) offered in a specific competitive environment (referred to as an *ecological niche*) (Araújo et al., 2006; Ross, Gupta & Sanders, 2018).

This theoretical conceptualisation underpins contemporary models of athlete development and performance preparation in sport, including nonlinear pedagogy (NLP) (Chow Davids, Hristovski, Araújo, & Passos, 2011), constraints-based coaching (CBC) (Renshaw, Davids, & Savelsbergh, 2010), and the Athletic Skills Model (ASM) (Wormhoudt, Savelsbergh, Teunissen, & Davids, 2017). In such models, practitioners are challenged to shift their role perspective from one of performance compliance with 'optimal' movement templates that are captured in coaching manuals grounded in historico-cultural ideology (i.e., 'in an organisation's DNA'), to one of a *designer* of a learning environment who fosters self-organised (and self-regulated) performer-environment interactions (Woods, McKeown, Rothwell, Araújo, Robertson, & Davids, 2020). This re-conceptualisation of a sport practitioner's role is captured within the notion of *representative design* (Brunswik, 1955). Initially discussed with reference to the alignment of methods and designs used in psychological research with behavioural contexts, representative design was later re-configured as *representative learning design* in sport performance contexts by Pinder and colleagues (2011a; 2011b).

Representative learning design promotes the design of learning activities in sports practice that are aligned with (i.e., representative of) the constraints experienced within a particular competitive performance environment. This ecological ontology eschewed representational accounts to emphasise key properties of task constraints present within practice and competitive environments that afford a performer with opportunities to both *select* and *control* actions (Golonka & Wilson, 2019). Specifically, through prolonged exposure to practice tasks that represent (or faithfully simulate) the constraints of a competitive environment, a performer learns to detect the information that specifies the relational properties of the affordances in their environment, encouraging their realisation (Headrick, Renshaw, Davids, Pinder, & Araújo, 2015; Seifert, Papet, Strafford, Coughlan, & Davids, 2019).

In ecological dynamics, representative learning design has a fundamental basis in early psychological research in motor learning that advocated the principle of specificity of learning (see Henry, 1958). In this early interpretation, the specificity principle in learning was needed to ensure that the central nervous system (CNS) of the learner was exposed to specific stimuli for channelling neural impulses to centres for motor control and coordination to support learning of specific movements. However, an ecological dynamics rationale avoids the problem of over-emphasising specificity of learning (higher in representative design), to the expense of more general learning experiences (lower in representative design) for developing physical literacy in individuals (see Rudd, Pesce, Strafford & Davids, 2020). It emphasises a deeply enmeshed relationship between action, cognition and perception which is needed by 'intelligent' performers, high in physical literacy, at all stages of the life course. As we elaborate later, this preference for achieving a nuanced balance between specificity and generality of motor learning does not favour particular developmental moments when individuals are more receptive to learning. However, athlete development models like the ASM do imply that there may need to be a greater emphasis on more general learning experiences earlier in life, and a greater emphasis of more specialised activities later in life (Wormhoudt et al., 2017).

A team of multidisciplinary practitioners can play an integral role in the design of representative practice tasks to enhance the specificity of learning contexts. Undoubtedly, the considerable experiential knowledge of practitioners such as psychologists, coaches, managers, analysts, and skill acquisition specialists can enrich the sampling and integration of relevant constraints from competitive performance within practice task designs, ensuring they are correctly targeted at the individual needs of each athlete or sports team (Greenwood, Davids, & Renshaw, 2012). However, while the importance of practitioner experiential knowledge is well accepted, contemporary athlete performance development and preparation models, grounded in ecological dynamics, imply how they can be further enriched by unlocking the experiential knowledge of the performers (learners / athletes) themselves.

A welcomed shift toward the blending of empirical and experiential knowledge

Traditionally, sport science has focused on developing empirical support for performance preparation through harnessing experimentation in separate sub-disciplines, such as psychology, physiology and biomechanics (Balagué, Torrents, Hristovski, & Kelso, 2017). Unquestionably, this knowledge transfer has enriched the understanding of many applications of sport science. However, empirical knowledge has often been adopted in a hierarchical way and treated as *the* sole knowledge source needed to design effective practice tasks and learning environments. As illustrated in Figure 1, this hierarchical approach to knowledge transfer between sport scientists and practitioners has tended to neglect the experiential knowledge of expert practitioners gained through prolonged exposure to, and analysis and experimentation in, diverse and varied practice environments in the support of athlete development. Concurrently, this traditional hierarchical approach typically relies on an implicit assumption of the validity of its methods and data, and is likely to have driven dissonance between theory and practice within sport science.

******INSERT FIGURE ONE ABOUT HERE******

Comparatively, as shown in Figure 2, a contemporary approach to performance preparation seeks interdisciplinarity, integrating empirical knowledge with sources of experiential knowledge (e.g., Greenwood et al., 2012; Burnie, Barrett, Davids, Stone, Worsfold, & Wheat, 2018; McCosker, Renshaw, Greenwood, Davids, & Gosden, 2019). In this more integrative and interdisciplinary approach, interactions between the different rich knowledge sources could emerge in a more heterarchical way. For example, the experiential knowledge of expert practitioners and performers could be viewed as a complementary source of knowledge, gained from many years of competing, and developing and preparing athletes for competition, that guides the integration of theory into practice (Greenwood et al., 2012). In doing so, performance preparation models would be underpinned by rigorous theoretical constructs, while being presented, or brought to life, in a way that is rich in meaning from the 'lived experience' of practitioners and performers.

