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The (Sport) Performer-Environment System as the Base Unit in Explanations of Expert Performance

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Abstract

In this article we propose that expertise can be best explained as the interaction of the varying constraints/characteristics of the environment and of the individual, framed by the ecological dynamics approach. This rationale of expert performance is contrasted with the typical way that science has approached the study of expertise: i.e., by looking for constraints, located in the individual, either nurture- or nature-based, and related to high performance levels. In ecological dynamics, the base unit of analysis for understanding expertise is the individual-environment system. Illustrating this perspective with Bob Beamon's 8.90 m long jump, whose 1968 world-record jump was substantially longer than any previous, we argue that expert performers should not be seen as an agglomeration of genes, traits, or mental dispositions and capacities. Rather, expert performance can be captured by the dynamically-varying, functional relationship between the constraints imposed by the environment and the resources of each individual performer.

Keywords

sport, expertise, affordance, ecological, dynamic, self-organization

Introduction

Six seconds was all it took for Bob Beamon to leap into history. He ran 19 strides down the runway, jumped, and landed 8.90 m later. In 1968 in Mexico City's University Olympic Stadium, Bob Beamon broke the world record for the farthest long jump. It remains, arguably, the greatest individual feat of the modern Olympics. For expertise researchers, questions arise immediately: How can we explain such expert performance? Was it due to genetics? Was it because of his physical characteristics/abilities. Or was it deliberate practice scheduling? Did Mexico City's altitude cause it? Or was it the wind? Did it happen by random chance? Was it due to the stadium's fast runway, or to competitive pressures?

We tend to respond affirmatively to all these questions, declaring that no single factor located solely in the performer or environment can explain expert performance. As argued elsewhere (e.g., Araújo & Davids, 2011), expertise and expert performance cannot be acquired or possessed by individuals (or be located in an environment). Like a rainbow, which does not exist in individual drops of water, or in an observer's visual system, or in the light rays from the sun, but in the interaction of these components, expertise and expert performance exist in the coupling of an individual and an environment. That is, expertise emerges from the specific interactions of system components. In this paper we present an ecological (transactional) dynamics rationale of expert performance (e.g., Davids, Araújo, Seifert, & Orth, 2015), practically illustrated by Bob Beamon's eminent performance.

An ecological dynamics perspective proposes that understanding any individual's performance requires an appreciation of the types of behaviors that a performer's environment *affords* (Gibson, 1979). In this way, the individual-environment system constitutes the base unit of analysis for understanding expertise in performance contexts like sports, work, science, education, and the performance arts. Ecological dynamics is informed partly by a dynamical systems approach to performance, which relies on mathematical concepts and tools of nonlinear dynamics to describe and interpret goal-directed behaviors (e.g., Turvey & Shaw, 1995). Goal-directed behaviors are understood as emergent states produced by self-organizing tendencies in a system (Kelso, 1995). Finally, and contrasting with ideas of Ericsson (2007), who is "interested in developing a science (that) should focus on athletes who can reproducibly match a given level of performance" (p.119), we argue that Beamon's jump is particularly well suited to exemplify expert performance precisely because of its exceptionality. This analysis of expert performance defies the explanatory power of most existing theories on expert performance. To emphasize our arguments, we look closely at information on Beamon's stand-out performance.

What Was So Exceptional in Beamon's 8.90-m Long Jump?

Bob Beamon caused an abrupt transition in the previously incremental progress that served as a hallmark for athletics world records (WR) (see Figure 1A.). The first official long jump WR was verified in 1901 and, until Beamon's jump in 1968, the most by which an existing long jump WR had been broken was 15 cm. He broke the existing WR by 55 cm. The long jump record had been broken or equaled 15 times between 1901 and 1968. Beamon's record lasted 23 years, until Mike Powell jumped 8.95 m, in 1991, the only regular recorded jump longer than Beamon's. After Powell, the best jumps of the year ranged between 8.35 m (the same mark as the 1965 world record that Beamon broke in 1968) and 8.74 m (see Figure 1B).

