

**Talent Development in Sport Requires Athlete Enrichment:  
Contemporary Insights from a Nonlinear Pedagogy and the  
Athletic Skills Model**

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4

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1    **Abstract**

2    Traditional talent identification and development programs have sought to identify and select the most  
3    promising children as athletes of the future, in order to provide them with specialised training and  
4    preparation for expert performance in sport from an early age. Traditional models of *talent identification*  
5    and development tend to be linear, emphasising the numbers of hours spent in specialised training.  
6    However, major concerns have been raised by evidence emerging on psycho-emotional and physical issues  
7    with early specialisation programmes, and negative associations with wellbeing and mental health. More  
8    contemporary models of *talent development* emphasise a deep integration of specialised training with more  
9    general enrichment of athleticism. This integrative process enhances self-regulation processes of perception  
10   and action, as well as emotional control and social interactions, all of which underpin sports performance  
11   at elite and sub-elite levels. Here, we discuss insights and principles of contemporary models of pedagogy,  
12   such as Nonlinear Pedagogy (NLP) and the Athletic Skills Model (ASM), which offer valuable frameworks  
13   for talent development. We conclude by considering implications of adopting such principles for  
14   developing athlete functionality in specific performance environments.

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18    **Key Points**

19    Traditional talent identification and models are based on a linear model of the learner and the learning  
20    process and lead to early specialisation in children as young as five years of age.

21    Nonlinear Pedagogy and the Athletic Skills Model comprise contemporary models that provide a nonlinear  
22    perspective on talent development, precluding identification and selection of children as athletes with  
23    potential specialisations at younger ages, indicating when specificity of practice is important and when  
24    general preparatory experiences are important for developing foundational movement capacities.

25    Nonlinear Pedagogy and the Athletic Skills Model focus on the development of general athleticism and  
26    require early work on physical literacy and functional movement skills, followed by later specialised  
27    training development and performance preparation programmes.

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## 1 **1 Introduction**

2 Sports organizations around the world have implemented talent identification (TI) and talent development  
3 (TD) programs seeking to identify and foster the next generation of elite athletes. Traditionally, TI programs  
4 are conceived to identify talented athletes in childhood (although talent can also be identified during  
5 adulthood) who putatively display superior performance in sport-specific skills that can be predictive of  
6 future career success at a senior level [1]. These ideas are not just idealistic, philosophical stances, but are  
7 reflected in overt political and economic decisions made at the highest levels of governments and elite  
8 sports organisations. A driver for early specialisation models of talent identification and development has  
9 been the deliberate practice approach (for an overview see [2]). This approach to expertise emphasises that  
10 highest levels of performance cannot be attained without undertaking an average of 10000 hrs of intense,  
11 not inherently enjoyable, specialised training in one specific domain [3].

12 Several physical, social and psych-emotional long-term negative consequences have been  
13 associated with the early specialisation approach (see, for example, [4]). Little conclusive evidence supports  
14 the effectiveness of traditional TI approaches, which are entirely predicated on the principle of specificity  
15 of training and practice. There is compelling evidence that children are treated as ‘mini-adults’ in such  
16 programmes, rather than engaging in childhood play and practice activities, both structured and  
17 unstructured [5]. Instead, children are being exposed to intensive, repetitive training drills during early  
18 development, which increases the risk of specific types of over-use injuries, decreased sport enjoyment,  
19 increasing burnout and dropout rates and stifled psychosocial development. Another major issue is that  
20 many linear TI programs tend to display an ‘organismic asymmetry’ [6], biased in early identification and  
21 selection towards an individual’s *physical* properties (e.g., height, weight, strength, power, speed assessed  
22 on performance in standardised tests) recorded in a snapshot at one moment in time [7]. A major issue  
23 underlying traditional linear models is that they are dominated by specificity principles and early  
24 specialisation experiences in a child’s development.

25 This inherent bias towards specificity and early specialisation experiences clearly plays down the  
26 contributory role of other more general play and practice experiences and their influence on motivation,  
27 self-regulation, propensity to learn and cognitive engagement, and emotional control. To counteract this  
28 organismic asymmetry, a comprehensive theoretical rationale has been proposed to provide a holistic,  
29 integrated view of a developing athlete as a complex, dynamical system [6]. Integrating key ideas from  
30 ecological dynamics and dynamical systems theory may serve as a valuable theoretical template for  
31 modelling and understanding expertise and talent in sports performance. The enrichment of general  
32 capacities and abilities during childhood, adolescence, and even into adulthood, can enhance physical  
33 literacy across the lifespan to underpin specialised training at the right time [8]. In this Current Opinion,  
34 we briefly overview current issues of traditional TI programmes, before proposing a novel way of viewing  
35 talent based on two levels: the development and adaptation of functional, general and specific abilities and  
36 skills throughout each individual’s lifespan.