******INSERT FIGURE TWO ABOUT HERE******

Related to this special issue of Psychology of Sport and Exercise, in the theory of Direct Perception, the ecological psychologist James Gibson (1966) distinguished between *knowledge of* the environment, which underpinned use of affordances to regulate interactions with a performance landscape, and *knowledge about* the environment, which facilitates an internalised symbolic manifestation (in the CNS) of the environment available (i.e., in 'white board' tactical analyses of sport performance – see Araújo, Hristovski, Seifert, Carvalho, & Davids, 2019b). An integral component of an ecological dynamics rationale is, therefore, an appreciation of the roles of expert coaches within the competitive performance context, conceptualised as an important member of a team of practitioners tasked with designing representative learning activities that develop an athlete's *knowledge of* a performance environment (Woods et al., 2020).

The practitioner as a learning environment designer

A performance environment has been conceptualised as a *rich landscape of affordances* in ecological psychology (Rietveld & Kiverstein, 2014). In sport, practice task designs could then be conceptualised as a means to direct or educate the search and attention of athletes for utilising relevant affordances (Button et al., 2020). Contemporary perspectives on this idea suggests that with experience, continued exposure, and informed design, performers enhance their decision-making by becoming increasingly competent at realising the most *soliciting* or *inviting* affordances within their ecological niche (Withagen, de Poel, Araújo, & Pepping, 2012; Withagen, Araújo, & de Poel, 2017; Araújo et al., 2019b). It is important to consider that these affordance solicitations in competition are not static, rather, they emerge and decay based on athlete intentions during performance, the action capabilities developed by an athlete, and the emergence of critical information sources (detected using a variety of modalities such as haptic, proprioceptive, visual and auditory) that specify relevant properties of the performance environment (Turvey, Shaw, Reed, & Mace, 1981; Fajen, Riley, & Turvey, 2009; Withagen et al., 2017; Guerin & Kunkle, 2004; Pinder et al., 2011a). Thus, certain affordances attract individuals to act upon them at different timescales and a central role of the practitioner is to match the current action capabilities of a developing performer to the constraints designed into a practice task (van Andel, Cole, & Pepping, 2017; Araújo, Dicks, & Davids, 2019a). This idea captures the skill of practice design, indicating how an expert practitioner (learning environment designer) can 'nudge' a developing athlete toward the acceptance of certain affordances while rejecting the less relevant opportunities or invitations for action. Importantly, this process of nudging attention toward soliciting affordances through the use of practice design is one that practitioners progressively learn through 'doing' and careful reflection and continuous adaptations to practice – that is, observing how performers interact with the opportunities for action designed in to the practice task.

These ideas underline that a central aspect of the sport practitioners' role in contemporary performance preparation is to identify the information that a performer can use to regulate behaviours within a competitive environment. It is constant exposure to representative practice task constraints that will help athletes progressively attune to specifying properties of relevant affordances within their environment through the detection of information to support actions. Further, through prolonged exposure to representative training tasks, athletes will be encouraged to develop a functionally adaptive, self-regulating relationship with their competitive environment, learning when and how to accept or reject emerging or decaying affordances in dynamic performance contexts (Guerin & Kunkle, 2004).

Representative co-design

Utilising the experiential knowledge of experienced performers in athlete development

While contemporary models of performance preparation and athlete development are advocating a role re-conceptualisation for sports practitioners grounded as *designers* (Araújo et al., 2019a; Woods et al., 2020), we propose that currently, a critical source of experiential knowledge is often overlooked – that of *intelligent performers*. Here, the term 'intelligent' refers to a highly adaptive, emotionally engaged and motivated performer who learns quickly (i.e., constantly (re)adjusting behaviours during learning and performance to achieve an intended task goal based on prior experiences), and who relies on cognitions, perceptions and actions to function effectively in sport and physical activity. In this sense, the 'intelligent' performer is an individual who effectively uses cognition (integrated with perception and action) in the way defined by Turvey and Carello (1981, p. 313). They argued that the process of 'cognition' should be considered at a general level to refer to the interactive coordination of an individual (especially his/her perceptions, decisions and actions) and a performance environment. For example, successful performance in team games involves the 'intelligent' performer being challenged beyond mere action template imitation to critically interpret emerging events in performance and autonomously make decisions to resolve issues and problems that challenge him/her. It is enriched 'intelligent' performer-practitioner interactions that could subsequently inform the design of practice tasks that consist of affordances available within a specific competitive performance environment, soliciting their realisation based on a performer's action capabilities at a certain stage of development. In high-performance sports like soccer, this approach could exemplify how the use of temporal or spatial constraints (jointly selected by the player and coach) could nudge players toward the use of affordances that enable varying speeds of ball movement. Comparatively, in early physical education experiences, a child could be free to manipulate the spacings between 'monkey bars', leading to more challenging and functional climbing behaviours based on his/her current arm span dimensions and perceptions of self-competence.

Contemporary performance preparation models across all developmental levels would, therefore, benefit greatly from the insights and experiences of 'intelligent' performers (Gee, 2005), providing practitioners with a deeper understanding on specific solicitations experienced in a rich landscape of affordances. Metaphorically, this idea would be synonymous with an architect (coach) working with an engaged and knowledgeable client (athlete) to design a building (representative practice task) that functionally suits the needs of the specific client. Although it is the architect who designs the building, it is this enabling platform that firmly places the client's needs at the core of the design. Further, the process of *co-design* would not only increase the functionality of the relationship between the client and building (athlete's performance environment), it would likely engage the client to develop a deeper understanding of the building's properties (performance environment) so that they can make informed decisions about how to shape its design.

We propose that *representative co-design* can be harnessed through multidisciplinarity, where the 'intelligent' performer would be considered as another integral member of a team of sporting practitioners who co-design practice landscapes rich in information (Chow et al., 2011). However, the practicalities of multidisciplinarity are not straightforward, with issues raised over the integration of multiple scientific sub-disciplines and practitioners, in addition to the hierarchical relationship between theory and practice mentioned earlier (Ross et al., 2018). From a practical point of view, the relationship and integration between the 'intelligent' performer and practitioner could be challenged when communications are taking place during the co-design process. In this situation, specific sub-discipline language and principles may complicate and confuse co-design ideas, meaning that further specialisation and fragmentation hinders integration. To address these challenges, effective multidisciplinary working can be more formally embedded within the Department of Methodology (DoM) concept (Rothwell, Davids, Stone et al., 2020a).