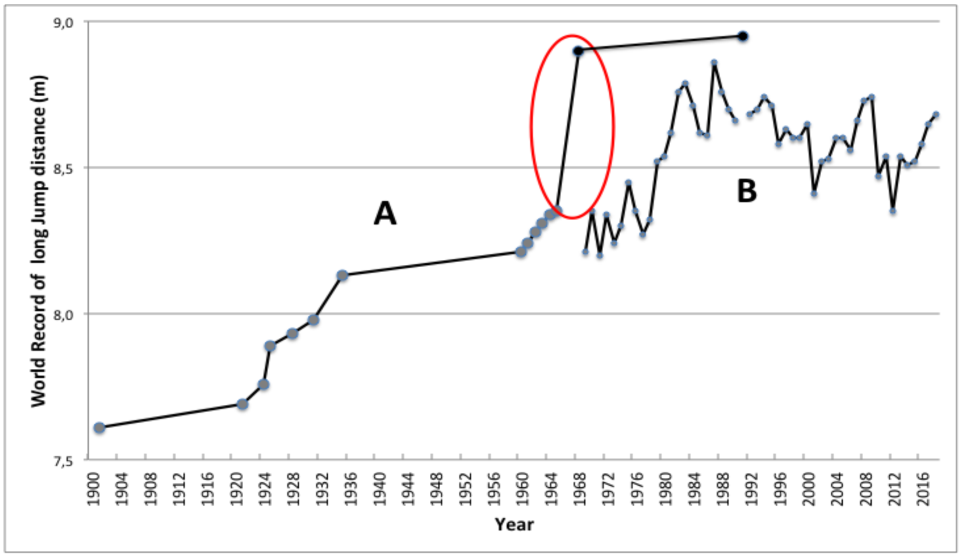

Figure 1. Official world records of long jump over time (A). Best mark of the year, 1968-1991, and after 1991 world record (B). The red ellipse signals the abrupt transition from previous world records to Beamon's 8.90 m jump in 1968. Data for A retrieved October 27, 2018, from https://en.wikipedia.org/wiki/Men%27s_long_jump_world_record_progression; data for B retrieved May 31, 2018, from https://www.iaaf.org/records/all-time-toplists/jumps/long-jump/outdoor/men/senior.

In the Olympic trial, Bob Beamon (age 22, 8.33 m as the best personal mark, with about 5 years of deliberate practice of long jump; previously he played basketball) joined Ralph Boston (age 29, 8.35 m as the best mark, world record co-holder at the time), Lynn Davies (age 26, former Olympic champion), and Ter-Ovanesyan (age 30, world record co-holder). The sportswriter Schaap labeled the competition "as a battle among four of the half-dozen greatest long jumpers in history" (Davis, 2015).

When the competition started, the three athletes who preceded Beamon missed their first attempt. Then Beamon jumped 8.90 m. He later said that his last thought (main intention) before hitting the board was "Don't foul." He also mentioned "my mind was blank during the jump. I was as surprised as anybody at the distance." Klaus Beer (age 26) was second (8.19 m), Ralph Boston third (8.16 m), Ter-Ovanesyan fourth (8.12 m), and Lynn Davies ninth (7.94 m).

The long jump was the first event of the afternoon program and the temperature was 23ºC. The wind speed on the track measured 2.0 m/s, the maximum allowed by the rules for setting official records. Mexico City is 2,250 m above sea level. At that altitude, it has been observed that the air is thinner, providing less air resistance. Mexico City is also further from the center of the Earth, and so gravitational forces are smaller. According to Allain (2012) these conditions can provide an advantage of up to 7 cm in every jump, compared to a corresponding jump under more typical ambient temperatures and pressure at sea level (see also Ward-Smith, 1986). Clearly, an explanation solely based on these physical environmental factors could not explain why Beamon's jump perturbed the perspective on long jump performance at that time, or the magnitude of the difference from previous world records. All the Olympic long jump finalists in 1968, including the two WR co-holders at the time, experienced the same environmental conditions, but only Beamon, and only once in his life, jumped so far. This perturbation to performance records is not unknown in long jumpers. For example, after Mike Powell broke the world record in 1991, his best regular jump was 8.70 m in 1993 (from 1992 to 2003 when he finished his athletic career, the mean value of his annual best recorded distances was 8.33 m).

