

Harnessing socio-cultural constraints on athlete development to create a form of life

ROTHWELL, Martyn <<http://orcid.org/0000-0002-3545-0066>>, DAVIDS, Keith <<http://orcid.org/0000-0003-1398-6123>> and STONE, Joseph <<http://orcid.org/0000-0002-9861-4443>>

Available from Sheffield Hallam University Research Archive (SHURA) at:

<http://shura.shu.ac.uk/18537/>

This document is the author deposited version. You are advised to consult the publisher's version if you wish to cite from it.

Published version

ROTHWELL, Martyn, DAVIDS, Keith and STONE, Joseph (2017). Harnessing socio-cultural constraints on athlete development to create a form of life. *Journal of Expertise*.

Copyright and re-use policy

See <http://shura.shu.ac.uk/information.html>

1 **Abstract**

2 The role of task constraints manipulation in pedagogical practice has received considerable attention in recent
3 years, although there has been little focus on the role of socio-cultural constraints on an athlete's development to
4 elite performance. Here, we aim to integrate ideas from a range of scientific sub disciplines to consider why
5 certain behaviours and cultures (socio-cultural constraints) may exist in sport performance and coaching. Using
6 recent conceptualisations of affordances in ecological dynamics, we explore how socio-cultural constraints may
7 influence an athlete's development and relationship with a performance context. We also highlight how
8 workplace practices emanating from the industrialisation of the nineteenth-century in countries like the UK may
9 have influenced coaching practice and organisational behaviours from that time on. In particular, features such
10 as strict work regimes and rigid role specification may have reduced personal autonomy, de-skilled performers
11 and induced a 'body as machine' philosophy within sporting organisations. These traits could be considered
12 counter to expert performance in sports where creativity and adaptive decision-making are important skills for
13 athletes to possess. We propose that ecological dynamics is a theoretical framework that enhances the
14 understanding of the influential nature of socio-cultural constraints on the development of athlete
15 performance. Key ideas suggest that sport pedagogists and practitioners could develop methodologies which
16 help design practice landscapes rich in information to encourage athlete autonomy to search for relevant
17 affordances which invite functionally relevant actions for competitive performance with physical, psychological,
18 emotional and social dimensions. Future research is needed to explore a range of sports to identify and clarify
19 the relationship between socio-cultural constraints and expertise acquisition.

20
21

22 **Key Words:** Ecological dynamics, affordance landscapes, socio-cultural constraints, learning design, expertise
23 acquisition

24
25
26
27
28

29 **1.0 Introduction**

30 Expertise in sport is multidimensional and emerges from the rich, continued interactions of an athlete
31 with a range of task and environmental constraints in performance, simulated in practice (Davids, Button &
32 Bennett, 2008). Ecological dynamics is a powerful theoretical framework to understand how sport practitioners
33 can support athlete development, predicated on these complex and dynamic interactions, emanating from
34 person-environment relationships (Davids, Handford & Williams, 1994). A key principle of ecological
35 dynamics, relevant for the challenge of athlete development, is the interacting influence of task and
36 environmental constraints on an athlete's ability to become attuned to the opportunities for action invited by
37 objects, surfaces, features, terrains, and other people, in a performance setting, (known as *affordances* in
38 ecological dynamics) (Davids, Güllich, Shuttleworth & Araújo, 2017). An increasingly functional relationship
39 with a performance environment is the basis of expertise from an ecological dynamics rationale (Araújo &
40 Davids, 2011). These ideas suggest that athletes who have been trained to select from a rich and diverse range of
41 affordances available in a competitive performance environment, will be better prepared to perceive information,
42 adapt their actions, make decisions and interact skillfully with ecological constraints of competition.

43 James Gibson (1979, p.119) argued that "the *affordances* of the environment are what it *offers* the
44 animal". For example, in rugby league, a ball offers kicking by players when travelling on the ground or
45 intercepting with their hands when moving through the air; a slow player invites a quicker player to run past
46 him/her, or a hard pitch offers sidestepping on. Recently, Gibson's initial conceptualisation of affordances has
47 been revisited to emphasise the invitational characteristic of affordances to individuals with the relevant
48 experiences, skills and capacities (Withagen, de Poel, Araújo & Pepping, 2012; Rietveld & Kiverstein, 2014;
49 Bruineberg & Rietveld, 2014; Withagen, Araújo & de Poel, 2017). Here, we elucidate what these refinements
50 imply for making sense of the variety of socio-cultural practices that are embedded in what the philosopher
51 Ludwig Wittgenstein termed *forms of life* (Wittgenstein, 1953), which consist of behaviours, skills, capacities,
52 attitudes, values, beliefs, practices and customs that shape the communities we live in. The features of a form of
53 life subsequently shape how we live (Rietveld & Kiverstein, 2014; Bruineberg & Rietveld, 2014).