Situating representative co-design within a Department of Methodology

From an ecological dynamics perspective, the design of a DoM considers that a form of life describes the everyday activities of sports organisations, capturing how surrounding social, cultural, and historical constraints shape the expression of inherent values, beliefs, traditions, customs, behaviours, and attitudes in a system (see Rothwell, Davids, Stone, Araújo & Shuttleworth, 2020b). Moreover, the aim of a DoM would be for the 'intelligent' performer and practitioner to work within a unified framework to: (i) coordinate activity through shared information, principles and language, (ii) communicate coherent ideas, and (iii) collaboratively design practice landscapes rich in information (i.e., visual, acoustic, and haptic) to guide the emergence of multidimensional behaviours in athlete performance.

To illustrate this, interacting constraints on a form of life in performance sport is particularly compelling in the pathway to one of the world's greatest sports teams: the New Zealand All Blacks. The form of life in New Zealand elite rugby union is predicated on self-regulation (players adapting and organising without external input) as a philosophy of a contemporary All Black being a 'faster learner than someone else', with the ability to 'adapt and adjust in the moment and then afterwards reflect and learn' (Napier, 2018, p. 3). Interestingly, coach Steve Hansen traced the All Blacks' philosophy of self-regulation back to the country's cultural heritage, where, due to its geographical isolation, New Zealanders had to be 'innovative, good decision-makers and do things for themselves' (Napier, 2018, p. 5). His perspective provides rich insights on the relationship between these historically relevant cultural values and attitudes and the potential benefits of co-designing practice environments in an everyday form of life proliferating in New Zealand rugby union. It is interesting to note how these capacities for self-regulation are well aligned with outcomes of a co-designing approach to sport practice methods for 'intelligent' performance. It is also noteworthy that the influence of cultural and historical constraints on sports performance preparation and athlete development has surfaced in a more context-driven sport psychology (see Schinke & Stambulova, 2017).

In the remaining sections of this position paper, we illustrate how the notion of *representative co-design* could enrich preparation for performance models across different developmental stages in sport – starting within a physical education curriculum and then progressing to a high-performance sport environment. In both examples, we propose that *representative co-design* could foster a rich platform where children / adolescents and professional athletes are empowered to take greater ownership of their learning and practice environments in a safe, but still uncertain way. Specifically, within physical education, we propose that the engagement of the student through the *co-design* of learning activities will beneficially develop their general physical activity 'intelligence', as they engage in deeper thought provocation of how to affect future learning designs within a curriculum. Additionally, within a high-performance environment, it is likely that the rich experiential knowledge exchange between a coach and athlete could foster not only an athlete's personal performance development, but the continuing development of 'next generation' coaches: athletes who are empowered to regulate the perceptions, cognitions, actions and emotions of themselves and teammates through the informed *co-design* of representative practice tasks in performance preparation.

Representative co-design: Enriching a physical education curriculum through the development of 'intelligent' performers

An important goal of physical education curricula worldwide is to progress learners beyond the scope of simply reproducing physical skill templates (such as an idealized 'swim stroke' or 'tennis stroke'), towards the development of self-regulating 'intelligent' performers who effectively use cognitive, perceptual and movement capacities to achieve strategic decisions and outcomes in complex and dynamic performance situations (Moy, Renshaw, Davids, & Brymer, 2019). As such, across the globe, government publications, national standards, professional bodies and curriculum documents in education have recognised that the development of 'intelligent' performers needs to start in childhood, emphasising the role of problem-solving, thinking and decision-making skills in physical education. For example, the UK's National Curriculum Physical Education, the USA's NASPE (National Association for Sport and Physical Education) and the Queensland Physical Education Senior Syllabus (Queensland Studies Authority, 2010), incorporate this outcome in all three of the major domains of learning: psychomotor, cognitive, and affective (see also the Australian Curriculum, Assessment and Reporting Authority, 2015; Department for Education, 2013; National Association for Sport and Physical Education, 2009; Queensland Studies Authority, 2010). Notably, the Studies Authority in Queensland, Australia (2010, p. 3) states that:

> *"Intelligent performance is characterised by high levels of cognitive functioning, using both rational and creative thought. Students are decision makers engaged in the active construction of meaning through processing information related to their personal experience and to the study of physical activity."* (emphasis added)

Existing ideas on 'intelligent' performers in sport are well aligned with connotations of physical literacy in physical education. Intelligent performers may be considered as physically literate individuals who can apply their physical, psychological, emotional and social competencies in a specific, high-level performance environment (Rudd et al., 2020).

The development of 'intelligent' performers in physical education leads imperviously to the notion of *representative co-design* within an ecological dynamics framework, exemplified through diverse and continuous interactions between a teacher and student. Initiated within early physical education settings, the experience of co-designing learning activities will not only enrich learning designs, but will develop a child's general performance 'intelligence', as (s)he is challenged to think more deeply about critical features of their learning environment that support self-regulated perceptions, cognitions and autonomous actions in performance (Gee, 2005). More specifically, co-design will empower the student to develop *knowledge of* their learning environment so they can make informed choices about how to manipulate its design (Gee, 2005).

