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COGNITION AND ACTION: AN ECOLOGICAL PERSPECTIVE IN SPORT

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ABSTRACT

The ecological approach that has come to be used in recent years to frame the learning and performance of sports skills, contrasts with the explanatory models of motor control that traditionally attach great importance to the mental representations of movement. In this sense, this work frames the ecological vision of cognition in sport in a comprehensive perspective, describing the athlete as a whole and not just what is happening inside his "head". We conclude that the emergent action in sports context results primarily from the interaction that the athlete establishes with the environment, therefore it is not necessary to use cognitive processes designed to succeed in the task. In this context, we propose to coaches that they should explore the functional aspects that underlie the manipulation of individual, environmental and task constraints, thus allowing their athletes to autonomously discover motor solutions and find relevant information-action couplings by themselves.

Key Words: cognition, action, ecological dynamics, environment, athlete

RESUMEN

El enfoque ecológico que ha sido empleado en los últimos años para explicar el aprendizaje y el rendimiento de las habilidades deportivas, contrastando con los modelos explicativos del Control del Motor más tradicionales, que atribuyen gran importancia a las representaciones mentales del movimiento. En este sentido, el presente trabajo se encuadra en la perspectiva ecológica del deporte desde la perspectiva holística, describiendo el comportamiento motor del deportista en su conjunto y no sólo a partir de lo que está sucediendo dentro de su cerebro. Se ha llegado a la conclusión de que la acción emergente en el contexto deportivo resulta esencialmente de la interacción que el deportista establece con el ambiente, no siendo así necesario recurrir a procesos cognitivos elaborados para tener éxito en la tarea. Desde esta perspectiva, proponemos a los entrenadores que exploren los aspectos funcionales que subyacen a la manipulación de las limitaciones o condicionantes individuales, ambientales y de la tarea, permitiendo así a sus deportistas descubrir de forma autónoma soluciones motoras y encontrar por sí mismos las adaptaciones de información-acción más relevantes para el rendimiento motor.

Palabras clave: cognición, acción, dinámica ecológica, ambiente, deportista

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INTRODUCTION

Ecology in competition is essential to understand how the human movement systems work, as it permits analysing athletes with their own traits, as well as the types of tasks/sports they carry out in direct interaction with the environment (Araújo, 2006). Therefore, the more traditional explanatory models of motor control, which describe the athlete as an information processing machine (Adams, 1971; Schmidt, 1975),who frequently uses the selection of motor programmes housed within the central nervous system to frame the execution of sports movements, do not explain how practitioners self-organise their performance in different contexts (Oliveira y Oudejans, 2005; Stepp et al., 2011).

In contrast to the above, Ecological Psychology (Gibson, 1966, 1979) establishes that the structure and physics of the environment, the biomechanics of the body of each athlete, the perceptual information about the information variables and specific requirements of the task, limit behaviour (Araújo et al., 2007). In this perspective, Gibson (1979) sustains that the theories of indirect perception are ambiguous insofar as people can directly perceive significant properties of the environment without having to use internal mediators.

Based on Gibson's contributions (1979), it is sustained that perception regulates action with respect to the information available in the environment. From this standpoint, task limitations that are representative of the context are crucial for the athlete to succeed in the sporting context, as they help understand how the latter perceives the circumstances of the performance environment (invariable) scaled up with respect to his body and action capacities (Araújo et al., 2009).

Athletes can also solve motor problems imposed by sporting tasks through the environment. For example, for an expert golfer to execute the put on the green he manages to easily identify the characteristics of the influence of the turf (e.g., its state and the slopes on the green), thus using his perception of the surroundings to execute the action (Dias et al., 2013; Pelz, 2000). The same occurs with sailing experts, who manage to perceive changes in the wind and maritime currents, and thus, depending on the reading of these environmental limitations, can obtain an advantage over their competitors (Araújo et al., 2005). This perspective also exists in the first serve in tennis, when a player has to analyse the intensity and changes in wind in order to place the ball with maximum precision in the opponent's court, thus taking advantage of this environmental factor to succeed in the task (Mendes et al., 2011).

The context of team sports is also rich in contextual information that can be directly taken from the environment. For example, a professional football player, who, apart from taking into account the opponents' actions during the match, manages to attune his performance and play in different fields, as well as face different atmospheric conditions (e.g., cold, wind and rain), managing to detach himself from the pressure of the public in the stadium (Davids et al., 2008). In addition to this series of environmental constraints or conditioning factors inherent to the situational and task characteristics, there are other organicist limitations that may influence performance, such as the players' morphological (e.g., weight, height and constitution) and functional (e.g., motivation and fatigue) characteristics - (Newell, 1986).