37

## 38 **2 Current issues with traditional talent identification and development models in sport systems**

39 A particularly important issue is that inherent linearity of traditional TI and TD models neglects criteria  
40 used to evaluate the potential of a child to become a *future* skilled, adult athlete, which is often confused

1 with *current* performance levels of a young person [9]. The timescales of development and performance  
2 preparation are interlinked but different. A key question is: How can we predict *future* potential in an  
3 individual as a nonlinear dynamical system, based on performance characteristics (e.g.,  
4 physical/physiological, technical, tactical, psychological, emotional and social) that may or may not change  
5 radically across time through maturation, development, practice, learning and experience, as well as being  
6 influenced by genes? A major concern of early identification systems is that athletes are selected according  
7 to observations of early performance measures without considering changes that may emerge during  
8 developmental stages of later childhood, adolescence, and early adulthood. Current performance values  
9 need to be considered as *tendencies*: no more than estimates, which may or not be eventually aligned with  
10 potential achieved. Indeed, correlations between junior and senior success in competitive sport  
11 achievements and performance outcomes are weak [10]. From an ecological dynamics perspective, of  
12 fundamental importance is what happens during enrichment experiences, non-specialised and specialised,  
13 in play and practice early in an individual athlete's development that can support specialisation at the right  
14 time for each individual.

#### 15 16 2.1 What does athlete enrichment mean?

17 Enrichment in athletic development refers to the rich variety of play, physical activities, games,  
18 and sports, that children and youth experience prior to (as well as during) the specialisation phase in talent  
19 pathways [11-12]. Enrichment activities are numerous and can engage perceptual, cognitive, psychological,  
20 emotional, and physical sub-systems in performance. Exposure to an extensive range of sport experiences  
21 can help a child gain vital foundational movement skills needed later in the demanding specialisation phase  
22 in athlete development programmes. Therefore, athlete enrichment is critical to specialisation in sport,  
23 especially prior to, but also during, dedicated training in a target sport. Enrichment starts in early physical  
24 education through the development of physical literacy to enable foundational movement behaviours and a  
25 love of moving [8-13-16]. An important aspect of enrichment through early motor learning experiences is  
26 skill adaptation through exposure to unstructured play and exploratory practice in more structured  
27 programmes [12-17-18].

28 Enrichment processes involve a subtle blend between specificity and generality of practice to  
29 provide each athlete with a distinctive skill set, adopting an 'athlete-centred' approach to talent  
30 development, which is completely aligned with a nonlinear perspective of human behaviour [10-12]. The  
31 aim is to enhance the self-regulating performance of each athlete, decreasing coach-dependency over time  
32 and focusing on an integrated mix of skills for cognitive and emotional control, perceptual awareness and  
33 a repertoire of actions to solve problems and face competitive challenges (for examples of self-regulation  
34 in swimming see [14], and throughout the rounds of a long jumping competition, see [19]). Enrichment  
35 continues during childhood and youth phases where the challenge is to integrate broader physical activities  
36 with more specialised training experiences (the latter could be viewed as a form of dedicated enrichment in  
37 specific performance environments). While specialised training is important and necessary at the right time  
38 for an individual athlete, *early specialisation* programmes can inhibit the innovation, creativity, curiosity  
39 and exploratory behaviours required of young children because they do not expose them to a diversity of

1 affordances or opportunities for action when needed (i.e. during the early stages of sport and motor  
2 development).

3 Motor learning theory has provided a body of research on the importance of specificity of practice  
4 and learning in sport [20], although there has been less attention, especially in recent decades, on effects of  
5 general learning experiences and activities and effects on expertise. Ecological dynamics has clarified that  
6 the relationship between specificity and generality of practice concerns an issue of *timing*, signifying that  
7 both have a role to play in athlete development, with the emphasis on each type of practice changing with  
8 development stages [10-12]. Sport scientists and coaches need to consider effects of specific and general  
9 practice at *different* times in an individual athlete's developmental pathway, attending to the nonlinearity  
10 of the constantly changing sub-systems underlying performance (e.g., psychological, emotional, cognitive,  
11 perceptual and physical), due to learning, experience, maturation and development [10-12]. Next, we  
12 consider how practice designs can be differentiated depending on the needs of each athlete on the pathway.  
13