As highlighted above, there is a *want* to create 'intelligent' performers in physical education. However, it too often fails to deliver on this aspect of the curriculum. A potential reason for this is not due to a lack of participation in physical education, an often-cited barrier, but due to popular curriculum designs used by teachers not allowing children to experience autonomous decision-making (Pelletier, Séguin-Lévesque & Legault, 2002). Traditionally, physical education teachers have been found to utilise more controlling, autocratic, strategies within their lesson designs compared to more autonomy-supportive strategies (Barrett & Boggiano, 1988; Taylor, Ntoumanis & Smith, 2009). This issue signifies that physical education professionals are prone to making the majority of decisions in regards to content and its pace of delivery, leaving students bereft of opportunities for taking responsibility for their learning (De Meyer, Soenens, Aelterman, De Bourdeaudjuij & Haerens, 2016). Another challenge for physical education curricula is an over-emphasis / specialism on team games (such as football or netball) and a lack of opportunity to explore actions through other forms of movement education, such as dance and gymnastics. Thus, in the following section, we explain how a creative dance curriculum that is *co-designed* by the teacher and student, can support the development of physical literacy in self-regulating, 'intelligent' performers.

Developing 'intelligent' performers in a co-designed dance curriculum

A creative dance curriculum allows students to explore different elements of dance, such as body, space, time, force, flow, and relationships. The creation of movements occurs through improvisation and spontaneous performance of movements in response to music and other environmental information, such as lesson themes (e.g., 'deep under the sea'). This informationally enriched landscape will offer many invitations to diverse action, encouraging students to explore their environment. To instantiate the development of an 'intelligent' performer through a dance curriculum, the student will first be challenged to couple (novel and diverse) movement solutions with the music's beat and tempo. With clear lesson intentions / expectations (such as creating a dance routine that follows an ABA form and structure[1]), they will progressively see the emergence of a dance routine. A teacher can further promote explorative behaviours through a learner-centred cyclical process, which is supportively aligned with an 'athlete-centred' approach to coaching. Specifically, the teacher could manipulate the tasks through the creation of scenarios or posing problems to be solved. Once a student becomes comfortable in their routine, the teacher's role is again challenged to re-engage them in exploratory (searching) behaviours. In such an instance, the teacher may engage the notion of *co-design*, inviting the student to: (i) manipulate the environment (e.g., the student being free to design features that invite specific behaviours), (ii) the theme of the lesson (e.g., the student being free to theme the intention based on special interests), or (iii) incorporate partner work (e.g., the student being free to engage peers within a co-designed environment or chosen theme). Through this process, it is likely that the student will engage in a deeper level of thought, being empowered to develop *knowledge of* the environment as he / she begins to control the richness and diversity of the learning experience, and in doing so, progressively develop into 'intelligent' performers.

At the start of this paper, it was highlighted that skilled movement behaviour evolves over timescales of performance, learning, and development (Button et al., 2020). Thus, the *co-designed* curriculum between the student and teacher will see each lesson become the performance. Learning

[1] ABA form begins with an opening theme, leads into a contrasting theme that complements the first, and concludes with a return to the opening theme. This conclusion is recognisable but somehow changes in order to bring the piece to its resolution. There is a cyclic feel, a sense of continuity, order and inevitability.

emerges through a unit of work (such as creative dance), as physical literacy develops through the schooling years. The experience of physical literacy will set up the majority of engaged students for a lifetime of recreational level physical activity and exercise. For a minority, it will also form a fundamental basis of a career in high-performance sport, leading us to the next section.

Representative co-design: Harnessing 'local-to-global' synergy formation processes in high-performance sport to develop 'next generation' coaches in current athletes

A central tenet of performance preparation in contemporary high-performance sporting environments is the appreciation of the athlete's needs being placed at its core (Woods et al., 2020). This approach is in stark contrast to the more traditional models of performance preparation, which have tended to place the coach at the centre of the instructional process (criticised earlier by Handford et al., 1997). In contemporary models of athlete development and performance preparation, the coach and athlete are envisioned as working in unison to *co-design* learning environments replete with critical information sources that solicit affordance realisation, supporting the development of self-regulating perceptions, cognitions, emotions and actions.

Contemporary models such as NLP, CBC and the ASM conceptualise athletes and sports teams as *complex adaptive systems* (e.g., Glazier & Davids, 2009; Komar, Chow, Chollet & Seifert, 2015). In complex adaptive systems, learning results in synergy formation (i.e., coordination and adaptations) between system components, such as muscles, joints and limb segments and synaptic connections in the brain, or between members of a sports team, resulting in functional performance adaptations (Glazier & Davids, 2009). Synergy formation in complex adaptive systems are shaped bidirectionally: *locally* between the players themselves or *externally*, shaped by practitioners in training (Ribeiro, Davids, Araújo, Guilherme, Silva, Garganta, 2019). For sport practitioners observing athletes in performance preparation, it is important to understand how different types of constraints (related to the task, individual and environment) converge to facilitate synergy formation for realising novel affordances. In ecological dynamics, learning involves constraints-induced synergy formation between players or parts of the body through exploration, invention and adaptation of action possibilities (Glazier & Davids, 2009; Davids, 2012).

Rich experiential knowledge from the athlete and coach can assist with the exploitation of *bidirectional synergy formation* (i.e., emphasising self-organising and self-regulating tendencies in athletes and teams, as well as the external influences of sport practitioners) (see Ribeiro et al., 2019). To exemplify, a coach may offer experiential knowledge that could guide the design of *global* 'principles of play' – affording flexible synergy formation from *global-to-local* levels. In contrast, the athlete could provide rich context to these principles based on current action capabilities, what information is being detected, and insights on the most soliciting affordances they perceive to be available for use within the performance environment. This is likely to drive *local* self-regulating interactions (between teammates and opponents) that lead to emergence of *global* behavioural patterns (Ribeiro et al., 2019).