During the qualifying stage Beamon followed the advice of Ralph Boston to take off well short of the board to ensure a clean jump. This advice was key for him to be in the final, because he missed his two previous qualifying attempts. The night before the final, Beamon had been concerned with personal problems. Shortly before his departure for Mexico City, he had lost his scholarship at Texas El-Paso University for participating, with other African American students, in a boycott of an athletics meeting against Brigham Young University, a Mormon institution whose racial policies disturbed them. He also was not getting along with his young wife. "Everything was wrong," he said. "So I went into town and had a shot of tequila. Man, did I feel loose" (R. Beamon & M. W. Beamon, 1999). Clearly, this background information helps us understand both the cognitions and emotions of the performer (self-regulating in an Olympic final), as well as the state of the environment, in seeking to explain the emergence of this performance outcome.

The Base Unit of Analysis for Explaining Expertise: The Performer-Environment System

In ecological dynamics, expert performance in sport is revealed by solutions that emerge from self-organizing system components to satisfy the unique set of constraints interacting upon an individual performer at that moment in time (Araújo et al., 2017) . Due to these continuous interactions, explanations of expertise, based solely on either personal (e.g., genes, mental structures, or psychological processes) or environmental constraints (e.g., physical conditions or amount of practice undertaken), are fundamentally limited (Davids & Baker, 2007; Hambrick, Macnamara, Campitelli, Ullén, & Mosing, 2016).

This is not a trivial point in the commercial world. With respect to environmental constraints, there have been recent warnings of the dangers of being overwhelmed by what has been termed "process industry training"

(Renshaw et al., in press). Over the past 10 years, different types of process training programs, predicated on the role of environmental constraints, such as cognitive training (including meta-cognitive training with video games), brain training, perceptual training, attention training (including Quiet Eye training), or mind training, has boomed, both as a research topic and as a commercial product. Referenced more generally by Harris, Wilson, and Vines (2018), "The overall cognitive training (CT) and assessment market is currently worth $1.98 billion (US) and set to rise to over $8 billion by 2021 (marketsandmarkets.com, 2017)." (p. 2). They continued by arguing that "Commercial CT devices are highly appealing for athletes and coaches due to their ease of use and eye-catching marketing claims. The extent to which this training transfers to performance in the sporting arena is, however, unclear." (p. 1).

These environmentally-biased, process-training programs are also supported by commercial interests in the form of popular science books which have not been subject to the rigorous peer-review process that academic literature has to undergo. Large swaths of the digital and conventional media provide broad support for the sometimes spurious claims of the process-training industry. For example, Moreau, Macnamara, & Hambrick (2018) have pointed out: "Thousands of scientific articles have been published on these topics, which have also captured the popular imagination through books such as *Smarter: The new science of building brain power* (Hurley, 2014), *Mindset: The new psychology of success* (Dweck, 2006), *Grit: The power of passion and perseverance* (Duckworth, 2016), and *Peak: The new science of expertise* (Ericsson & Pool, 2017)." (pp. 4-5). They went on to note, "Some of these areas of research have also spawned lucrative commercial ventures. Brain training is a multibillion-dollar industry, and commercial mindset interventions are used in schools around the world." (p. 5). Their key message resonated with our warnings against accepting an environment bias; i.e., that process-training programs must be aware of the dangers of "overemphasizing the malleability of abilities and other traits" (Moreau, 2018).

