1   *Representative co-design*: Utilising a source of experiential knowledge for athlete development and

2   performance preparation

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13 **Abstract**

14 Contemporary models for athlete development and performance preparation in sport have advocated a

15 role re-conceptualisation for coaches grounded as *learning environment designers*. Within this re-

16 conceptualisation, expert practitioners are encouraged to draw upon their experiential knowledge to

17 design representative and meaningful learning activities that place the performer-environment

18 interaction at its core. However, we propose that currently, a critical source of experiential knowledge

19 is often overlooked within the process of learning design – that of performers. Specifically, practitioner-

20 performer interactions could enrich the design of learning environments by promoting the utilisation of

21 soliciting affordances and encouraging the psychological engagement of performers. This position

22 paper introduces the concept of *representative co-design* – a notion which builds on existing research

23 by framing how the insights and experiences of performers can be negotiated within the design of

24 practice tasks that seek to faithfully simulate interacting constraints of competition to enrich learning

25 environments. We frame the notion of *representative co-design*, and contend its importance within more

26 contemporary athlete development and performance preparation models, at two levels: (i) that of

27 enriching physical education curricula to develop thought provoking, 'intelligent' child / adolescent

28 learners, and (ii) that of enriching contemporary athlete preparation models in high-performance sport

29 to enhance learning and engagement, and to develop 'next generation' coaches within current athletes.

30 To bring this conceptualisation to life, we present two exemplars demonstrating the notion of

31 *representative co-design*, while concurrently highlighting areas for future empirical research.

32 **Key words:** Ecological dynamics; Athlete development; Contemporary performance preparation;

33 Experiential knowledge; Representative co-design

34

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

61 integration of experiential and empirical knowledge and the role that expert practitioners have in

62 performance preparation.

63 **Contemporary performance preparation models in sport**

64 *Situating an ecological dynamics framework*

65   The work of Davids, Handford and Williams (1994) and Handford, Davids, Bennett and Button

66 (1997) indicated the need for a bio-physical perspective on skill acquisition and movement

67 development. These papers called for sport practitioners to appreciate the complex and entwined

68 interactions between an individual performer, task and environmental systems on movement

69 organisation (Newell, 1986). Over two decades later, these conceptual ideas have evolved into

70 ecological dynamics (Araújo, Davids, & Hristovski, 2006), a contemporary theoretical framework on

71 performance and learning that integrates concepts from ecological psychology (Gibson, 1979),

72 constraints on dynamical systems (Newell, 1986), the complexity sciences (Edelman & Gally, 2001)

73 and evolutionary science (Araújo, Davids, & Renshaw, 2020). An ecological dynamics rationale views

74 perceptions, cognitions and actions as interacting and self-organised phenomena that emerge from the

75 continuously dynamic interplay of a performer's action capabilities (defined as their *effectivities*) and

76 the affordances (defined as *opportunities for action*; Gibson 1979) offered in a specific competitive

77 environment (referred to as an *ecological niche*) (Araújo et al., 2006; Ross, Gupta & Sanders, 2018).

78   This theoretical conceptualisation underpins contemporary models of athlete development and

79 performance preparation in sport, including nonlinear pedagogy (NLP) (Chow Davids, Hristovski,

80 Araújo, & Passos, 2011), constraints-based coaching (CBC) (Renshaw, Davids, & Savelsbergh, 2010),

81 and the Athletic Skills Model (ASM) (Wormhoudt, Savelsbergh, Teunissen, & Davids, 2017). In such

82 models, practitioners are challenged to shift their role perspective from one of performance compliance

83 with 'optimal' movement templates that are captured in coaching manuals grounded in historico-

84 cultural ideology (i.e., 'in an organisation's DNA'), to one of a *designer* of a learning environment who

85 fosters self-organised (and self-regulated) performer-environment interactions (Woods, McKeown,

86 Rothwell, Araújo, Robertson, & Davids, 2020). This re-conceptualisation of a sport practitioner's role

87 is captured within the notion of *representative design* (Brunswik, 1955). Initially discussed with

88   reference to the alignment of methods and designs used in psychological research with behavioural

89   contexts, representative design was later re-configured as *representative learning design* in sport

90   performance contexts by Pinder and colleagues (2011a; 2011b).

91   Representative learning design promotes the design of learning activities in sports practice that

92   are aligned with (i.e., representative of) the constraints experienced within a particular competitive

93   performance environment. This ecological ontology eschewed representational accounts to emphasise

94   key properties of task constraints present within practice and competitive environments that afford a

95   performer with opportunities to both *select* and *control* actions (Golonka & Wilson, 2019). Specifically,

96   through prolonged exposure to practice tasks that represent (or faithfully simulate) the constraints of a

97   competitive environment, a performer learns to detect the information that specifies the relational

98   properties of the affordances in their environment, encouraging their realisation (Headrick, Renshaw,

99   Davids, Pinder, & Araújo, 2015; Seifert, Papet, Strafford, Coughlan, & Davids, 2019).

100   In ecological dynamics, representative learning design has a fundamental basis in early

101   psychological research in motor learning that advocated the principle of specificity of learning (see

102   Henry, 1958). In this early interpretation, the specificity principle in learning was needed to ensure that

103   the central nervous system (CNS) of the learner was exposed to specific stimuli for channelling neural

104   impulses to centres for motor control and coordination to support learning of specific movements.