Unlike other sports that are practiced indoors, one thing that sports such as golf, sailing and football have in common is that athletes are trained to autonomously achieve favourable solutions directly in the environment. In other words, they do not resort to mental representations of movement. This type of contextual information is fundamental for the athletes' performance and it may be decisive in their options and their decision-making (Davids et al., 2008). Considering these arguments, we are going to study these four sports in greater depth to have a better understanding of cognition in the action that is not inside the athlete's "head". Thus, underpinned by the theoretic assumptions of the ecological approach (Araújo 2006; Gibson, 1966, 1979), an analysis will be made of the athletes' performance that emerges in these sports as a whole, based on the interaction with the medium, and not just based on the start-up of motor programmes stored at a central level.

Perception and action in golf putting

The factors covered by competition ecology permit understanding the performance of golfers, bearing in mind that, in general, these athletes are exposed to known, but variable, environmental stimuli (Dias et al., 2013; Pelz, 2000). Based on these principles, golfers are not expected to be able to store all the competition information in their heads, but rather, they need to detect and use this information through the environment. Considering the previous assumptions, it is urgent to understand the skills that golfers (novel and expert) have in order to face up to the vicissitudes of training and competition, above all, when they have mostly environmental information to overcome the challenges imposed by the task (Hammond & Stewart, 2001; Shaw, 2001).

Golf is a sport in which environmental conditions can be crucial for the success of the match. Based on this, one movement in particular, - the put -, which consists in a short stroke that is made on the green (e.g., short turf), depends a great deal on the environmental conditions (e.g., rain, snow, wind, morning dew) and on the state of the grass (e.g., short, high, badly looked after and crushed by the spikes of the players' shoes). These aspects may significantly contribute to altering the speed and trajectory of the ball on the green before it reaches the hole (Pelz, 2000). On the other hand, the complexity of the motor execution of this movement may affect how the player "reads" the green and how his performance constantly adapts to the environmental conditions of different golf courses (Dias et al., 2010, 2011).

On the other hand, expert golfers can interact with the medium and draw affordances from participation. For example, after the putting stick hits the ball, players with a low handicap have a perception of whether it is going to enter the hole or not before it even reaches it. This is something that requires great perceptive adjustment by the golfer with respect to the environmental context where the performance occurs (Gibson, 1979; Pelz, 2000). This "reading" of the action can be carried out on the green through routines and "rituals" that allow players to decide if to increase or decrease the power, speed and amplitude of the path of the putting stick to hit the ball. However, this does not mean that the player has to encode, search or programme all these variable movements when striking the ball, as performance in action is something that occurs directly (Dias et al., 2013; Pelz, 2000).

Given this "direct perception" of the medium, players can become actively attuned in order to capture the invariants of their participation and manage to acquire the most relevant properties to carry out the action (Araujo & Carvalho, 2007; Gibson, 1966, 1979). In this regard, Pelz (2000) shows that the green contains practically all the information players need to succeed in the task, so they must learn to "read" their action possibilities in different environmental contexts. Along this line of thought, Pelz (2000) leads us to the hypothesis that it is not the brain that is responsible for controlling the movement of the putting stick, but rather, the combination of several environmental factors that help improve the golfer's performance. The same author states that the mind barely leads the body to believe that a good put can be made, placing emphasis on the fact that not even the best trained memory could, on its own, control the environmental conditions and the characteristics of the green.

Ecological approach in the Tennis serve

Training in tennis has been traditionally dominated by the reductionist and mechanist perspective of the player and of the game (Crespo, 2009). This traditional methodology does not respond to the demands that characterise the time dynamics, and dynamical and ecological interception skills that are typical of this modality (Farrow & Reid, 2010). In this regard, Araújo et al. (2004) estimated that the action is not pre-programmed, insofar as it is the game situation that guides it, thus providing the tennis player with the possibility of actively exploring the affordances that are present in the environment (Gibson, 1979). This ecological dynamics of the action permits understanding how the player perceives to act, and also how he acts to perceive (Araújo, 2006). In other words, the context guides the information so that the athlete can understand how to control his performance (Araújo y Carvalho, 2007).

Recently, in order to promote a non-linear pedagogy together with the coaches (Davids et al., 2010), the International Tennis Federation started up the Play and Stay programme. The main objective of this programme was to encourage coaches to teach/coach based on the game, leaving linear approaches, based solely on technique, in a second plane (Farrow & Reid, 2010). In essence, the aim was to create a positive commitment to practice, adapting the dimensions of the court, racket and ball to the anthropometric characteristics of the child (body-scaled). The above was carried out with the aim of safeguarding the functional adaptation of each practitioner, considering the singularity of their motor behaviour. Bearing these elements in mind, the coach can "tune in" his training methodology so that the athlete can lead the action in the game context, providing him with representative exercises and conditioning him to choose solutions that will enable him to reach the objective (Araújo & Carvalho 2007).

Transferring this vision to the specific case of the tennis serve, the coach is also conditioned by mechanical consistency (Reid et al., 2010) as well as by training precision and power, with little margin for variability in the practice conditions (Mendes et al., 2011). However, expert players, rather than managing information in their superior processing centres, try to use visual search strategies that will enable them to find the best solutions (Elliott et al., 2009; Moreno, Reina, Sanz & Ávila, 2002; Reina, Moreno & Sanz, 2007). Thus, the actions depend on the environment and on the flow of interactions that the practitioner establishes with the opponent. Consequently, the player's actions spontaneously adapt to the game situation, and not only due to the mental representations that he processes regarding the task that he is carrying out (Gibson, 1979; Carvalho y Araujo, 2007).