This perspective uncovers an important feature of *representative co-design* in developing 'principles of play', or tactics perceived as important to overcome specific opponents or performance challenges. Notably, such strategising has historically been considered the sole domain of the coach, who develops a 'game model' or performance plan that athletes simply adhere to (Ribeiro et al., 2019). Framed through *representative co-design*, however, 'intelligent' athlete(s) and coaches work together to share rich experiential knowledge surrounding performance principles or tactics. Indeed, such principles are developed with the players' needs and action capabilities placed at the core – fostering greater player engagement, self-regulation and ownership of the learning and preparation environment. Thus, instead of offering putatively 'optimised', 'ready-made', and pre-programmed task solutions (according to personal preferences), a coach would work *with* the athlete to develop individualised and creative solutions for performance problems, which are continually evolving in line with tactical developments in a sport. In this way, both coaches and athletes find solutions to the emergent problems encountered in dynamic competitive performance environments *together* (Araújo, Davids, Chow, & Passos, 2009). We will specifically address this point in a practical example in proceeding sections of this paper.

It is likely that such sharing of experiential knowledge will foster a platform in which the athlete is challenged to become more self-regulating and engage in deeper thought. It is through this deeper level of engagement and thinking that the athlete may develop richer *knowledge of* the performance environment and its affordances (Araujo et al., 2019a; 2019b), facilitating a progressive evolution into a 'next generation' coach. Specifically, we propose that the process of *representative co-design* may foster a platform where the athlete will be safely challenged to develop their *knowledge of* the performance environment, enabling him / her to design in information they perceive is integral to the achievement of specific task goals through the realisation of relevant affordances. Further, in team sports, *representative co-design* would encourage these 'next generation' coaches to develop a deeper understanding of their teammates action capabilities given the intent of designing in relevant affordances that can be utilised within practice tasks based on the current action capabilities of their teammates. They could exploit this deeper understanding during practice tasks by educating a teammates attention toward the most relevant affordances within the environment based on their action capabilities and the intended task goal. Thus, such an approach will reflect upon them following *representative co-design*, in much the same way a coach's role has been re-conceptualised through a *designer* lens (Woods et al., 2020). We envisage these 'next generation' athlete 'leaders' as integral members of a team of sport practitioners who function collectively to *co-design* and enrich performance preparation programmes.

Bringing life to the notion of representative co-design in contemporary performance preparation models: Examples in high-performance sport

The notion of *representative co-design* being an integral component of contemporary athlete development and performance preparation in sport would be complemented by offering exemplars to bring the conceptualisation to life. The following sections of this position paper, therefore, present two examples from high-performance sport, in which a team of sporting practitioners, inclusive of coaches and 'intelligent' athletes, function within a DoM to exemplify *representative co-design*. These examples do not intend to offer comprehensive insight or hypothesis testing relative to *representative co-design*, but act as a conduit for current sports practitioners interested in applying its notions to salient features of their performance preparation models in high-performance sport.

Example 1: Co-designing a practice task to promote the exploration of varied passing interactions between elite Australian footballers

A foundational component of performance preparation in elite Australian football orients the design of practice tasks that enable players the opportunities to develop their disposal skill, specifically, their kicking skill. In this example, a practice task consisting of two teams of 9 players are challenged to outscore each other through the accumulation of 'points' by successfully passing the ball (via a 'kick') to a teammate who 'marks' (i.e., catches) it in a defined scoring zone. It is important to note here that, within an ecological dynamics framework, this initial practice design would have been informed by a team of practitioners, who worked to sample and integrate relevant informational constraints experienced by players within competition that shaped kicking skill. Following this, and in accordance with the notion of *representative co-design*, the coach discusses the practice design with an identified game 'intelligent' player (deemed as being a 'next generation' coach) prior, during and following the practice task intervention. Through this rich dialogue, the player is free to share his/her opinions (both verbally and through actions) regarding the design features of the practice task, with a specific focus on its representativeness. Examples of this coach-player dialogue prior, during and following the practice task intervention are offered below:

<u>Prior to the practice task:</u>

- Design feature: *The scoring system*
    - Coach-player reflections and discussions prior to the task could orient whether (or not) certain kicks should have a greater point allocation (i.e., kicks perceived by the player to be more 'difficult'), which could enhance their invitation within the affordance landscape. Accordingly, these discussions could lead to kicks agreed as being 'more challenging' by both the coach and player yielding a greater point allocation, encouraging, or inviting, players to explore their action capabilities and undertake a variety of kicks of differing levels of perceived difficulty during the task.

<u>During the practice task:</u>

- Design feature: *The dimensions of scoring zones*

    - Coach-player reflections and discussions during the task could orient whether (or not) the dimensions of the scoring zones are appropriately scaled to invite exploration of certain kicks based on players' action capabilities. Specifically, if the scoring zones are perceived to be too small to invite its score exploitation, a player could be free to manipulate its dimensions to encourage teammates to utilise it during the task.

<u>Post the practice task:</u>

- Design feature: *The global 'representativeness' of the practice design*
    - Coach-player reflections and discussions following task completion could orient whether (or not) they perceived that the design actually facilitated the exploration of kicks, shaped by representative informational constraints experienced in competition. Importantly, a player could be prompted to offer a 'perceived representative value' which (s)he felt reflected how 'game-like' the design was. This arbitrary value could be presented on a 0-10 scale (0 being 'not competition conditions at all', and 10 being 'complete competition conditions'), and used to inform the design of future task iterations.

Example 2: Co-designing 'principles of play' for attack in elite Rugby League

Beyond practice task design, the notions of *representative co-design* could be applied to the establishment of 'principles of play'. As discussed earlier, more traditional models of performance preparation advocate the coach as the sole individual (global source) responsible for the development of a 'game model' (Ribeiro et al., 2019). However, conceptualised through *representative co-design*, it would be the coach and 'intelligent' player(s) who each contribute rich experiential knowledge and insights surrounding the establishment of performance principles. An important consideration here is that the player(s) could voice opinions from the perspective of their teammates (and their teammates' action capabilities), which would concurrently empower ownership of, and responsibility for, the learning, development and preparation environment. Through such a lens, both coaches and 'intelligent' player(s) would develop 'principles of play' capable of exploiting emergent problems encountered in competition, such as specific opposition tactics or external environmental constraints (e.g., weather conditions or idiosyncrasies of opposition grounds). Thus, in this example, a group of rugby league coaches and 'intelligent' players are working collectively to establish a set of 'principles of play' in attack.