105   However, an ecological dynamics rationale avoids the problem of over-emphasising specificity of

106   learning (higher in representative design), to the expense of more general learning experiences (lower

107   in representative design) for developing physical literacy in individuals (see Rudd, Pesce, Strafford &

108   Davids, 2020). It emphasises a deeply enmeshed relationship between action, cognition and perception

109   which is needed by 'intelligent' performers, high in physical literacy, at all stages of the life course. As

110   we elaborate later, this preference for achieving a nuanced balance between specificity and generality

111   of motor learning does not favour particular developmental moments when individuals are more

112   receptive to learning. However, athlete development models like the ASM do imply that there may need

113   to be a greater emphasis on more general learning experiences earlier in life, and a greater emphasis of

114   more specialised activities later in life (Wormhoudt et al., 2017).

115   A team of multidisciplinary practitioners can play an integral role in the design of representative

116   practice tasks to enhance the specificity of learning contexts. Undoubtedly, the considerable experiential

117   knowledge of practitioners such as psychologists, coaches, managers, analysts, and skill acquisition

118   specialists can enrich the sampling and integration of relevant constraints from competitive performance

119   within practice task designs, ensuring they are correctly targeted at the individual needs of each athlete

120   or sports team (Greenwood, Davids, & Renshaw, 2012). However, while the importance of practitioner

121   experiential knowledge is well accepted, contemporary athlete performance development and

122   preparation models, grounded in ecological dynamics, imply how they can be further enriched by

123   unlocking the experiential knowledge of the performers (learners / athletes) themselves.

124   *A welcomed shift toward the blending of empirical and experiential knowledge*

125   Traditionally, sport science has focused on developing empirical support for performance

126   preparation through harnessing experimentation in separate sub-disciplines, such as psychology,

127   physiology and biomechanics (Balagué, Torrents, Hristovski, & Kelso, 2017). Unquestionably, this

128   knowledge transfer has enriched the understanding of many applications of sport science. However,

129   empirical knowledge has often been adopted in a hierarchical way and treated as *the* sole knowledge

130   source needed to design effective practice tasks and learning environments. As illustrated in Figure 1,

131   this hierarchical approach to knowledge transfer between sport scientists and practitioners has tended

132   to neglect the experiential knowledge of expert practitioners gained through prolonged exposure to, and

133   analysis and experimentation in, diverse and varied practice environments in the support of athlete

134   development. Concurrently, this traditional hierarchical approach typically relies on an implicit

135   assumption of the validity of its methods and data, and is likely to have driven dissonance between

136   theory and practice within sport science.

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

138   Comparatively, as shown in Figure 2, a contemporary approach to performance preparation seeks

139   interdisciplinarity, integrating empirical knowledge with sources of experiential knowledge (e.g.,

140   Greenwood et al., 2012; Burnie, Barrett, Davids, Stone, Worsfold, & Wheat, 2018; McCosker,

141   Renshaw, Greenwood, Davids, & Gosden, 2019). In this more integrative and interdisciplinary

142   approach, interactions between the different rich knowledge sources could emerge in a more

143   heterarchical way. For example, the experiential knowledge of expert practitioners and performers

144   could be viewed as a complementary source of knowledge, gained from many years of competing, and

145   developing and preparing athletes for competition, that guides the integration of theory into practice

146   (Greenwood et al., 2012). In doing so, performance preparation models would be underpinned by

147   rigorous theoretical constructs, while being presented, or brought to life, in a way that is rich in meaning

148   from the 'lived experience' of practitioners and performers.

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

150   Related to this special issue of Psychology of Sport and Exercise, in the theory of Direct

151   Perception, the ecological psychologist James Gibson (1966) distinguished between *knowledge of* the

152   environment, which underpinned use of affordances to regulate interactions with a performance

153   landscape, and *knowledge about* the environment, which facilitates an internalised symbolic

154   manifestation (in the CNS) of the environment available (i.e., in 'white board' tactical analyses of sport

155   performance – see Araújo, Hristovski, Seifert, Carvalho, & Davids, 2019b). An integral component of

156   an ecological dynamics rationale is, therefore, an appreciation of the roles of expert coaches within the

157   competitive performance context, conceptualised as an important member of a team of practitioners

158   tasked with designing representative learning activities that develop an athlete's *knowledge of* a

159   performance environment (Woods et al., 2020).