In addition, this explanation does not in any way endorse the view that hereditary, genetic constraints are the dominant characteristic in expert performance. This is important, given that several existing theoretical approaches are dominated by biases towards organismic characteristics. Some theories assume that, for expertise development, the environment enriches internal traits or dispositions that incur relatively permanent changes in an individual's capabilities (e.g., Gagné, 2015). According to this view, the aim of practice is to increase the strength of relevant performance characteristics possessed by an individual. Therefore, research is needed to understand what has been acquired through practice to change an individual's internal state (e.g., Ericsson, Nandogopal, &: Roring, 2009), or what transformations have occurred to internal entities (e.g., Gagné, 2015). For example, Ericsson's theory of exceptional performance (e.g., Ericsson et al., 2009) attempts to locate constructs that distinguish experts (e.g., deliberate practice forms specific mental representations, long-term working memory structures), especially in the minds of those individuals. These theories seek to differentiate skilled individuals from unskilled by identifying specific traits exploited during learning. Accordingly, expertise, knowledge, and skill are viewed as entities possessed by expert individuals. Learning results in the acquisition of an enhanced trait, or the increased sophistication of mental structures (or knowledge). It has been argued (e.g., Dunwoody, 2006) that contemporary behavioral science, with its emphasis on acquisition of enriched internal "traits," has developed an *organismic asymmetry* in its approach to understanding human behavior. In this view the environment is simply characterized as a backdrop to the demonstration of expertise (not as part of the explanation). This biased theoretical stance has dominated psychology and sport science and is founded on separation of the performer from the performance context. It logically detaches content from context—and *abilities* from *situations*—in which expert performance occurs (Araújo & Davids, 2011).

Therefore, it is not surprising that several research programs based on this type of contemporary theorizing claim to have identified constructs within specific individuals that distinguish experts from non-experts (e.g., based on genes, gifts, talents, see Hambrick et al., 2016, for a review). This dualistic view of dominant intrinsic characteristics and environmental influences encourages conceptual divisions. The result is intractable problems which emerge under careful consideration about how internal "properties" of experts become connected to the environment (Turvey & Shaw, 1995). For example, where are such internal constructs located in expert nervous systems (talents, mental representations, traits, and dispositions) and how did they originate? How do environment-individual interactions occur that explain those traits? How can such environment-individual interactions that form traits be tested? Put simply, environmental tasks where internal "traits" are expressed tend to be excluded from an explanation of expertise, or in some cases interpreted with a task description that is not commensurate with measured internal variables (Hoffman, Ward, Feltovich, DiBello, Fiore, & Andrews, 2014).

The previous section highlighted a configuration of performer, environment, and task constraints that interacted to make Bob Beamon's expert performance possible. How can an explanation of expert performance in sport (exemplified here by long jumping) simultaneously entail constraints related to the performer and the environment? To performance analysts in athletics, Beamon was a slim, long-legged athlete with an inconsistent technique (Davis, 2015). This means that on some occasions his technique facilitated good performances, and in others it did not. The influence of altitude, weather conditions, his weight/strength ratio, his psychological state due to agitation the night before, the intense competition with the other high-level athletes in competition, the fast runway of Olympic Stadium, and his past variable sport practice experiences may have all coalesced to support his performance at that single moment. All these constraints may have influenced his actions to self-organize in a performance that cannot be explained by referring to any single component of performance individually. Self-organization can be identified in a system (here the performer-environment system in sport) by capturing certain properties (e.g., multi-stability, hysteresis; see Kelso, 1995). These properties do not exist in the components alone but emerge spontaneously from person-environment interactions.

The key message here is that self-organization does not signify the effects of a sum of weights of different correlated variables. Rather self-organization tendencies can result in an emergent system solution that is richer and more functional than the sum of the parts. When a system establishes a state (i.e., Beamon performing the long jump task in the Olympic Stadium) as a result of the dynamical interactions among several interacting system components, self-organization tendencies causally facilitate such a state. Behaviors that emerge may be temporarily assembled and are different from the elemental components that make up the system. In this way, human performance can be understood as an expression of self-organizing tendencies under constraints, rather than organization exclusively imposed from the inside (e.g., feelings, speed, technique, intentions) or the outside (e.g., the altitude, fast runway, competitive pressure).