### 14 **3 Enrichment of athletic talent in sport through integrating generality and specificity of practice**

15 Previous research has revealed that the principle of specificity is highly important from the perspective of  
16 practice and training for skill acquisition and physiological conditioning. It has taken longer to clarify that  
17 generality of practice, concerning enrichment of underpinning skills, capacities and abilities, is also  
18 important to develop athleticism. Over the decades, two important aspects of practice and training designs  
19 (specificity and generality of sport practice experiences) have tended to be juxtapositioned against each  
20 other in a false scientific dualism [20]. The main issues debated included the role of general motor abilities  
21 in underlying a learner's development in one context and transfer of practice task design (do learning  
22 experiences need to be specific or can one's performance potential in a target sport be predicted from  
23 performance in a different, related sport or activity?).

24 In contrast to the specificity of skill learning, research sought to highlight the importance of an  
25 underlying motor ability, which is more or less general, more or less inherent, supporting the identification  
26 and selection of individuals to learn specialised motor skills easily and to become proficient in a target  
27 domain [20]. This idea was not supported by research which showed that to become proficient at a specific  
28 sport domain (e.g. ice climbing), one has to be exposed to specific learning experiences in climbing on  
29 frozen surfaces, such as glacial waterfalls [20]. The 'debate' on *specificity vs. generality* of abilities was  
30 resolved in favour of specificity, and the potential contribution of *generality* of motor learning play and  
31 practice experiences, which underpin athlete enrichment, may have been downplayed as a result. The key  
32 issue concerning the *complementary relations* between specificity and generality of learning experiences  
33 in play and practice gained less attention in research: When do learners need to be exposed to general  
34 movement experiences to develop their underlying athleticism and functional abilities in perception,  
35 movement and cognition, and when do they need to specialise in training with highly specific experiences?  
36 This relevant issue will be discussed in the next sections.  
37

### 38 **4 Reframing ideas on specificity and generality of practice designs, training transfer and talent** 39 **development: An ecological dynamics rationale**

1 Previous studies (see, e.g., [21-25]), have contrasted experimental data from non-specific and specific  
2 training. For example, the article by Memmert & Roth [21], examined the efficacy of various training  
3 approaches in team ball sports. Results showed that groups provided with non-specific training improved  
4 in general creativity, whilst specific-training groups improved in the game-oriented creativity in which they  
5 were trained. Another study by Memmert et al. [22] examined the role of practice conditions in the  
6 development of creative behaviours in team ball sports. They analysed self-reported data from athletes on  
7 the quantity and type of sport-specific and other related practice activities experienced throughout their  
8 careers. Results indicated that more creative players accumulated more time in training for their main sport  
9 than their less creative counterparts. Findings suggested that practice experiences and early play are  
10 important influences on the development of sport creativity. These studies provided relevant, empirical  
11 tests and associated statistical analyses of specific and non-specific practice experiences in sport. What is  
12 still needed are compelling theoretical explanations *why* a better balance between specialized and general  
13 training is important for developing athletes.

14 Contemporary models of practice, like NLP and the ASM [e.g., see 26-31] have provided such a  
15 conceptualisation, enhancing understanding of the complementary relations between specificity and  
16 generality of practice experiences in motor learning. In more specific practice designs, a close relationship  
17 is developed with the rich range of varied information sources and affordances present in a competitive  
18 performance environment [19]. Representative learning designs enhance the quality of skill acquisition  
19 experiences and preparation for performance by facilitating a close match with information for action  
20 regulation and affordances to utilise for intended task goals [11-12-32].

21  
22  
23 **\*Insert Figure 1 near here\***  
24  
25

26 **Fig. 1.** Specifying and non-specifying information in ecological psychology differentiates specificity and  
27 generality of practice designs.  
28

29 Highly specific learning experiences are valuable for matching representative task dynamics with  
30 an individual's intrinsic system dynamics (i.e., genes, dispositional tendencies, capacities, propensities, and  
31 abilities) to enhance skill acquisition (see [33] for a coordination dynamics explanation). An individual's  
32 intrinsic dynamics (i.e., spontaneous coordination tendencies) are continually modified and adapted by  
33 learning, experience and practice to underpin self-regulation in sport performance, supporting physical,  
34 perceptual-cognitive and psychological, emotional and social interactions emerging during competitive  
35 performance [10]. Intrinsic dynamics support athlete effectivities, i.e., capacities for utilising affordances  
36 (opportunities for action) available in specific performance settings [6]. In ecological dynamics, an  
37 individual's effectivities can be continually enriched and developed by general sport and play experiences  
38 in throughout the lifespan, shaping an individual's skill adaptation: the propensity to use an extensive range  
39 of affordances in uncertain performance landscapes.