160   *The practitioner as a learning environment designer*

161   A performance environment has been conceptualised as a *rich landscape of affordances* in

162   ecological psychology (Rietveld & Kiverstein, 2014). In sport, practice task designs could then be

163   conceptualised as a means to direct or educate the search and attention of athletes for utilising relevant

164   affordances (Button et al., 2020). Contemporary perspectives on this idea suggests that with experience,

165   continued exposure, and informed design, performers enhance their decision-making by becoming

166   increasingly competent at realising the most *soliciting* or *inviting* affordances within their ecological

167   niche (Withagen, de Poel, Araújo, & Pepping, 2012; Withagen, Araújo, & de Poel, 2017; Araújo et al.,

168   2019b). It is important to consider that these affordance solicitations in competition are not static, rather,

169   they emerge and decay based on athlete intentions during performance, the action capabilities developed

170   by an athlete, and the emergence of critical information sources (detected using a variety of modalities

171   such as haptic, proprioceptive, visual and auditory) that specify relevant properties of the performance

172   environment (Turvey, Shaw, Reed, & Mace, 1981; Fajen, Riley, & Turvey, 2009; Withagen et al., 2017;

173   Guerin & Kunkle, 2004; Pinder et al., 2011a). Thus, certain affordances attract individuals to act upon

174   them at different timescales and a central role of the practitioner is to match the current action

175   capabilities of a developing performer to the constraints designed into a practice task (van Andel, Cole,

176   & Pepping, 2017; Araújo, Dicks, & Davids, 2019a). This idea captures the skill of practice design,

177   indicating how an expert practitioner (learning environment designer) can 'nudge' a developing athlete

178   toward the acceptance of certain affordances while rejecting the less relevant opportunities or

179   invitations for action. Importantly, this process of nudging attention toward soliciting affordances

180   through the use of practice design is one that practitioners progressively learn through 'doing' and

181   careful reflection and continuous adaptations to practice – that is, observing how performers interact

182   with the opportunities for action designed in to the practice task.

183   These ideas underline that a central aspect of the sport practitioners' role in contemporary

184   performance preparation is to identify the information that a performer can use to regulate behaviours

185   within a competitive environment. It is constant exposure to representative practice task constraints that

186   will help athletes progressively attune to specifying properties of relevant affordances within their

187   environment through the detection of information to support actions. Further, through prolonged

188   exposure to representative training tasks, athletes will be encouraged to develop a functionally adaptive,

189   self-regulating relationship with their competitive environment, learning when and how to accept or

190   reject emerging or decaying affordances in dynamic performance contexts (Guerin & Kunkle, 2004).

191   **Representative co-design**

192   *Utilising the experiential knowledge of experienced performers in athlete development*

193   While contemporary models of performance preparation and athlete development are advocating

194   a role re-conceptualisation for sports practitioners grounded as *designers* (Araújo et al., 2019a; Woods

195   et al., 2020), we propose that currently, a critical source of experiential knowledge is often overlooked

196   – that of *intelligent performers*. Here, the term 'intelligent' refers to a highly adaptive, emotionally

197   engaged and motivated performer who learns quickly (i.e., constantly (re)adjusting behaviours during

198   learning and performance to achieve an intended task goal based on prior experiences), and who relies

199   on cognitions, perceptions and actions to function effectively in sport and physical activity. In this sense,

200   the 'intelligent' performer is an individual who effectively uses cognition (integrated with perception

201   and action) in the way defined by Turvey and Carello (1981, p. 313). They argued that the process of

202   'cognition' should be considered at a general level to refer to the interactive coordination of an

203   individual (especially his/her perceptions, decisions and actions) and a performance environment. For

204   example, successful performance in team games involves the 'intelligent' performer being challenged

205   beyond mere action template imitation to critically interpret emerging events in performance and

206   autonomously make decisions to resolve issues and problems that challenge him/her. It is enriched

207   'intelligent' performer-practitioner interactions that could subsequently inform the design of practice

208   tasks that consist of affordances available within a specific competitive performance environment,

209   soliciting their realisation based on a performer's action capabilities at a certain stage of development.

210   In high-performance sports like soccer, this approach could exemplify how the use of temporal or spatial

211   constraints (jointly selected by the player and coach) could nudge players toward the use of affordances

212   that enable varying speeds of ball movement. Comparatively, in early physical education experiences,

213   a child could be free to manipulate the spacings between 'monkey bars', leading to more challenging

214   and functional climbing behaviours based on his/her current arm span dimensions and perceptions of

215   self-competence.

216   Contemporary performance preparation models across all developmental levels would, therefore,

217   benefit greatly from the insights and experiences of 'intelligent' performers (Gee, 2005), providing

218   practitioners with a deeper understanding on specific solicitations experienced in a rich landscape of

219   affordances. Metaphorically, this idea would be synonymous with an architect (coach) working with an

220   engaged and knowledgeable client (athlete) to design a building (representative practice task) that

221   functionally suits the needs of the specific client. Although it is the architect who designs the building,

222   it is this enabling platform that firmly places the client's needs at the core of the design. Further, the

223   process of *co-design* would not only increase the functionality of the relationship between the client

224   and building (athlete's performance environment), it would likely engage the client to develop a deeper

225   understanding of the building's properties (performance environment) so that they can make informed

226   decisions about how to shape its design.