But how do the many interacting components of such systems exploit self-organization tendencies? It seems that the answer lies in the surrounding patterns of stimulus energy (which provides information for action, see below) in an environment (i.e., information in Gibson's [1979] sense) that pressure a complex system to change, resulting in the spontaneous emergence of distinctive patterns (behavior) between system components (Davids, Araújo, Hristovski, Passos, & Chow, 2012). The role of adaptive capacities and self-organizing tendencies is reflected in the variety of behaviors that individuals can exploit during performance—and their ability to vary those behaviors from trial to trial to achieve superior performance outcomes (see Davids et al., 2015). Adaptive movement variability provides the capacity of individuals to achieve high performance outcomes under perturbations within dynamic performance environments (e.g., successfully hit the take-off board during a run-up in varied environmental conditions).

The scale of adaptation to constraints is intentionally regulated by performers, depending on the nature of dynamic performance environments (Araújo, Davids, & Hristovski, 2006). For example, in soccer, performers may intentionally constrain their actions, depending on available affordances in a performance context, to shoot, dribble, or pass the ball. During performance there are variants of each action that emerge during sub-phases of play, constrained by co-positioning and movements of teammates and opponents, weather conditions, field surface, properties of the ball, current score of the match, team strategies, and tactics (Davids, Güllich Araüjo, & Shuttleworth, 2017).

In contrast, in performance of self-paced timing tasks without direct opponent interactions, such as climbing or long jumping, task performance is more stable, and there are only a small—but influential—number of variations in conditions of the performance environment. In long jumping, these variations include properties of the track, board, air resistance (altitude), and weather conditions such as ambient temperature, and wind velocity and direction (Scott, Li, & Davids, 1997; Greenwood, Davids, & Renshaw, 2013; McClosker et al., in press). When running to place the foot on a target, an athlete's kinematics and kinetics of locomotion vary in each attempt, and indeed from stride to stride (captured in variables like speed, stride lengths, lower limb joint angles, and dynamics) (Renshaw & Davids, 2006).

Moreover, this approach can expand our understanding of phenomena in performance of activities such as music or chess (for an ecological theory applied to chess, see Vicente & Wang, 1998). Our argument is that performance solutions implicate constitutive causation provided by self-organization and emergence among influencing factors. These influencing factors are both internal *and* external to the performer. For example, van Harreveld, Wagenmakers, & van der Maas (2007), showed that skill differences between chess players become less predictive of competitive outcomes as time pressure increases. Also, Gobet and Simon (1996) compared the performance of the grandmaster Garry Kasparov under normal tournament circumstances to his performance when Kasparov was playing a *simul* (i.e., playing several players at the same time) and the time to contemplate his moves was restricted. Gobet and Simon (1996) showed that Kasparov's chess rating (a numerical measure of skill) drops from 2,750 to 2,646 when he has to play faster. Calderwood, Klein, and Crandall (1988) asked grandmasters to rate the quality of moves made in fast (*blitz*) and slow games. Their results showed that greater time pressure decreased the quality of play. Moreover, Chabris and Hearst (2003) have shown that even grandmasters make more and bigger mistakes under conditions where they have less time than usual to select their moves. Clearly, environmental time pressure and task type influence the performance context in meaningful ways and must be taken into account in an explanation of expert performance in chess.

Regarding more tragic anecdotal evidence, during the 41st Chess Olympiad in Tromsø, Norway, 2014, Kurt Meier, a Swiss-born member of the Seychelles team, collapsed during his final match of the chess marathon two-week contest. Hours later, a player from Uzbekistan was found dead in his hotel room in central Tromsø. This Olympiad involved 1,800 competitors from 174 countries, accompanied by more than 1,000 coaches, delegates and fans. The event sees players compete in national teams over 11 rounds, often playing matches that last for up to six hours, and claims a worldwide online audience of tens of millions (Addley, 2014). While the two men's deaths were attributed to cardiovascular causes, they raise questions about the mental and physical stress that tournaments place on players. Meier is not the first player to die in the middle of a chess match, in a tournament environment. In 2000, Vladimir Bagirov, a Latvian grandmaster, had a fatal heart attack during a tournament in Finland, while in the same year, another Latvian, Aivars Gipslis, while playing in Berlin, suffered a stroke from which he later died. One of Australia's leading players, Ian Rogers, retired abruptly from chess in 2007, saying he had been warned by his doctors that the stress of top-level competition was causing him serious health problems. The tournament environment is characterized by uncertainty and intense competition, coinciding with the high levels of motivation to succeed that competitors have. Potentially stressful tasks, such as those in which expert performance has been studied, tend to be ones where competitive performance is public and feedback (and consequent judgments by the audience) is immediate (Murphy, 2012). In short, an ecological dynamics approach to expert performance is a promising avenue to conceptualize how a number of interacting constraints—personal (e.g., age), task (e.g., competitive chess) and environmental (e.g., intense coverage in the media)—interact to shape behaviors in every performance domain, not just in the sports that get the most media attention.