40 Thus, practice is a process of searching for increasing functionality in unpredictable performance  
41 environments and increasing functionality in a specific performance environment characterises talent [6,

1 34-36]. This rationale is exemplified by Nikolai Bernstein's [37], p134) advocacy of practice designs to  
2 facilitate 'repetition without repetition' (see Figure 2). Therefore, broadening the search of a performance  
3 landscape of an athlete when they are already on the talent development pathway is significant, and typically  
4 builds throughout the lifespan of an individual. Indeed, early experiences set up the athlete for further  
5 exploration, refinement, adaptation, and development of skills throughout life. High levels of athlete  
6 functionality emerge when an individual becomes skilled in interacting with concurrent and multiple  
7 affordances during practice and competition [38].

8 The richer and more varied the learning experiences of learners early in the pathway, the better the  
9 athletic foundation for specialised training at a later stage. To enrich athlete functionality coaches needed  
10 to create practice environments that preserve a rich landscape of affordances that provide opportunities for  
11 perceiving and acting on information, and shaping intentionality in competition [10, 39].

12  
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14 **\*Insert Figure 2 near here\***

15 **Fig. 2.** A continuum of practice designs with different affordances available for learners. Learners are  
16 typically directed to fewer, similar affordances in specified areas of the learning landscape by coaches and  
17 instructors (symbolised by the uniform shapes, few in number) during highly structured and isolated  
18 practices. A more diverse and vast range of affordances can be found at the more varied and less structured  
19 end of the landscape for practice designs (symbolised by the rich and varied shapes and sizes available).

20  
21 Through skilled intentionality (responsiveness to a field of affordances) athletes can display a  
22 tendency towards an optimal grip of affordances (the tendency of a skilled athlete to improve his/her  
23 capacity to respond to solicitations from the environment) [40]. According to Rothwell et al. [41], targeting  
24 an optimal grip is inherently related to self-regulation tendencies and the functionality of human behaviours  
25 in performance environments. Although the capacity to operate at the highest performance levels may be  
26 domain-specific, the self-regulating nature of athlete functioning is profoundly sustained by non-domain  
27 specific capacities and evolving dispositional tendencies which can be psycho-social, physical and  
28 emotional [6]. A key challenge is to identify athletes with possible dispositional tendencies (greater or less  
29 talent potential – based on a long-term monitoring of key indicators (physical, technical, tactical,  
30 psychological, emotional, etc.) that can be informative of potential future success) to operate effectively in  
31 specific performance contexts over the macro-timescales of years and decades [6]. Also, according to the  
32 dispositional tendencies displayed by a successful athlete, one might consider looking at different  
33 *configurations of talent* (i.e., abilities, effectivities that differ among talented athletes).

#### 34 35 *4.1 The Athletic Skills Model for developing talented athletes*

36 Principles of NLP are aligned with those of the ASM (see, [27], for a detailed explanation of principles of  
37 ASM), a practitioner-developed pedagogical approach that provides an alternative framework to traditional  
38 talent development models. The ASM is a practical and scientifically based talent development model for  
39 elite and non-elite athlete development at all ages. The model is an outcome from the combined theoretical  
40 ideas of ecological dynamics, key scientific findings, and experiential knowledge from extensive practice  
41 in high performance sport (see [27]). The ASM is based on ideas from other established models such as



1 talent model of Bloom [42], the diversification ideas of Côté et al. [43-45], and the different pedagogic  
2 aims of Balyi and Hamilton [46]. Importantly, the ASM focuses on two levels of practice design in talent  
3 development pathways in sport programmes: both general and specific. A key issue concern *when* to  
4 emphasise general motor learning experiences and *when* to undertake specialised training steeped in  
5 specificity of practice. Both NLP and ASM advocate a learner-centred approach with an individual showing  
6 potential talent for high-level sport performance required to become a good athlete first. The initial phase  
7 of the ASM involves enrichment training of foundational movement skills, including perceptual and  
8 cognitive skills required to solve problems, make decisions, perceive information to regulate performance  
9 and emotionally engage with challenges of a competitive performance environment. In the first phase,  
10 children could be encouraged to participate in multiple different sports to acquire relevant perceptual,  
11 cognitive and movement competencies which can provide a powerful basis for later specialisation. There  
12 should also be opportunities to engage in *donor sport* activity, which share affordance fields with related  
13 sports. *Donor sports* include complementary sport activities that promote transfer of varied and specific  
14 movement experiences across a range of non-specific and specific practice environments, supporting  
15 performance functionality at the specific moment of specialisation. Abilities deemed critical to athlete  
16 development can be “donated” by performance and experience in selected sports that share adjacent fields  
17 of an affordance landscape including an extensive range of opportunities for action that can support skills  
18 transfer from a donor sport to a target sport. For example, futsal has been proposed as donor sport for  
19 learners with potential to develop ball manipulation skills for use in tight spaces of football fields [47] and  
20 opportunities for developing awareness through visual exploratory behaviours like scanning. It has been  
21 observed that, without the ball, futsal players scanned around them up to three times more often than  
22 football players [48].