227   We propose that *representative co-design* can be harnessed through multidisciplinarity, where

228   the 'intelligent' performer would be considered as another integral member of a team of sporting

229   practitioners who co-design practice landscapes rich in information (Chow et al., 2011). However, the

230   practicalities of multidisciplinarity are not straightforward, with issues raised over the integration of

231   multiple scientific sub-disciplines and practitioners, in addition to the hierarchical relationship between

232   theory and practice mentioned earlier (Ross et al., 2018). From a practical point of view, the relationship

233   and integration between the 'intelligent' performer and practitioner could be challenged when

234   communications are taking place during the co-design process. In this situation, specific sub-discipline

235   language and principles may complicate and confuse co-design ideas, meaning that further

236   specialisation and fragmentation hinders integration. To address these challenges, effective

237   multidisciplinary working can be more formally embedded within the Department of Methodology

238   (DoM) concept (Rothwell, Davids, Stone et al., 2020a).

239   *Situating representative co-design within a Department of Methodology*

240   From an ecological dynamics perspective, the design of a DoM considers that a form of life

241   describes the everyday activities of sports organisations, capturing how surrounding social, cultural,

242   and historical constraints shape the expression of inherent values, beliefs, traditions, customs,

243   behaviours, and attitudes in a system (see Rothwell, Davids, Stone, Araújo & Shuttleworth, 2020b).

244   Moreover, the aim of a DoM would be for the 'intelligent' performer and practitioner to work within a

245   unified framework to: (i) coordinate activity through shared information, principles and language, (ii)

246   communicate coherent ideas, and (iii) collaboratively design practice landscapes rich in information

247   (i.e., visual, acoustic, and haptic) to guide the emergence of multidimensional behaviours in athlete

248   performance.

249   To illustrate this, interacting constraints on a form of life in performance sport is particularly

250   compelling in the pathway to one of the world's greatest sports teams: the New Zealand All Blacks.

251   The form of life in New Zealand elite rugby union is predicated on self-regulation (players adapting

252   and organising without external input) as a philosophy of a contemporary All Black being a 'faster

253   learner than someone else', with the ability to 'adapt and adjust in the moment and then afterwards

254   reflect and learn' (Napier, 2018, p. 3). Interestingly, coach Steve Hansen traced the All Blacks'

255   philosophy of self-regulation back to the country's cultural heritage, where, due to its geographical

256   isolation, New Zealanders had to be 'innovative, good decision-makers and do things for themselves'

257   (Napier, 2018, p. 5). His perspective provides rich insights on the relationship between these historically

258   relevant cultural values and attitudes and the potential benefits of co-designing practice environments

259   in an everyday form of life proliferating in New Zealand rugby union. It is interesting to note how these

260   capacities for self-regulation are well aligned with outcomes of a co-designing approach to sport

261   practice methods for 'intelligent' performance. It is also noteworthy that the influence of cultural and

262   historical constraints on sports performance preparation and athlete development has surfaced in a more

263   context-driven sport psychology (see Schinke & Stambulova, 2017).

264   In the remaining sections of this position paper, we illustrate how the notion of *representative*

265   *co-design* could enrich preparation for performance models across different developmental stages in

266   sport – starting within a physical education curriculum and then progressing to a high-performance

267   sport environment. In both examples, we propose that *representative co-design* could foster a rich

268   platform where children / adolescents and professional athletes are empowered to take greater

269   ownership of their learning and practice environments in a safe, but still uncertain way. Specifically,

270   within physical education, we propose that the engagement of the student through the *co-design* of

271   learning activities will beneficially develop their general physical activity 'intelligence', as they engage

272   in deeper thought provocation of how to affect future learning designs within a curriculum.

273   Additionally, within a high-performance environment, it is likely that the rich experiential knowledge

274 exchange between a coach and athlete could foster not only an athlete's personal performance

275 development, but the continuing development of 'next generation' coaches: athletes who are

276 empowered to regulate the perceptions, cognitions, actions and emotions of themselves and teammates

277 through the informed *co-design* of representative practice tasks in performance preparation.

278 **Representative co-design: Enriching a physical education curriculum through the development**

279 **of 'intelligent' performers**

280 An important goal of physical education curricula worldwide is to progress learners beyond the

281 scope of simply reproducing physical skill templates (such as an idealized 'swim stroke' or 'tennis

282 stroke'), towards the development of self-regulating 'intelligent' performers who effectively use

283 cognitive, perceptual and movement capacities to achieve strategic decisions and outcomes in complex

284 and dynamic performance situations (Moy, Renshaw, Davids, & Brymer, 2019). As such, across the

285 globe, government publications, national standards, professional bodies and curriculum documents in

286 education have recognised that the development of 'intelligent' performers needs to start in childhood,

287 emphasising the role of problem-solving, thinking and decision-making skills in physical education.