To best unlock the bidirectionality of synergy formation under constraint, both players and coaches could develop a set of *global* principles in attack based on their experiential *knowledge of* rugby league, while mutually acknowledging that players are free to actualise these principles *locally*, based on their action capabilities and emergent interactions with environmental and task constraints. From this perspective, the set of principles in attack would not formally define a 'structure' (as is typified in more traditional models of preparation), but enable a flexible (less structured) performance landscape by which players are free to explore and exploit (for an example in professional rugby union, see McKay & O'Connor, 2018). An example of one of these 'principles of play' in rugby league is presented below:

- Co-designed principle of play: *Fluid Ball Movement*
    - This principle could be converged upon by both 'intelligent' players and coaches given its evocation of ball movement intended to continually and dynamically challenge an opponent's defensive stability. Importantly, players are free to exploit this *co-designed* principle through the adaptability of their action capabilities relative to the informational constraints perceived within the environment. For example, 'fluidity' could be exemplified through dynamic ball movement, as players detect and exploit emergent and decaying affordances offered by an opponent's defence (i.e., detecting and exploiting a sudden gap afforded in a defensive line to pass or run into), or it could be exemplified through more conservative ball movement given the inability to penetrate an opposition's defensive structure at a given moment or within the action capabilities of the player in possession of the ball. Irrespective, the point here is that the players are free to exemplify this *co-designed* principle through any means they feel 'brings it to life' based on their action capabilities and interactions with the constraints of the performance environment.

Where to next?

Conclusions and future research directions on the notion of representative co-design

The aim of this position paper was to propose the notion of *representative co-design*, discussing its implications for contemporary athlete development and preparation for performance models in sport. It was argued that *representative co-design* would be an important methodological advancement for athlete development by closely simulating the task constraints of a competitive performance environment to exploit the experiences and insights of established performers at certain developmental stages. Concurrently, we argued that through *representative co-design*, contemporary sports organisations would not only unlock a source of experiential knowledge of use for development and performance preparation, but they would empower performers (at all developmental stages) to take greater ownership of their learning environment. It is through this process that performers are likely to develop richer *knowledge of* their competitive environment, and in doing so, develop into more thought provoking, 'intelligent' individuals.

Accompanying our propositions were exemplars demonstrating how *representative co-design* may be brought to life in a high-performance sport environment. While we feel these exemplars are integral components of this position paper as they offer readers a platform to understand how to integrate *representative co-design* into high-performance sport, they do lead to some important research questions that should be addressed. Specifically, the first example promoted an interesting aspect of *representative co-design*, that of engaging the 'intelligent' performer to provide a 'perceived representative value' to reflect the practice task's representativeness to competition. We propose two investigations could stem from the extraction of such experiential knowledge. First, researchers could look to validate this 'perceived representative value' against constraints sampled from both the practice task and competition. This would likely enable the development of an additional tool (such as a questionnaire), engrained within the notion of *representative co-design*, that a coach could use in the design of practice tasks. Second, it would be of interest to unpack the information sources players detect (attune to) when basing their 'perceived representative value'. This likely subjective analysis could unlock further experiential knowledge within the 'intelligent' performer, affording a practitioner with deeper information of use for the continued (re)design and refinement of practice tasks that faithfully simulate competition demands. Moreover, this process could help researchers better understand what 'information' actually is, which in ecological dynamics is highly individualistic, continuously facilitating environmental interactions based on a range of constraints. Last, we proposed that *representative co-design* would develop an 'intelligent' athlete's *knowledge of* the performance environment, leading to greater ownership and responsibility for learning and performance development. To test this proposition, it would be of interest for future work to examine the evolving behavioural tendencies (such as emergent leadership qualities) and coaching career trajectories of performers benefiting from pedagogies exploiting the notion of *representative co-design*. These analyses would provide informed insights into the capability of *co-designing* approaches to indeed develop future 'intelligent' athletes and 'next generation' coaches.

References

Araújo, D. Davids, K., Chow, J. Y., & Passos, P. (2009). The development of decision making skill in sport: an ecological dynamics perspective. In D. Araujo, H. Ripoll, & M. Raab, Markus (Eds.), *Perspectives on Cognition and Action in Sport*, (pp. 157-169). Suffolk: Nova Science Publishers, Inc.

Araújo, D., Davids, K., & Hristovski, R. (2006). The ecological dynamics of decision making in sport. *Psychology of Sport and Exercise*, *7*, 653-676, doi: 10.1016/j.psychsport.2006.07.002

Araújo, D., Dicks, M., & Davids, K. (2019a). Selecting among affordances: a basis for channeling expertise in sport. In M. L. Cappuccio (Ed.), *Handbook of Embodied Cognition and Sport Psychology,* (pp. 537-556). Cambridge, MA: The MIT Press

Araújo, D., Hristovski, R., Seifert, L., Carvalho, J. & Davids, K. (2019b). Ecological cognition: expert decision-making behaviour in sport. *International Reviews in Sport and Exercise Psychology, 12*, 1-25, doi: 10.1080/1750984X.2017.1349826

Araújo, D., Davids, K., & Renshaw, I. (2020). Cognition, emotion and action in sport: an ecological dynamics perspective. In G. Tenenbaum and R. C. Eklund (Eds.), *The Handbook of Sport Psychology, 4th Edition*. John Wiley & Sons Limited

Balagué, N., Torrents, C., Hristovski, R., & Kelso, J. A. S. (2017). Sport science integration: An evolutionary synthesis. *European Journal of Sport Science*, *17*, 51-62, doi: 10.1080/17461391.2016.1198422.