54 Extrapolating these ideas, we contend that there are current examples of 'forms of life' identifiable in
55 sport (e.g. related to ski-ing in Northern Europe, soccer in Brazil, cricket in South Asia, and rugby union in New
56 Zealand). These forms of life in specific sports demonstrate how influential specific socio-cultural and historical
57 constraints have been in developing sporting excellence. They can explain why certain performance styles are

58 developed in certain regions and why they are valued and exploited to establish dominance in elite sport.
59 Athletic sprinting in Jamaica, for example, is ingrained in the sporting culture and has a history and tradition of
60 excellence, strongly influenced by the G. C. Foster College for Physical Education and Sports where the
61 country's athletic coaches are educated in a Jamaican 'way of sprinting' (Moore, 2015). In these sporting cultures
62 a form of life can be highly influential in how sport practitioners construct and design the micro structure of
63 practice, that could have positive or negative effects on athlete performance. However, the notion of different
64 countries or regions being associated with a particular 'style' or 'way' of practicing and performing in a sport is
65 rather simplistic, lacks theoretical substance and requires conceptual clarification in order to help us understand
66 the basis for performance development. For example, to enhance athlete development, is it feasible for one
67 country to simply imitate a way of practicing or performing associated with another (highly successful) nation in
68 a sport (Harris, 2017)? Simply imitating the traditional practices of another nation may present performance
69 challenges without first exploring, understanding, and embracing the form of life that influences the factors that
70 lead to another nation's success in competitive sport.

71 Here we contend that differences in quality of performance and playing styles are substantively based
72 on a specific 'form of life', often developed under specific historical, socio-cultural constraints in particular
73 geographical locations in the world. Forms of life are predicated on highly specific customary, habitual, highly
74 developed, yet responsive, modes of performing, competing, training and practising which result in the
75 preference to design specific types of *affordance landscapes* in athlete development programmes. Exploiting the
76 invitational nature of affordances when designing affordance landscapes in practice task designs (Withagen et
77 al., 2012; Withagen et al., 2017), should aim to make effective skilled action more likely to emerge. In these
78 affordance landscapes, specific practice task designs guide developing athletes in their search for functional
79 relationships with performance environments founded on skill, expertise and talent (Davids et al., 2017).
80 Although recent clarifications of Gibson's conceptualization have made valuable contributions to the literature
81 on affordances, little is known in sport domains about how a form of life can help sport practitioners to harness
82 local socio-cultural practices to influence affordance utilisation and the acquisition of sporting expertise.
83 Understanding more about this issue can help sport pedagogists to identify and exploit key socio-cultural
84 constraints to enhance the quality of athlete development in specific sports (Uehara, Button, Falcous & Davids,
85 2016; Araújo et al., 2010). First, we provide a brief historical case into why 'forms of life' and associated
86 behaviours and customs may exist and influence sport expertise.

87 **2.0 Historical Influences on Sport Performance and Coaching: The case of UK Rugby Football League**

88 As with any social phenomenon, the extent to which history influences socio-cultural practices cannot
89 be ignored. In the case of sport coaching in the United Kingdom, for example, industrialisation during the
90 nineteenth-century influenced social structures and trends, which in turn influenced workplace practice and
91 behaviours from that time onwards, shaping training methods in later years (Lyle, 2002). Increasing
92 industrialisation during the 1800s was successful, in part, to the production line ethos, which was later strongly
93 influenced by the American mechanical engineer Fredrick Winslow Taylor's systematised approach to industrial
94 efficiency. During a lecture on industrial efficiency in 1907, Taylor (2008, p. 215) provided insights into the
95 work place practices that contributed to his systematic management methods. His advice was straightforward:

96 *Managers should not allow employees to think for themselves but make sure they simply carry out*
97 *tasks as instructed, our scheme does not ask any initiative in a man. We do not care for this initiative.*
98 All we want of them is to obey the orders we give them, do what we say, and do it quick. That scheme
99 of giving minute instructions to every man, that is assigning him a task, having that task all planned for
100 everyone [Emphasis added].