288 For example, the UK's National Curriculum Physical Education, the USA's NASPE (National

289 Association for Sport and Physical Education) and the Queensland Physical Education Senior Syllabus

290 (Queensland Studies Authority, 2010), incorporate this outcome in all three of the major domains of

291 learning: psychomotor, cognitive, and affective (see also the Australian Curriculum, Assessment and

292 Reporting Authority, 2015; Department for Education, 2013; National Association for Sport and

293 Physical Education, 2009; Queensland Studies Authority, 2010). Notably, the Studies Authority in

294 Queensland, Australia (2010, p. 3) states that:

295 *"Intelligent performance is characterised by high levels of cognitive functioning, using*

296 *both rational and creative thought. Students are decision makers engaged in the active*

297 *construction of meaning through processing information related to their personal*

298 *experience and to the study of physical activity."* (emphasis added)

299 Existing ideas on 'intelligent' performers in sport are well aligned with connotations of physical literacy

300 in physical education. Intelligent performers may be considered as physically literate individuals who

301   can apply their physical, psychological, emotional and social competencies in a specific, high-level

302   performance environment (Rudd et al., 2020).

303   The development of 'intelligent' performers in physical education leads imperviously to the

304   notion of *representative co-design* within an ecological dynamics framework, exemplified through

305   diverse and continuous interactions between a teacher and student. Initiated within early physical

306   education settings, the experience of co-designing learning activities will not only enrich learning

307   designs, but will develop a child's general performance 'intelligence', as (s)he is challenged to think

308   more deeply about critical features of their learning environment that support self-regulated perceptions,

309   cognitions and autonomous actions in performance (Gee, 2005). More specifically, co-design will

310   empower the student to develop *knowledge of* their learning environment so they can make informed

311   choices about how to manipulate its design (Gee, 2005).

312   As highlighted above, there is a *want* to create 'intelligent' performers in physical education.

313   However, it too often fails to deliver on this aspect of the curriculum. A potential reason for this is not

314   due to a lack of participation in physical education, an often-cited barrier, but due to popular curriculum

315   designs used by teachers not allowing children to experience autonomous decision-making (Pelletier,

316   Séguin-Lévesque & Legault, 2002). Traditionally, physical education teachers have been found to

317   utilise more controlling, autocratic, strategies within their lesson designs compared to more autonomy-

318   supportive strategies (Barrett & Boggiano, 1988; Taylor, Ntoumanis & Smith, 2009). This issue

319   signifies that physical education professionals are prone to making the majority of decisions in regards

320   to content and its pace of delivery, leaving students bereft of opportunities for taking responsibility for

321   their learning (De Meyer, Soenens, Aelterman, De Bourdeaudjuij & Haerens, 2016). Another challenge

322   for physical education curricula is an over-emphasis / specialism on team games (such as football or

323   netball) and a lack of opportunity to explore actions through other forms of movement education, such

324   as dance and gymnastics. Thus, in the following section, we explain how a creative dance curriculum

325   that is *co-designed* by the teacher and student, can support the development of physical literacy in self-

326   regulating, 'intelligent' performers.

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

328   A creative dance curriculum allows students to explore different elements of dance, such as body,

329   space, time, force, flow, and relationships. The creation of movements occurs through improvisation

330   and spontaneous performance of movements in response to music and other environmental information,

331   such as lesson themes (e.g., 'deep under the sea'). This informationally enriched landscape will offer

332   many invitations to diverse action, encouraging students to explore their environment. To instantiate

333   the development of an 'intelligent' performer through a dance curriculum, the student will first be

334   challenged to couple (novel and diverse) movement solutions with the music's beat and tempo. With

335   clear lesson intentions / expectations (such as creating a dance routine that follows an ABA form and

336   structure[1]), they will progressively see the emergence of a dance routine. A teacher can further promote

337   explorative behaviours through a learner-centred cyclical process, which is supportively aligned with

338   an 'athlete-centred' approach to coaching. Specifically, the teacher could manipulate the tasks through

339   the creation of scenarios or posing problems to be solved. Once a student becomes comfortable in their

340   routine, the teacher's role is again challenged to re-engage them in exploratory (searching) behaviours.

341   In such an instance, the teacher may engage the notion of *co-design*, inviting the student to: (i)

342   manipulate the environment (e.g., the student being free to design features that invite specific

343   behaviours), (ii) the theme of the lesson (e.g., the student being free to theme the intention based on

344   special interests), or (iii) incorporate partner work (e.g., the student being free to engage peers within a

345   co-designed environment or chosen theme). Through this process, it is likely that the student will engage

346   in a deeper level of thought, being empowered to develop *knowledge of* the environment as he / she

347   begins to control the richness and diversity of the learning experience, and in doing so, progressively

348   develop into 'intelligent' performers.