23 Taken together, scientific theory and pedagogical evidence suggests that multisport and donor sports  
24 experiences can act as a bridge to a career in specific sports or groupings of sports. It is important to note  
25 that experience in a specific target sport at an early stage of development may be useful, of course. But  
26 specific training and performance experiences in a target sport are not deterministic in labelling a child as  
27 only a specialist performer in a single sport. Building on high quality play and practice experiences in the  
28 initial phase, later training involves more opportunities to specialise in one sport after being identified with  
29 *athletic potential* and selected to be part of a specific sport programme e.g., football, swimming, diving,  
30 rowing. It is important to note that, less extensive affordance landscapes in more specialized training tends  
31 to emphasise more technique rehearsal, repetition and reproduction of movements. On the other hand, a  
32 more diverse and wide range of affordances are provided at the less specialized end of the performance  
33 landscape. Athletes need to be free to explore different and varied regions of their performance landscape  
34 in the achievement of task goals, in order to expand their effectivities. Enrichment of an athlete’s  
35 effectivities may allow them to negotiate the dynamical landscape of competitive performance, which is  
36 always evolving. Hence, the more general ecology of a performance landscape, the greater will be  
37 opportunities for skill adaptation and synergy (re)formation amongst motor system degrees of freedom.  
38 Consequently, athletes will be able to expand their performance landscape and thus develop effectivities to  
39 exploit many varied, available affordances. This process of general athletic enrichment can help them to  
40 specialise and benefit from more specified coaching later in their development. Principles of NLP and ASM

1 advocate a careful, nuanced, and continuous transition between generality (non-target sports and activities)  
2 and specificity (engaging with various forms of a target sport) of transfer needed in talent development  
3 programmes [11-12].

4 Specialisation readiness is not necessarily dependent on a specific age, but on the developmental  
5 status of an individual learner at any point in time [16]. Even at the more specialist stage of athlete  
6 development – when athletes are on their development pathway (i.e., these stages are called specializing  
7 years (13-16 years) and investment years (+16 years) – they may need some generalised experiences to  
8 enhance their athleticism which might aid them to continue to specialise in their target sport despite effects  
9 of injuries, illnesses or ageing. Summarising, even at the general developmental phase, athletes may be  
10 exposed to some specialised experiences at an early age and at a more specialised training phase, individual  
11 athletes can benefit from some general athletic enrichment experiences. In contemporary motor learning  
12 approaches (i.e., ecological dynamics) and pedagogical models (NLP and ASM), a clear bi-directional  
13 relational approach is advocated between the generality and specificity of skill acquisition and learning  
14 experiences throughout each individual’s career.

## 16 **5 Conclusions and practical applications**

17 This Current Opinion proposed a model to develop talented athletes, grounded on key ideas from NLP and  
18 the ASM. If we are going to persist with TI rather than TD then, first, we need to develop ways of identifying  
19 general athleticism in young children and youth (general through assessing physical literacy). After being  
20 identified with some dispositional tendencies (abilities towards reaching expertise in specific sports),  
21 athletes can then be introduced to specialisation (bi-directional tendency between generality and  
22 specificity).

## 24 **Compliance with Ethical Standards**

25 No sources of funding were used to assist in the preparation of this article.

## 27 **Conflict of interest**

28 João Ribeiro, Keith Davids, Pedro Silva, Patrícia Coutinho, Daniel Barreira, and Júlio Garganta declare  
29 that they have no conflicts of interest relevant to the content of the article.