101 Of interest is how these ideas filtered into cultural practices in institutional programmes in education
102 and sport affecting the development of individuals. One sport with a relevant socio-cultural-historical backdrop
103 to provide insights into how coaching behaviours and practice design shape how players acquire performance
104 skills, is British rugby football league. Historically, rugby football league's roots originated in the north of
105 England, where playing regions had been built on the key industries of the Victorian era (1837 to 1901). The
106 writings of sport historian Tony Collins (2006, p. 149) provide insights into how these strong social-cultural-
107 historical roots may have influenced the values of rugby league players, suggesting that 'the attitudes of rugby
108 league players were, therefore, shaped and defined by the world of industrial labour, which was intensely
109 physical, often aggressively oppositional to management and, above all, almost absolutely masculine'.

110 It is understandable that the reductionist nature of Taylor's methods and the attitudes and behaviours
111 associated with industrial labour were manifested in other parts of society at that time, including the sport
112 domain (Kiely, 2012). This process of perfidious filtration had strong connections to coaches and trainers
113 applying 'production line principles' to design systematic training programmes aimed to enhance athlete
114 performance (Smith & Davids, 1992). A stronger focus on enhanced athlete performance was perhaps down to

115 the increasing professionalisation of sport performance through structuring practice and training requirements
116 during the early 1900s (Day & Carpenter, 2015). The sporting forms of life that adopted ideas from Taylorism
117 and the industrial workplace in the commodification of athletes, were applied to the design of sports
118 performance programmes, where strict work regimes and rigid role specification reduced personal autonomy
119 and induced a 'body as machine' philosophy (Smith & Davids, 1992). Taylor's legacy is still evident in the sport
120 domain today, where 'reproductive style' coaching approaches that favor the decomposition of movement into
121 anatomical units to 'reproduce' skilled actions are still common (Davids, Güllich, Shuttleworth, & Araújo, 2017).
122 In rugby league, for example, when learning the "6 O'clock pass" performers are required to: (i) point the ball to
123 6 O'clock, and (ii), pass over the front foot (Rugby Football League Level 2 Coaching Manual, 2014). These
124 traits were valued in the socio-cultural contexts of the Victorian era in the UK but run counter to attributes
125 considered conducive to team sport performance, in contemporary society, where, autonomy within
126 collaborative efforts, creativity and adaptive decision-making are viewed as important skills for athletes to
127 possess (Memmert, Baker & Bertsch, 2010; Araújo & Davids, 2015). As discussed next, socio-cultural
128 constraints shape the way that an athlete develops a relationship with the available affordances to invite
129 functional actions and behaviours during competition.

130 **3.0 Sporting Forms of Life, Affordances and Athlete Performance**

131 A key tenet of Gibson's (1979) theory of affordances is the relational nature between affordances and
132 an ecological niche. Within an athlete performance context, this is especially related to an individual's current
133 available experience, abilities and capacities, captured in their *intrinsic dynamics* (dispositional tendencies) in a
134 constraints-based framework (Schöner, 1994; Vallacher, van Geert & Nowak, 2015). Gibson (1979), and more
135 recently, Rietveld and Kiverstein (2014, p. 326) suggested that affordances are not simply action opportunities
136 offered by the environment, but are dependent on the 'abilities available in a particular ecological niche';
137 important to this point is how an ecological niche can be 'shaped and sculpted by the rich variety of social
138 practices humans engage in'. Rietveld and Kiverstein's (2014) conceptualisation of affordances connotes the
139 mutuality of the athlete-environment relationship which is embedded in *forms of life*. The theory of affordances
140 embedded in forms of life provides a powerful rationale for the application of this key idea by sport practitioners
141 to consider the (socio-cultural and historical constraints in) environments which shape expectations and beliefs
142 on how athletes should behave, perform in competition, develop and learn (for example, Taylorism and
143 systematic workplace practices may have influenced the same employee's view of performing, developing and

144 training, who then went on to coach and play team sports). This conceptualization is important for considering
145 how to maximise the design and resourcefulness of practice environments and the socio-cultural practices that
146 athletes engage in around the globe in different societies, and communities with distinct social, physical and
147 geographical locations. It can provide a lens for practitioners to understand the potential for transfer of
148 (successful) practices and methods from one cultural context to another.