349   At the start of this paper, it was highlighted that skilled movement behaviour evolves over

350   timescales of performance, learning, and development (Button et al., 2020). Thus, the *co-designed*

351   curriculum between the student and teacher will see each lesson become the performance. Learning

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[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.

352 emerges through a unit of work (such as creative dance), as physical literacy develops through the

353 schooling years. The experience of physical literacy will set up the majority of engaged students for a

354 lifetime of recreational level physical activity and exercise. For a minority, it will also form a

355 fundamental basis of a career in high-performance sport, leading us to the next section.

356 **Representative co-design: Harnessing 'local-to-global' synergy formation processes in high-**

357 **performance sport to develop 'next generation' coaches in current athletes**

358 A central tenet of performance preparation in contemporary high-performance sporting

359 environments is the appreciation of the athlete's needs being placed at its core (Woods et al., 2020).

360 This approach is in stark contrast to the more traditional models of performance preparation, which

361 have tended to place the coach at the centre of the instructional process (criticised earlier by Handford

362 et al., 1997). In contemporary models of athlete development and performance preparation, the coach

363 and athlete are envisioned as working in unison to *co-design* learning environments replete with critical

364 information sources that solicit affordance realisation, supporting the development of self-regulating

365 perceptions, cognitions, emotions and actions.

366 Contemporary models such as NLP, CBC and the ASM conceptualise athletes and sports teams

367 as *complex adaptive systems* (e.g., Glazier & Davids, 2009; Komar, Chow, Chollet & Seifert, 2015). In

368 complex adaptive systems, learning results in synergy formation (i.e., coordination and adaptations)

369 between system components, such as muscles, joints and limb segments and synaptic connections in

370 the brain, or between members of a sports team, resulting in functional performance adaptations

371 (Glazier & Davids, 2009). Synergy formation in complex adaptive systems are shaped bidirectionally:

372 *locally* between the players themselves or *externally*, shaped by practitioners in training (Ribeiro,

373 Davids, Araújo, Guilherme, Silva, Garganta, 2019). For sport practitioners observing athletes in

374 performance preparation, it is important to understand how different types of constraints (related to the

375 task, individual and environment) converge to facilitate synergy formation for realising novel

376 affordances. In ecological dynamics, learning involves constraints-induced synergy formation between

377 players or parts of the body through exploration, invention and adaptation of action possibilities (Glazier

378 & Davids, 2009; Davids, 2012).

379   Rich experiential knowledge from the athlete and coach can assist with the exploitation of

380   *bidirectional synergy formation* (i.e., emphasising self-organising and self-regulating tendencies in

381   athletes and teams, as well as the external influences of sport practitioners) (see Ribeiro et al., 2019).

382   To exemplify, a coach may offer experiential knowledge that could guide the design of *global*

383   'principles of play' – affording flexible synergy formation from *global-to-local* levels. In contrast, the

384   athlete could provide rich context to these principles based on current action capabilities, what

385   information is being detected, and insights on the most soliciting affordances they perceive to be

386   available for use within the performance environment. This is likely to drive *local* self-regulating

387   interactions (between teammates and opponents) that lead to emergence of *global* behavioural patterns

388   (Ribeiro et al., 2019).

389   This perspective uncovers an important feature of *representative co-design* in developing

390   'principles of play', or tactics perceived as important to overcome specific opponents or performance

391   challenges. Notably, such strategising has historically been considered the sole domain of the coach,

392   who develops a 'game model' or performance plan that athletes simply adhere to (Ribeiro et al., 2019).

393   Framed through *representative co-design*, however, 'intelligent' athlete(s) and coaches work together

394   to share rich experiential knowledge surrounding performance principles or tactics. Indeed, such

395   principles are developed with the players' needs and action capabilities placed at the core – fostering

396   greater player engagement, self-regulation and ownership of the learning and preparation environment.

397   Thus, instead of offering putatively 'optimised', 'ready-made', and pre-programmed task solutions

398   (according to personal preferences), a coach would work *with* the athlete to develop individualised and

399   creative solutions for performance problems, which are continually evolving in line with tactical

400   developments in a sport. In this way, both coaches and athletes find solutions to the emergent problems

401   encountered in dynamic competitive performance environments *together* (Araújo, Davids, Chow, &

402   Passos, 2009). We will specifically address this point in a practical example in proceeding sections of

403   this paper.