Barrett, M., & Boggiano, A. K. (1988). Fostering extrinsic orientations: use of reward strategies to motivate children. *Journal of Social and Clinical Pyschology, 6*, 293-300, doi: 10.1521/jscp.1988.6.3-4.293

Brunswik, E. (1955). Representative design and probabilistic theory in a functional psychology. *Psychological Review, 62*, 193-217, doi: 10.1037/h0047470

Burnie, L., Barrett, P., Davids, K., Stone, J., Worsfold, P. & Wheat J. (2018). Coaches' philosophies on the transfer of strength training to elite sports performance. *International Journal of Sports Science and Coaching 13*, 729–736, doi: 10.1177/1747954117747131

Button, C., Seifert, L., Chow, J. Y., Araújo, D., & Davids, K. (2020). Dynamics of skill acquisition: an ecological dynamics approach. Champaign, IL: Human Kinetics

Chow, J. Y., Davids, K., Hristovski, R., Araújo, D., & Passos, P. (2011). Nonlinear pedagogy: learning design for self-organizing neurobiological systems. *New Ideas in Psychology 29*: 189-200, doi: 10.1016/j.newideapsych.2010.10.001

Davids, K. (2012). Learning design for nonlinear dynamical movement systems. *Open Sport Science Journal, 5*, 9-16, doi: 10.2174/1875399X01205010009

Davids, K., Güllich, A., Araújo, D., & Shuttleworth, R. (2017). Understanding environmental and task constraints on talent development. analysis of micro-structure of practice and macro-structure of development histories. In J. Baker, S, Cobley, J. Schorer, & N. Wattie (Eds.), *Routledge Handbook of Talent Identification and Development in Sport* (pp. 192-206). London, Taylor & Francis Group

Davids, K., Handford, C. & Williams, M. A. (1994). The natural physical alternative to cognitive theories of motor behaviour: An invitation for interdisciplinary research in sports science? *Journal of Sport Sciences, 12*, 495- 528, doi: 10.1080/02640419408732202

De Meyer, J., Soenens, B., Aelterman, N., De Bourdeaudjuij, I., & Haerens, L. (2016). The different faces of controlling teaching: implications of a distinction between externally and internally controlling teaching for students' motivation in physical education. *Physical Education and Sport Pedagogy, 21*, 632-652, doi: 10.1080/17408989.2015.1112777

Department for Education. (2013). National curriculum in England: Physical education programmes of study.

Edelman, G. M., & Gally, J. A. (2001). Degeneracy and complexity in biological systems. *Proceedings of the National Academy of Sciences of the United States of America, 98*, 13763-13768, doi: 10.1073/pnas.231499798

Fajen, B. R., Riley, M. A., & Turvey, M. T. (2009). Information, affordances, and the control of action in sport. *International Journal of Sport Psychology, 40*, 79–107

Gee, J. P. (2005). Learning by design: good video games as learning machines. *E-Learning, 2*, 1-12

Gibson, J. J. (1966). The senses considered as perceptual systems. Boston: Houghton-Mifflin.

Gibson, J.J. (1979). The ecological approach to visual perception. Boston, MA: Houghton Mifflin

Glazier, P. S., & Davids, K. (2009). Constraints on the complete optimization of human motion. *Sports Medicine, 39*, 15-28, doi: 10.2165/00007256-200939010-00002

Golonka, S., & Wilson, A. D. (2019). Ecological representations. *Ecological Psychology, 31*, 235-253, doi: 10.1080/10407413.2019.1615224

Greenwood, D., Davids, K., & Renshaw, I. (2012). How elite coaches' experiential knowledge might enhance empirical research on sport performance. *International Journal of Sport Science & Coaching, 7*, 411-422, doi: 10.1260/1747-9541.7.2.411

Guerin, S., & Kunkle, D. (2004). Emergence of constraint in self-organizing systems. *Nonlinear Dynamics, Psychology and Life Sciences, 8*, 131–146

Handford, C., Davids, K., Bennett, S., & Button, C. (1997). Skill acquisition in sport: some applications of an evolving practice ecology. *Journal of Sport Sciences, 15*, 621-640, doi: 10.1080/026404197367056

Headrick, J. J., Renshaw, I., Davids, K., Pinder, R. & Araújo, D. (2015). The dynamics of expertise acquisition in sport: a conceptual model of affective learning design. *Psychology of Sport and Exercise 16*, 83-90

Henry, F. M. (1958). Specificity vs. Generality in Learning Motor Skills. *Proceedings of College of Physical Education Association, 61*, 126-128

Komar, J., Chow, J. Y., Chollet, D., & Seifert, L. (2015). Neurobiological degeneracy: supporting stability, flexibility and pluripotentiality in complex motor skill. *Acta Psychologica, 154*, 26-35, doi: 10.1016/j.actpsy.2014.11.002

McCosker, C., Renshaw, I., Greenwood, D., Davids, K. & Gosden, E. (2019). How performance analysis of elite long jumping can inform representative training design through the identification of key constraints on behaviour. *European Journal of Sports Science 19*, 913-922, doi: 10.1080/17461391.2018.1564797

McKay, J., & O'Connor, D. (2018). Practicing unstructured play in team ball sports: a rugby union example. *International Sport Coaching Journal, 5*, 273-280, doi: **doi.org/10.1123/iscj.2017-0095**

Moy, B., Renshaw, I., Davids, K. & Brymer, E. (2019). Preservice teachers implementing a nonlinear physical education pedagogy. *Physical Education and Sport Pedagogy, 24*, 565-581, doi: 10.1080/17408989.2019.1628934