149 Forms of life are recognisable within coaching values, practice, and behaviours across sports, which are
150 constructed by the relationship between wider social values and key individuals involved in specific sports (Day
151 & Carpenter, 2015). An individual who transitions between social contexts (i.e. communities, workplaces and
152 the coaching arena) is influenced by normalised social values which continuously influence the relational nature
153 between affordances and the ecological niche (Bronfenbrenner, 1979). Consider a form of life in British rugby
154 league, where 'percentages, position and possession have been the prevailing mind set of late' (Woods, 2017, p.
155 7). The players being considered almost as mere machinery in the greater strategic planning of the high
156 performance sports organisation. The consequences of this form of life are exemplified by the perceptions of ex-
157 Great Britain Rugby League International Phil Clarke (2016, p. 11), warning against the normalisation of
158 'machine-like' behaviours in athletes:

159 I worry that we are *stifling the talents of more players* by getting them to *play like robots* [Emphasis
160 added]. The obsession with completion rates discourages players from taking a risk. We need to
161 radically alter that thinking and encourage players not to worry about being wrong and losing the ball,
162 mistakes will happen.

163 This account is consistent with the occupational ideals of Taylorism, prevailing assumptions of
164 managerialism and the socio-cultural-historical insights into rugby league provided earlier. This process-
165 oriented approach that adopts a dualist stance (i.e., separating mind and body) can be embedded in the socio-
166 cultural practices that are manifested through a sports or teams coaching practices and behaviours (Lombardo,
167 1999), where coaches design practice tasks based on the decomposition of complex individual or team skills
168 (Chow, Davids, Button & Renshaw, 2016). Although structure and organisation may have benefits during
169 athlete learning, over exposure to practice landscapes that reduce opportunities for action and promotes
170 systematic and predictable behaviours, can affect an athlete's responsiveness to relevant affordances. This
171 perspective is exemplified by ex-Great Britain international Phil Clarke (2016, p. 7/10) who describes a
172 common structured playing style:

173 *The 'structured' play of who stands where, runs into which hole in their opponents' defensive line,*
174 *passes behind which team-mate, it's a bit like watching a driverless car There is a bigger danger*
175 *that the shift away from autonomous thinking in attack will become boring - if it hasn't already. Worse*
176 *still, we are in danger of damaging young players by encouraging them to copy this style of play*
177 [Emphasis added].

178 Withagen et al. (2017) have argued against this mechanistic conception of human behaviour, instead
179 favouring the role of *agency* (i.e. individuals can make their own way in the world) to better understand how
180 affordances *can* be designed to invite or solicit functional behaviours. The notion of agency does not mean
181 athletes should be 'programmed' to respond to certain affordances, but should 'unreflectively' interact with the
182 affordances available in a performance environment that invite their actions (Rietveld, 2008). Importantly,
183 advocating that athletes have agency and can, therefore, act autonomously in *their* performance environment,
184 prioritises the person-environment relationship as the important scale of analysis in regards to developing
185 human movement behaviours (Withagen et al., 2017). This idea implies that sport pedagogists, and the socio-
186 cultural practices they influence, must support the autonomy needed by athletes during competitive performance.
187 They can develop the autonomy of athletes by facilitating their active exploration of a landscape of available
188 affordances during practice, which helps them to perceive and pick up action opportunities which exist in a
189 performance environment (Araújo, Davids & Hristovski, 2006). This re-conceptualisation proposes a significant
190 role for coaches as 'designers' of affordance landscapes, as part of a comprehensive 'form of life' in high
191 performance and elite development programmes, which simulate critical aspects of competitive performance
192 environments. Although this approach to expertise acquisition is theoretically coherent, within professional
193 rugby league, experiential knowledge of experts has pointed to the existence of a form of life that is more
194 consistent with mechanistic and reductionist approaches in line with traditional working practices.