Expert Performance Explained by the Ecological Dynamics Approach

Ecological dynamics emphasizes the laws and symmetry conditions at nature's ecological scale, implying the detection of environmental information that is used to guide behaviors. Gibson (1979) attempted to identify the relationship between the structured energy distributions of the environment available to a performer's perceptual systems and the environmental properties causally responsible for that structure. This conceptualization of the ecophysical basis of performance behaviors underpins the regulation of actions and should not be viewed as some sort of "New Age" interpretation of mystical energy sources available in the environment. Information for action, in Gibson's sense, underpins human behaviors which can be explained with reference to the laws of physics and the evolution of perceptual systems designed to detect and utilize available energy sources as information to guide human behaviors.

For example, optical energy, in the form of light. is reflected from surrounding objects, slanted and textured surfaces, and features of the environment. Light is reflected in straight lines and exists in highly structured energy distributions called an optical array (Gibson, 1979). Similarly, acoustic energy provides sound as vibrations that propagate an audible pressure wave, which can help humans locate the presence of an approaching object. Gibson (1979) argued that there are properties from the surrounding energy flows, which remain constantly available for detection, despite transformations associated with movement of observers and the environment; i.e., they are invariants. Despite the continuous changes to energy distributions surrounding a performer, invariants provide information about the environment. The key point concerns the relationship between an individual and a performance environment, according to Gibson (1979). He proposed that the optic energy array detected by the observer offers information for visually regulating actions. Available information sources allow a performer to directly and unambiguously perceive the layout and properties of objects, events, and features within a performance environment. The patterned energy distribution in the environment informs an actor about its relevant properties that can support action. In research on the event of long jumping, previous studies have attempted to identify these information sources available energy distributions. These studies have suggested how optical information from objects located near the take-off board (Greenwood, Davids & Renshaw, 2014), as well as light reflected from the take-off board itself (e.g., Scott, Li & Davids, 1997; De Rugy et al., 2002; Renshaw & Davids, 2006), can help skilled jumpers regulate their gait during the approach phase.

For Gibson, the process of detecting information from the surrounding energy arrays is carried out by a functional system distributed throughout an active performer. Expertise in perceiving key perceptual variables that can regulate actions emerges as a result of extensive periods of practice and training in specific performance environments (Davids, Güllich, Araújo & Shuttleworth, 2017). Skilled adjustments of peripheral organs, such as turning the eyes and head at the right moment to regulate the locomotion system, play as significant a role in direct perception. In Gibson's (1979) theory, perception of the environment is not inferred, nor interpreted/construed as internalized activity of the brain and the nervous system. Rather perception of information from surrounding energy arrays is directly perceived and coupled to actions. This description of the environment is not achieved in individual-neutral physical terms (e.g., mass, length, time), but in functional (goal-related) terms (e.g., Araújo et al., 2014).

Another major idea from Gibson (1979) was that the environment is perceived in behavioral terms (i.e., affordances) which are defined as possibilities for action offered by the environment. His ideas imply that performers perceive objects, surfaces, other athletes, or events by what they offer or demand in terms of action opportunities. Affordances are properties of performer-environment systems that can be exploited in patterns of stimulus energy (information) and that can, therefore, be directly perceived (i.e., not mentally mediated). Affordances are goal relevant descriptions of the environment, and perceiving an affordance is to perceive how one can act in a particular set of performance conditions.