404   It is likely that such sharing of experiential knowledge will foster a platform in which the athlete

405   is challenged to become more self-regulating and engage in deeper thought. It is through this deeper

406   level of engagement and thinking that the athlete may develop richer *knowledge of* the performance

407   environment and its affordances (Araujo et al., 2019a; 2019b), facilitating a progressive evolution into

408   a 'next generation' coach. Specifically, we propose that the process of *representative co-design* may

409   foster a platform where the athlete will be safely challenged to develop their *knowledge of* the

410   performance environment, enabling him / her to design in information they perceive is integral to the

411   achievement of specific task goals through the realisation of relevant affordances. Further, in team

412   sports, *representative co-design* would encourage these 'next generation' coaches to develop a deeper

413   understanding of their teammates action capabilities given the intent of designing in relevant

414   affordances that can be utilised within practice tasks based on the current action capabilities of their

415   teammates. They could exploit this deeper understanding during practice tasks by educating a

416   teammates attention toward the most relevant affordances within the environment based on their action

417   capabilities and the intended task goal. Thus, such an approach will reflect upon them following

418   *representative co-design*, in much the same way a coach's role has been re-conceptualised through a

419   *designer* lens (Woods et al., 2020). We envisage these 'next generation' athlete 'leaders' as integral

420   members of a team of sport practitioners who function collectively to *co-design* and enrich performance

421   preparation programmes.

422   **Bringing life to the notion of representative co-design in contemporary performance preparation**

423   **models: Examples in high-performance sport**

424   The notion of *representative co-design* being an integral component of contemporary athlete

425   development and performance preparation in sport would be complemented by offering exemplars to

426   bring the conceptualisation to life. The following sections of this position paper, therefore, present two

427   examples from high-performance sport, in which a team of sporting practitioners, inclusive of coaches

428   and 'intelligent' athletes, function within a DoM to exemplify *representative co-design*. These examples

429   do not intend to offer comprehensive insight or hypothesis testing relative to *representative co-design*,

430   but act as a conduit for current sports practitioners interested in applying its notions to salient features

431   of their performance preparation models in high-performance sport.

432　*Example 1: Co-designing a practice task to promote the exploration of varied passing interactions*

433　*between elite Australian footballers*

434　　　A foundational component of performance preparation in elite Australian football orients the

435　design of practice tasks that enable players the opportunities to develop their disposal skill, specifically,

436　their kicking skill. In this example, a practice task consisting of two teams of 9 players are challenged

437　to outscore each other through the accumulation of 'points' by successfully passing the ball (via a

438　'kick') to a teammate who 'marks' (i.e., catches) it in a defined scoring zone. It is important to note

439　here that, within an ecological dynamics framework, this initial practice design would have been

440　informed by a team of practitioners, who worked to sample and integrate relevant informational

441　constraints experienced by players within competition that shaped kicking skill. Following this, and in

442　accordance with the notion of *representative co-design*, the coach discusses the practice design with an

443　identified game 'intelligent' player (deemed as being a 'next generation' coach) prior, during and

444　following the practice task intervention. Through this rich dialogue, the player is free to share his/her

445　opinions (both verbally and through actions) regarding the design features of the practice task, with a

446　specific focus on its representativeness. Examples of this coach-player dialogue prior, during and

447　following the practice task intervention are offered below:

448　Prior to the practice task:

449　　• Design feature: *The scoring system*

450　　　　o Coach-player reflections and discussions prior to the task could orient whether (or not)

451　　　　certain kicks should have a greater point allocation (i.e., kicks perceived by the player

452　　　　to be more 'difficult'), which could enhance their invitation within the affordance

453　　　　landscape. Accordingly, these discussions could lead to kicks agreed as being 'more

454　　　　challenging' by both the coach and player yielding a greater point allocation,

455　　　　encouraging, or inviting, players to explore their action capabilities and undertake a

456　　　　variety of kicks of differing levels of perceived difficulty during the task.

457　During the practice task:

458　　• Design feature: *The dimensions of scoring zones*

459   o   Coach-player reflections and discussions during the task could orient whether (or not)

460   the dimensions of the scoring zones are appropriately scaled to invite exploration of

461   certain kicks based on players' action capabilities. Specifically, if the scoring zones are

462   perceived to be too small to invite its score exploitation, a player could be free to

463   manipulate its dimensions to encourage teammates to utilise it during the task.

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

465 • Design feature: *The global 'representativeness' of the practice design*

466   o   Coach-player reflections and discussions following task completion could orient

467   whether (or not) they perceived that the design actually facilitated the exploration of

468   kicks, shaped by representative informational constraints experienced in competition.

469   Importantly, a player could be prompted to offer a 'perceived representative value'

470   which (s)he felt reflected how 'game-like' the design was. This arbitrary value could

471   be presented on a 0-10 scale (0 being 'not competition conditions at all', and 10 being

472   'complete competition conditions'), and used to inform the design of future task

473   iterations.

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

475   Beyond practice task design, the notions of *representative co-design* could be applied to the

476 establishment of 'principles of play'. As discussed earlier, more traditional models of performance

477 preparation advocate the coach as the sole individual (global source) responsible for the development

478 of a 'game model' (Ribeiro et al., 2019). However, conceptualised through *representative co-design*, it

479 would be the coach and 'intelligent' player(s) who each contribute rich experiential knowledge and

480 insights surrounding the establishment of performance principles. An important consideration here is

481 that the player(s) could voice opinions from the perspective of their teammates (and their teammates'

482 action capabilities), which would concurrently empower ownership of, and responsibility for, the

483 learning, development and preparation environment. Through such a lens, both coaches and 'intelligent'

484 player(s) would develop 'principles of play' capable of exploiting emergent problems encountered in

485 competition, such as specific opposition tactics or external environmental constraints (e.g., weather

486 conditions or idiosyncrasies of opposition grounds). Thus, in this example, a group of rugby league

487 coaches and 'intelligent' players are working collectively to establish a set of 'principles of play' in

488 attack.