195 A challenge for sport pedagogists is to develop evidence-based methodologies which help them move
196 away from mechanistic and reductionist approaches that force athletes to seek putative 'common optimal
197 movement templates' in training (Brisson & Alain, 1996). Rather, sport pedagogists and practitioners could
198 work collaboratively guided by a universal principled theoretical framework with other practitioners (e.g.,
199 strength and conditioning specialists, psychologists, trainers, coaches, performance analysts, skill acquisition
200 specialists) in a 'Department of Methodology'. The aim of a Department of Methodology could be for group
201 members to collaboratively design practice landscapes rich in information (i.e. visual, acoustic, and haptic)

202 based on a powerful and comprehensive theory of human behavior to guide implementation of methods,
203 encouraging the exploration of affordances utilised to shape and guide performance behaviours with physical,
204 psychological, emotional and social dimensions (Davids, Araújo, Hristovski, Passos & Chow, 2012).
205 Collaborative work in a Department of Methodology, based on an ecological dynamics rationale, could lead to
206 an agreed understanding of when, how, why and, by whom, particular fields of a landscape can be searched
207 during practice. If sporting forms of life provide athletes with opportunities to explore practice landscapes
208 varying in informational constraints, providing what Bernstein (1967, p. 204) called 'repetition without
209 repetition' (i.e., athletes exploring and discovering multiple performance solutions to achieve the same goal
210 directed task), they are more likely to develop the functionality required to continuously co-adapt their
211 behaviors to a range of evolving environmental and task constraints (Seifert, Button & Davids, 2013; Pinder,
212 Davids, Renshaw & Araújo, 2011). Individuals who improve their situation in a performance setting by
213 unreflectively responding to relevant affordances (solicitations of the environment) are considered to have an
214 *optimal grip* on the situation (e.g. simultaneous attunement to multiple relevant affordances) (Rietveld &
215 Kiverstein, 2014; Bruineberg & Rietveld, 2014), the basis of autonomous behaviors in sport performance
216 contexts. The notion of *skilled intentionality* (an individual's tendency towards an optimal grip) can provide
217 sport practitioners with a suitable conceptual framework to understand how to support athletes' to become
218 attuned to a *field of affordances*, underpinning their agency in competitive sport. Skilled intentionality is
219 founded on the intertwined relationship between emotion, cognition, perception and action of athletes who are
220 challenged by sport practitioners to adapt to dynamic constraints of specific fields of an affordance landscape.
221 The aim is to support each athlete in gaining an optimal grip on the relevant affordances in a landscape to
222 develop a functional relationship with the performance environment (Araújo & Davids, 2011).

223 The phenomenological notions of skilled intentionality, optimal grip, and field of affordances applied
224 to athletes, signify that they: (i) have developed high levels of functionality to adapt to varied challenges in
225 performance settings, enhancing their decision making capacities and the autonomy needed to interact with
226 teammates and opponents; (ii) have adapted to the relevant physical conditioning to function at high levels
227 throughout competition, and (iii), have developed the resilience and emotional regulation strategies needed to
228 flourish in competitive performance. Consequently, an athlete's concerns and abilities are constantly evolving,
229 signifying that their functionality towards an optimal grip on a field of affordances is adaptable to varied
230 situations (Rietveld & Kiverstein, 2014; Bruineberg & Rietveld, 2014), through their ability to develop a
231 functional relationship with dynamic performance environments (Araújo & Davids, 2011). This point is

232 demonstrated by the experiential knowledge of Castleford Tigers Head Coach, Daryl Powell (2017, p. 4) (At the
233 time of writing Castleford Tigers were top of the British Super League table, having scored 149 more points
234 than their closest rivals (BBC, 2017)).

235

236 *For me, you should have your own philosophy and culture as a coach – and at Castleford we believe*
237 *that we're different. I like the way we play and I'm excited by it – I'm coaching them, so I should be.*
238 *If you're not excited about what you're doing, you should be doing something else. We have a way of*
239 *playing, but we're always tweaking it. If teams expect something from us then we'll throw something*
240 *else at them. We're hard to coach against and we won't change that. As a coaching group we like to be*
241 *inventive and I know the players enjoy playing the way we do [Emphasis added].*

242 This extract suggests the existence of a form of life (philosophy and culture embedded in a
243 methodological framework) that refuses to subscribe to conventional styles of play, discussed earlier by Phil
244 Clark. Consequently, the team has a different way of playing that exploits evolving practice landscapes that
245 require players to use information to continuously co-adapt their actions to the movements of opponents and
246 teammates in achieving task goals (Chow et al., 2016). Being embedded in a form of life of this nature means
247 that players become sensitive to and utilize (rapidly appearing and dissolving) affordances in dynamic
248 performance contexts that are not effectively simulated under the narrow task constraints of traditional socio-
249 cultural practices (i.e. styles of play). These ideas imply how transitioning of teams between performance states
250 of stability and relative instability, can emerge to underpin successful performance in sports such as rugby
251 league.