Napier, L. (2018). https://www.theguardian.com/sport/2018/nov/09/the-all-blacks-secret-never-stand-still-or-you-get-overtaken-england-rugby-union

National Association for Sport and Physical Education USA. (2009). *Opportunity to learn: Guidelines* *for high school physical education.* 3rd ed. Reston, VA: NASPE

Newell, K. M. (1986). Constraints on the development of coordination. In M. G. Wade & H. T. A. Whiting (Eds.), *Motor development in children: aspects of coordination and control* (pp. 341-360). Dordrecht, Netherlands: Martinus Nijhoff

Pelletier, L. G., Séguin-Lévesque, C., & Legault, L. (2002). Pressure from above and pressure from below as determinants of teachers' motivation and teaching behaviors. *Journal of Educational Psychology, 94*(1), 186–196, doi: 10.1037/0022-0663.94.1.186

Pinder, R. A., Davids, K., Renshaw, I., & Araújo, D. (2011a). Representative learning design and functionality of research and practice in sport. *Journal of Sport and Exercise Psychology, 33*, 146-155, doi: 10.1123/jsep.33.1.146

Pinder, R. A., Renshaw, I., Davids, K., & Kerherve, H. (2011b). Principles for the use of ball projection machines in elite and developmental sport programmes. *Sports Medicine, 41*, 793-800

Queensland Studies Authority. 2010. *Physical education senior syllabus.* Brisbane: QSA.

Renshaw, I., Davids, K., & Savelsbergh, G. J. P. (2010). Motor learning in practice: a constraints-led approach. Abingdon, Oxon: Routledge.

Ribeiro, J., Davids, K., Araújo, D., Guilherme, J., Silva, P., & Garganta, J. (2019). Exploiting bi-directional self-organizing tendencies in team sports: the role of the game model and tactical principles of play. *Frontiers in Psychology*, doi: 10.3389/fpsyg.2019.02213

Rietveld, E., & Kiverstein, J. (2014). A rich landscape of affordances. *Ecological Psychology, 26*, 325-352, doi: 10.1080/10407413.2014.958035

Schinke, R. J., & Stambulova, N. (2017) Context-driven sport and exercise psychology practice: Widening our lens beyond the athlete. *Journal of Sport Psychology in Action, 8*, 71-75, doi: 10.1080/21520704.2017.1299470

Ross, E., Gupta, L. & Sanders, L. (2018). When research leads to learning, but not action in high performance sport. *Progress in Brain Research, 240*, 201-217, doi: 10.1016/bs.pbr.2018.08.001

Rothwell, M., Davids, K., Stone, J., O'Sullivan, M., Vaughan, J., Newcombe, D., & Shuttleworth, R. (2020a). A department of methodology can coordinate transdisciplinary sport science support. *Journal of Expertise, 3*, 55-65

Rothwell, M., Davids, K., Stone, J., Araújo, D. & Shuttleworth, R. (2020b). The talent development process as enhancing athlete functionality: Creating forms of life in an ecological niche. In J.

Baker, S. Cobley, J. Schorer & N. Wattie (2nd Ed.), Routledge Handbook of Talent Identification and Development in Sport. Abingdon, UK: Routledge.

Rudd, J. R., Pesce, C. Strafford, B., & Davids, K. (2020). An ecological dynamics rationale for individual enrichment: enhancing performance and physically activity in all. *Frontiers in Psychology,* doi: 10.3389/fpsyg.2020.01904

Seifert, L., Papet, V., Strafford, B. W., Coughlan, E. K., & Davids, K. (2019). Skill transfer, expertise and talent development: an ecological dynamics perspective. *Movement & Sport Sciences, 102*, 39-49, doi: 10.1051/sm/2019010

Taylor, I. M., Ntoumanis, N., & Smith, B. (2009). The social context as a determinant of teacher motivational strategies in physical education. *Psychology of Sport and Exercise, 10*, 235-243, doi: 10.1016/j.psychsport.2008.09.002

Turvey, M. T., Shaw, R. E., Reed, E. S., & Mace, W. M. (1981). Ecological laws of perceiving and acting: in reply to Fodor and Pylyshyn. *Cognition, 9*, 237–304, doi: 10.1016/0010-0277(81)90002-0

Turvey, M. T., & Carello, C. (1981). Cognition: the view from ecological realism. *Cognition, 10*, doi: 10.1016/0010-0277(81)90063-9

van Andel, S., Cole, M. H., & Pepping, G. J. (2017). A systematic review on perceptual-motor calibration to changes in action capabilities. *Human Movement Science, 51*, 59–71, doi: 10.1016/j.humov.2016.11.004

Withagen, R., Araújo, D., & de Poel, H. J. (2017). Inviting affordances and agency. *New Ideas in Psychology, 45*, 11-18, doi: 10.1016/j.newideapsych.2016.12.002

Withagen, R., de Poel, H. J., Araújo, D., & Pepping, G. P. (2012). Affordances can invite behaviour: reconsidering the relationship between affordances and agency. *New Ideas in Psychology, 30*, 250-258, doi: 10.1016/j.newideapsych.2011.12.003

Woods, C. T., McKeown, I., Rothwell, M., Araújo, D., Robertson, S., & Davids, K. (2020). Sport practitioners as sport ecology designers: How ecological dynamics has progressively changed perceptions of skill 'acquisition' in the sporting habitat. *Frontiers of Psychology*, doi: 10.3389/fpsyg.2020.00654

Wormhoudt, R., Savelsbergh, G. J. P., Teunissen, J. W., & Davids, K. (2017). The athletic skills model: Optimizing talent development through movement education. Abingdon, Oxon; New York, NY: Routledge.

List of Figures

Figure 1. The traditional hierarchical approach predicated on human performance being considered unidimensional.

Figure 2. Contemporary athlete development and preparation for performance models in sport informed by the integration of experiential and empirical knowledge