## 31 **Ethics approval**

32 Not applicable.

## 34 **Consent to participate**

35 Not applicable.

## 37 **Consent for publication**

38 Not applicable.

## 40 **Availability of data and material**

1 Not applicable.

2

3 **Code availability**

4 Not applicable.

5

6 **Author Contributions**

7 JR: conceived the idea of this paper and wrote the first draft; KD, PS, PC, DB, and JG: significantly  
8 contributed to further drafts and all read and edited the paper.

9

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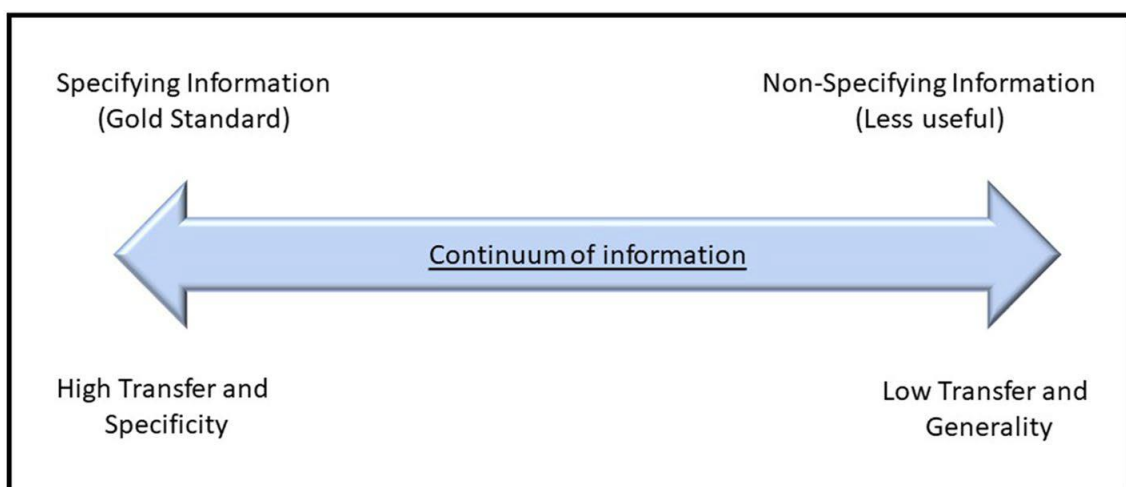
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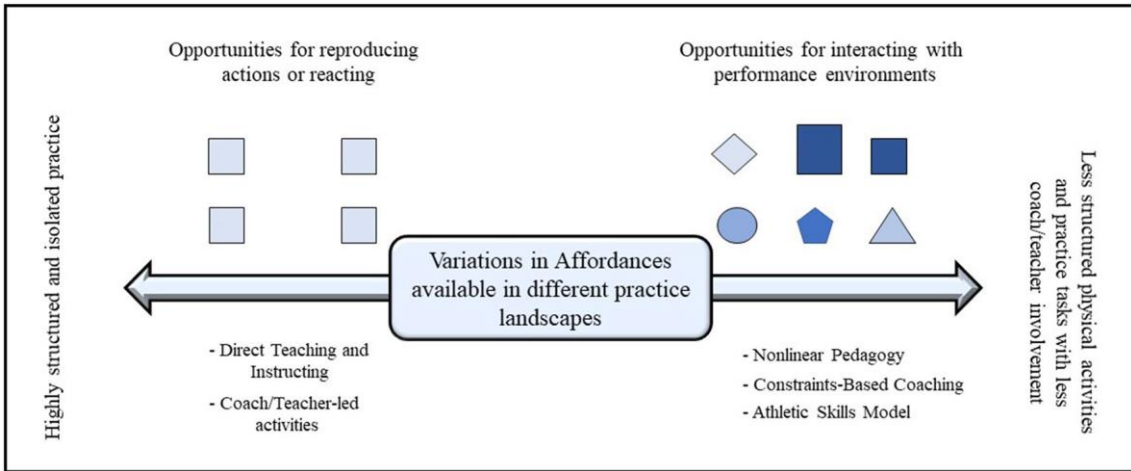
31 Fig. 1 Specifying and nonspecifying information in ecological psychology differentiates specificity and generality of  
32 practice designs

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1 Fig. 2 A continuum of practice designs with different affordances available for learners. Learners are typically  
 2 directed to fewer, similar affordances in specified areas of the learning landscape by coaches and instructors  
 3 (symbolised by the uniform shapes, few in number) during highly structured and isolated practices. A more diverse  
 4 and vast range of affordances can be found at the more varied and less structured end of the landscape for practice  
 5 designs (symbolised by the rich and varied shapes and sizes available)  
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