252 **4.0 Conclusions and Future Research**

253 We argued that the social, cultural, and historical contexts in which athletes develop an increasingly
254 functional relationship with a performance context are important constraints on expertise which are relevant to
255 understand in sport. This category of constraints is currently lacking in substantive empirical research,
256 especially with respect to their effects on expertise in sport (Uehara et al., 2016), although there are strong
257 theoretical and philosophical ideas which implicate their importance in shaping behaviors. An important
258 challenge for sport practitioners is to elucidate the role of socio-cultural constraints in the design of affordance
259 landscapes to enhance the development of sport expertise. In tackling this challenge, high performance sport can
260 use a powerful theoretical and methodological framework to guide sport practitioners in exploring socio-cultural

261 constraints to facilitate an athlete's utilization of the multitude of available affordances to support skilled action.
262 The role of ecological dynamics in this task will focus attention on the person-environment relationship, leading
263 to a better understanding of the relationship between socio-cultural constraints and the emergence of an athlete's
264 skilled behaviours (Araújo, 2010).

265 To address these challenges Bronfenbrenner's proposed bioecological model of human development
266 provides methodological guidance for identifying relevant socio-cultural constraints that affect the development
267 of athletes (Bronfenbrenner, 1979), and looks beyond the athlete's immediate environment (although important)
268 to explore the wider socio-cultural constraints that influence skilled behaviour (Gabbard & Krebs, 2012). The
269 evolution of the bioecological model of human development (Rosa & Tudge, 2013) does not provide a universal
270 explanatory theory of skilled behavior (Araújo et al., 2010). However, adopting the model can provide
271 methodological guidance to analyse the relationships that evolve between an athlete's exposures to a multitude
272 of constraints (e.g., person, process, context, time), the influence these constraints have on affordance utilization,
273 and the socio-cultural practices that are embedded in sporting forms of life (Krebs, 2009). To explore these
274 relationships a mixed methods research approach can be employed to detail a form of life in a specific sport,
275 establish the relationships between a form of life and an athlete's capacity to utilize available affordances, and
276 analyse the task-specific relations between athletes and dynamic practice and competition settings. An
277 ecological dynamics examination of the person environment relationship will allow a functional analysis to
278 identify how perception and action can be harnessed to pick up and utilize affordances by individuals (Warren,
279 1988).

280

281 References

- 282 Araújo, D., Fonseca, C., Davids, K., Garganta, J., Volossovitch, A., Brandão, R., & Krebs, R. (2010). The Role
283 of Ecological Constraints on Expertise Development. *Talent Development & Excellence*, 2(2), 165–179.
- 284 Araújo, D., & Davids, K. (2015). Towards a theoretically-driven model of correspondence between behaviours
285 in one context to another: Implications for studying sport performance. *International Journal of Sport*
286 *Psychology*, 46, 268–280.
- 287 Araújo, D., Davids, K., & Hristovski, R. (2006). The ecological dynamics of decision making in sport.
288 *Psychology of Sport and Exercise*, 7(6), 653-676.
- 289 Araújo, D., & Davids, K. (2011). What Exactly is Acquired During Skill Acquisition? *Journal of Consciousness*
290 *Studies*, 18(3), 7–23.
- 291 Araújo, D., Davids, K., Bennett, S.J., Button, C., & Chapman, G. (2004). Emergence of sport skills under
292 constraint. In A.M. Williams & N.J. Hodges (Eds.), *Skill Acquisition in Sport: Research, Theory and Practice*,
293 London: Routledge, Taylor & Francis.