489   To best unlock the bidirectionality of synergy formation under constraint, both players and

490 coaches could develop a set of *global* principles in attack based on their experiential *knowledge of* rugby

491 league, while mutually acknowledging that players are free to actualise these principles *locally*, based

492 on their action capabilities and emergent interactions with environmental and task constraints. From

493 this perspective, the set of principles in attack would not formally define a 'structure' (as is typified in

494 more traditional models of preparation), but enable a flexible (less structured) performance landscape

495 by which players are free to explore and exploit (for an example in professional rugby union, see McKay

496 & O'Connor, 2018). An example of one of these 'principles of play' in rugby league is presented below:

497   • Co-designed principle of play: *Fluid Ball Movement*

498   o This principle could be converged upon by both 'intelligent' players and coaches given

499   its evocation of ball movement intended to continually and dynamically challenge an

500   opponent's defensive stability. Importantly, players are free to exploit this *co-designed*

501   principle through the adaptability of their action capabilities relative to the

502   informational constraints perceived within the environment. For example, 'fluidity'

503   could be exemplified through dynamic ball movement, as players detect and exploit

504   emergent and decaying affordances offered by an opponent's defence (i.e., detecting

505   and exploiting a sudden gap afforded in a defensive line to pass or run into), or it could

506   be exemplified through more conservative ball movement given the inability to

507   penetrate an opposition's defensive structure at a given moment or within the action

508   capabilities of the player in possession of the ball. Irrespective, the point here is that

509   the players are free to exemplify this *co-designed* principle through any means they

510   feel 'brings it to life' based on their action capabilities and interactions with the

511   constraints of the performance environment.

512   **Where to next?**

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

514   The aim of this position paper was to propose the notion of *representative co-design*, discussing

515   its implications for contemporary athlete development and preparation for performance models in sport.

516   It was argued that *representative co-design* would be an important methodological advancement for

517   athlete development by closely simulating the task constraints of a competitive performance

518   environment to exploit the experiences and insights of established performers at certain developmental

519   stages. Concurrently, we argued that through *representative co-design*, contemporary sports

520   organisations would not only unlock a source of experiential knowledge of use for development and

521   performance preparation, but they would empower performers (at all developmental stages) to take

522   greater ownership of their learning environment. It is through this process that performers are likely to

523   develop richer *knowledge of* their competitive environment, and in doing so, develop into more thought

524   provoking, 'intelligent' individuals.

525   Accompanying our propositions were exemplars demonstrating how *representative co-design*

526   may be brought to life in a high-performance sport environment. While we feel these exemplars are

527   integral components of this position paper as they offer readers a platform to understand how to

528   integrate *representative co-design* into high-performance sport, they do lead to some important research

529   questions that should be addressed. Specifically, the first example promoted an interesting aspect of

530   *representative co-design*, that of engaging the 'intelligent' performer to provide a 'perceived

531   representative value' to reflect the practice task's representativeness to competition. We propose two

532   investigations could stem from the extraction of such experiential knowledge. First, researchers could

533   look to validate this 'perceived representative value' against constraints sampled from both the practice

534   task and competition. This would likely enable the development of an additional tool (such as a

535   questionnaire), engrained within the notion of *representative co-design*, that a coach could use in the

536   design of practice tasks. Second, it would be of interest to unpack the information sources players detect

537   (attune to) when basing their 'perceived representative value'. This likely subjective analysis could

538   unlock further experiential knowledge within the 'intelligent' performer, affording a practitioner with

539 deeper information of use for the continued (re)design and refinement of practice tasks that faithfully

540 simulate competition demands. Moreover, this process could help researchers better understand what

541 'information' actually is, which in ecological dynamics is highly individualistic, continuously

542 facilitating environmental interactions based on a range of constraints. Last, we proposed that

543 *representative co-design* would develop an 'intelligent' athlete's *knowledge of* the performance

544 environment, leading to greater ownership and responsibility for learning and performance

545 development. To test this proposition, it would be of interest for future work to examine the evolving

546 behavioural tendencies (such as emergent leadership qualities) and coaching career trajectories of

547 performers benefiting from pedagogies exploiting the notion of *representative co-design*. These

548 analyses would provide informed insights into the capability of *co-designing* approaches to indeed

549 develop future 'intelligent' athletes and 'next generation' coaches.

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700

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

703   unidimensional.

704   **Figure 2.** Contemporary athlete development and preparation for performance models in sport informed

705   by the integration of experiential and empirical knowledge