Perceiving an affordance includes detecting information about the environment, and also the action capabilities (capacities or skills) that attune performers to some affordances and not to others. The concept of affordances cuts across the incompatible objective-subjective divide (Heft, 2013), and is located at the athlete-environment system (transactional) level. For example, in long jumping, the eyes of a jumper can detect the light reflected off surrounding objects and surfaces—the take-off board, the pit, a windsock placed near the jumping area—providing each performer with information for regulating functional actions during the run-up and jump phases of performance, as can be captured by (Greenwood et al. 2013). The rate of dilation of an image of an approaching object on an individual's eye can provide time-to-interception information (placing the foot in the take-off board), mathematically modelled as Tau, without the need to mentally compute either distance or speed of the object to intercept it (Lee, Lishman, & Thomson, 1982).

According to Gibson (1979) one's actions guide the detection of information for further adjustments of behavior. The cyclical relationship between action and perception implies that information presented in a sport task (e.g., gaps, distances, angles, obstacles, target sizes, equipment) will be used to regulate an athlete's performance behaviors (see Harrison, Turvey, & Frank, 2016, for modeling). From this viewpoint, expertise is not defined by an athlete's fixed set of genetic or acquired components, but rather by a dynamically varying relationship captured by the constraints imposed by the task experienced, the physical and social environment, and the personal characteristics of a performer (Araújo & Davids, 2011).

Conclusion

Expertise viewed as a more functional *relationship* of an individual with a performance environment is distinct from theories which emphasize the repetition of a particular movement pattern or coordination mode through constant practice (Ericsson et al., 2009). It recognizes the need for each individual learner to adapt to, and satisfy, the unique array of interaction constraints impinging on the learner at a specific moment. Expert performers are able constantly, and subtly, to re-invent themselves as key constraints change (Davids et al., 2015). Due to inherent nonlinearities in complex adaptive systems, the amount of time needed to achieve an individual's potential cannot be precisely specified; e.g., due to 10,000 hours of deliberate practice (Phillip, Davids, Renshaw, & Portus, 2010; Macnamara et al., 2016). An individual's potential is not static, but rather is dynamic, and continuously open to ongoing influences of task, individual and environmental constraints; e.g., genes, motivation, practice, and availability of facilities and coaching support (Davids, et al., 2015)

For example, the idea of (deliberate) practice as an influence of the environment concerned how context enriches the performers' abilities (e.g., Ericsson et al, 2009). This approach contrasts with the explanation that individuals and contexts co-determine each other through ecological practice (Davids et al., 2015). Both individual and environment—physical or social—have the potential to be affected and transformed by these interactions. In ecological dynamics, experts are not an agglomerate of physical or mental traits, but active individuals engaged in ongoing dynamical transactions with their functionally defined environments. Expertise is not a possession acquired by an individual, nor a fixed property of a performer, but rather a dynamically varying relationship captured by the constraints of the environment and those of the performer of a task (Araújo & Davids, 2011).

Ecological dynamics emphasizes understanding of the transaction between *affordances* (opportunities for action) and skills, i.e., how performers become *attuned* to perceive key variables that specify goal achievement. Through exploratory, varied actions in specific contexts, perceptual systems become progressively attuned to some affordances and not to others (Vicente & Wang, 1998). The variables detected become more subtle, elaborate, and precise with task-specific experience and are successfully coupled to actions (for an ecological dynamics explanation of learning, see Davids et al., 2012).

Key constraints on the performance of expert long jumpers like Bob Beamon, such as technique, altitude, weather conditions, psychological and emotional states, peer competition, the fast runway of Olympic Stadium, and varied sport experiences, may have all converged to support performance at a single moment in time. Ecologically constrained self-organization tendencies have the power to explain emergent performances such as Bob Beamon's jump, which caused an abrupt transition in long jump. This explanation implies how more outstanding achievements and outcomes in sport may emerge as constraints converging to shape performances destined to be remembered for a lifetime. In short, what makes one individual's performance more expert than another is not some possessed ability, but its contextualized functional value during goal-directed behavior.

Authors' Declarations

The authors declare that there are no personal or financial conflicts of interest regarding the research in this article.

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