- 298
 299 BBC Sport Rugby League. (2017). Retrieved from <http://www.bbc.co.uk/sport/rugby-league>.
 300
 301 Bernstein, N. A. (1967). *The control and regulation of movements*. London: Pergamon Press.
 302
 303 Bruineberg, J., & Rietveld, E. (2014). Self-organization, free energy minimization, and optimal grip on a field of
 304 affordances. *Frontiers in Human Neuroscience*, 8(599), 1-14.
- 305
 306 Brisson, T. A., & Alain, C. (1996). Should common optimal movement patterns be identified as the criterion
 to be achieved? *Journal of Motor Behavior*, 28, 211–223.
- 307
 308 Bronfenbrenner, U. (1979). *The ecology of human development. Experiments by nature and design*. Cambridge,
 MA: Harvard University Press.
 309
- 310 Buekers, M., Ibáñez-Gijón, J., Morice, A., Rao, G., Mascret, N., Laurin, J., & Montagne, G. (2017).
 311 Interdisciplinary Research: A Promising Approach to Investigate Elite Performance in Sports. *Quest*, 69(1), 65-
 312 79. doi:10.1080/00336297.2016.1152982.
- 313
 314 Collins, T. (2006). *Rugby League in Twentieth Century Britain: A Social and Cultural History*. London:
 315 Routledge.
 316
- 317
 318 Chow, J.-Y., Davids, K., Button, C., & Renshaw, I. (2016). *Nonlinear Pedagogy in Skill Acquisition: An
 Introduction*. Routledge: London.
- 319
 320 Clarke, P. (2016, May 5). Creativity is being coached out of rugby league. *Sky Sports*. Retrieved from
 321 <http://www.skysports.com/rugby-league/news/12532/10269065/phil-clarke-creativity-is-being-coached-out-of-rugby-league>.
- 322
 323 Davids, K., Button, C., & Bennett, S. (2008). *Dynamics of skill acquisition: A constraints-led approach*.
 Champaign, IL: Human Kinetics.
 324
- 325
 326 Davids, K., Handford, C., & Williams, M. (1994). The natural physical alternative to cognitive
 327 theories of motor behaviour: An invitation for interdisciplinary research in sports science? *Journal of Sports
 Sciences*, 12, 495–528. doi:10.1080/02640419408732202.
 328
- 329
 330 Davids, K., Güllich, A., Shuttleworth, R., & Araújo, D. (2017). Understanding Environmental and Task
 331 Constraints on Talent Development, In J. Baker, S. Cobley, J. Schorer & N. Wattie (Eds.), *Routledge Handbook
 of Talent Identification and Development in Sport*. Abingdon: Routledge.
- 332
 333 Davids, K., Araújo, D., Hristovski, R., Passos, P., & Chow, J. Y. (2012). Ecological dynamics and motor
 334 learning design in sport. In N. Hodges & M. Williams (Eds.), *Skill Acquisition in Sport: Research, theory
 and practice*. Abingdon, UK: Routledge.
- 335
 336 Day, D., & Carpenter, T. (2015). *A History of Sports Coaching in Britain: Overcoming Amateurism*. London:
 Routledge.
 337
- 338
 339 Gabbard, C., & Krebs, R. (2012). Studying environmental influence on motor development in children. *Physical
 Educator*, 69, 146-149.
- 340
 341 Gibson, J. J. (1979). The theory of affordances. In R. E. Shaw & J. Bransford (Eds.), *Perceiving, acting, and
 knowing: Toward an ecological psychology*. Hillsdale, NJ: Lawrence Erlbaum Associates.
 342
- 343
 344 Glazier, P. (2015). Towards a Grand Unified Theory of sports performance. *Human Movement Science*.
 doi.org/10.1016/j.humov.2015.08.001.
 345
- 346
 347 Harris, B. (2017, June 15). All Blacks-lite: Wallabies take inspiration from their rivals across the Tasman. *The
 Guardian*. Retrieved from <https://www.theguardian.com/sport/2017/jun/16/all-blacks-lite-wallabies-take-inspiration-from-their-rivals-across-the-tasman>.
 348
 349
- 350
 351 Ibáñez-Gijón, J., Buekers, M., Morice, A., Rao, G., Mascret, N., Laurin, J., & Montagne, G. (2017). A

- 351 scale-based approach to interdisciplinary research and expertise in sports. *Journal of Sport Sciences*, 35(3), 290-
 352 301. doi:10.1080/02640414.2016.1164330.
- 353
- 354 Kiely, J. (2012). Periodization Paradigms in the 21st Century: Evidence-Led or Tradition-Driven? *International*
 355 *Journal of Sports Physiology and Performance*, 7, 242-250. doi: 10.1123/ijsp.7.3.242.
- 356 Krebs, R. J. (2009). Bronfenbrenner's bioecological theory of human development and the process of
 357 development of sports talent. *International Journal of Sport Psychology*, 40(1), 108-136.
- 358 Lombardo, B. (1999). Coaching in the 21st century: Issues, concerns and solutions. *Sociology of Sport Online*,
 359 2(1). Retrieved from <http://physhed.otago.ac.nz/sosol/v2i1/v2i1a4.htm>.
- 360
- 361 Lyle, J. (2002). *Sports Coaching Concepts: A Framework for Coaches' Behaviour*. London:
 362 Routledge.
- 363 Memmert, D., Baker, J., & Bertsch, C. (2010). Play and practice in the development of sport-specific creativity
 364 in team ball sports. *High Ability Studies*, 21(1), 3-18.
- 365 Moore, R. (2015). *The Bolt Supremacy: Inside Jamaica's Sprint Factory*. London: Yellow Jersey Press.
- 366
- 367 Phillips, E., Davids, K., Renshaw, I., & Portus, M. (2010). Expert Performance in Sport and the Dynamics
 368 of Talent Development. *Sports Medicine*, 40, 271-283.
- 369 Pinder, R., Davids, K., Renshaw, I., Araújo, D. (2011). Manipulating informational constraints shapes
 370 movement reorganization in interceptive actions. *Attention, Perception & Psychophysics*, 73(4), 1242-1254.
- 371 Powell, D. (2017, February 3). In G. Walker, Castleford boss Daryl Powell promises flair and urges Super
 372 League sides to 'fight back' against Aussie style. *Mirror*. Retrieved from [http://www.mirror.co.uk/sport/rugby-](http://www.mirror.co.uk/sport/rugby-league/castleford-boss-daryl-powell-promises-9750729)
 373 [league/castleford-boss-daryl-powell-promises-9750729](http://www.mirror.co.uk/sport/rugby-league/castleford-boss-daryl-powell-promises-9750729).
- 374 Rosa, E. M., & Tudge, J. R. H. (2013). Urie Bronfenbrenner's theory of human development: Its
 375 evolution from ecology to bioecology. *Journal of Family Theory & Review*, 5, 243-258. doi:10.1111/jftr.12022.
- 376
- 377 Rietveld, E. (2008). Situated normativity: The normative aspect of embodied cognition in unreflective action.
 378 *Mind*, 117, 973-1001.
- 379 Rietveld, E., & Kiverstein, J. (2014). A rich landscape of affordances. *Ecological Psychology*, 26, 325-352.
- 380
- 381 Rugby Football League. (2014). Certificate in coaching rugby league level 2. Leeds: Coachwise Ltd.
- 382
- 383 Schöner, G. (1994). Dynamic theory of action-perception patterns: The time-before-contact paradigm. *Human*
 384 *Movement Science*, 13, 415-440.
- 385 Seifert, L., Button, C. & Davids, K. (2013). Key properties of expert movement systems in sport: An ecological
 386 dynamics approach. *Sports Medicine*, 43, 167-172.
- 387 Smith, L., & Davids, K. (1992). Uncertainty and Resourcefulness in Performance Environments: A Theoretical
 388 Note. *European Work and Organisational Psychologist*, 2(4), 331-344.
- 389
- 390 Taylor, F. W. (2008). "Report of a lecture by and questions put to Mr F.W. Taylor: a transcript". *Journal of*
 391 *Management History*, 14(3), 214-236. doi: 10.1108/17511340810885657.
- 392
- 393 Uehara, L., Button, C., Falcous, M., & Davids, K. (2016). Contextualised skill acquisition research: a new
 394 framework to study the development of sport expertise. *Physical Education and Sport Pedagogy*, 21(2), 153-168.
- 395
- 396 Vallacher, R., van Geert, P. & Nowak, A. (2015). The intrinsic dynamics of psychological process. *Current*
 397 *Directions in Psychological Science*, 24, 58-64.
- 398 Warren, W. H. (1988). Action modes and laws of control for the visual guidance of action. *Advances*
 399 *in Psychology*, 50, 339-379.
- 400

Socio-Cultural Constraints and Athlete Development

- 401 Withagen, R., de Poel, H. J., Araújo, D., & Pepping, G. J. (2012). Affordances can invite behaviour:
402 Reconsidering the relationship between affordances and agency. *New Ideas in Psychology*, 30(2), 250-258.
- 403 Withagen, R., Araújo, D., & de Poel, H.J. (2017). Inviting affordances and agency. *New Ideas in Psychology*, 45,
404 11-18.
- 405 Wittgenstein, L. (1953). *Philosophical investigations*. Oxford, UK: Blackwell.
- 406 Woods, D. (2017, February 7). Super League returns: English clubs should forget NRL and turn on the style in
407 2017. *BBC*. Retrieved from <http://www.bbc.co.uk/sport/rugby-league/38862223>.
408
409
410