Although this is the skill that depends the most on the player, the serve, compared with other actions in tennis, is influenced by different types of extrinsic factors throughout a match, and very especially by environmental factors such as the wind and the opponent's action (Mendes et al., 2011). In the study carried out by Mendes et al. (2013) with 12 expert players who had to hit a first flat serve under the effect of "artificial side wind", an adaptive process was verified in the throw of the ball, the stabilisation of the vertical axis compensated by greater variability in the horizontal axis, and especially, in the side axis. Along that same line, Menayo et al (2012), in a study where they analysed motor variability and its relationship with performance in the tennis serve with 17 advanced players, found a negative relationship between the amount of variability produced in the kinematics of the gesture, and the precision and ball speed reached. At the same time, they determined the existence of positive and significant correlations between some kinematic variables and sample entropy (SampEn) obtained from the position, speed and linear acceleration of the hand holding the racket during the gesture. These results show the need to understand the motor behaviour of the serving tennis player, within a non-linear dynamic process, characterised by variability processes and determinism, during which the neuromotor system introduces stochastic fluctuations that alter the quantity of variability inherent to the movement and its own structure. This will provide a constant sampling of different movement patterns, so the player can select the most adequate pattern (Van Emmerik & Van Wegen, 2000). Thus, the coach should move away from mechanist training models for this and other typical tennis strokes, and focus, with the learner, on interaction processes with all the game elements, in order to guide him to overcome and adapt to the conditioning factors that will lead him to higher performance rates.

Considering the above, the biological noise and variability present in movement, and that result from the interaction of internal parameters (e.g., morphological characteristics, players' techniques, degree of fatigue, etc.) and external factors (e.g., side wind, opponent's action and presence of the public, among others) convert the execution of the tennis serve into something singular and unique for each practitioner (Davids et al., 2003). This is not something that depends exclusively on mental representations that are stored in the tennis player's memory but, more likely, on his ability to adapt to the medium, to the limitations or conditioning factors, and to the characteristics of the task (Davids et al., 2008.).

Ecological dynamics in Sailing

Sailing is a water sport in which the technical and tactical actions are based on analysing the environmental conditions (e.g., wind intensity and direction, state of the sea), and the actions of the adversaries (Rocha et al., 2005). Bearing these arguments in mind, the sailing practitioner tries to select the contextual information available in the environment (Araujo et al., 2005). The environmental conditions that surround the sport of sailing are very important in the athletes' performance, and they are also essential in the discrimination of visual signs and in perceptive adjustment. Here, the affordances are offered to the racer by the atmosphere. These properties indicate invariants that are available in the relationship between the practitioner and the context, which are essential to guide the athlete's performance throughout the development of the task (Araujo et al., 2004).

In this sense, Manzanares, Segado & Menayo (2012) conclude in their study review on sailing that, apart from the factors related to the racer's physical and physiological characteristics, there are other factors that determine performance in this sport. These are the capacity to perceive stimuli and decision-making, which should also be considered in order to analyse this sport in terms of an ecological approach. Thus, in a study on the visual behaviour of 20 racers in a sailing simulator, Manzanares et al. (2013) found that the most experienced racers did not use a visual pattern that followed an order with respect to the stimuli present in the race course. Instead, they developed more unpredictable visual search patterns, which became more adaptive to the changes in the environmental conditions. This visual behaviour confirms the importance of the perception of affordances during sailing. The more functional the visual perception process is, the more intervention possibilities the racers have with respect to the actions that may occur. Racers who use sight in a more exploratory manner, have greater capacity to perceive the affordances offered by the surroundings (Fajen, Riley & Turvey, 2009). In this sense, an increase in functionality of the use of the visual system by experienced racers shows greater capacity to adapt to the information constraints related to the task of handling the vessel.

The factors inherent to the ecology of competition are equally important to understand the performance of sailing practitioners (Warren, 2006). For example, in each race, the racer has to identify the best side to start, and also establish the best side of the race course. Based on these principles, it is predictable that the athletes will not manage to store all the information of the competition in their heads. Instead, they need to detect and use the information in the surroundings (Araújo, 2006). Therefore, on doing away with mental representations in the execution of movements, we understand that the great challenge of sailing involves discovering the skills the practitioner has in order to adapt to the vicissitudes of training and of competition.

The ecological perspective of football

Football is characterised by the demand on practitioners to have a high perceptive capacity that allows them to cope with the unpredictability and randomness of the actions (Araújo et al., 2009). Considering the importance of this contextual information that characterises ball sports, prefabricated actions and decisions rarely occur as mentally represented. Consequently, the aim of exploring the context of a football match, which has great variability, is to achieve the team's objective, namely, to put the rival team off balance, and above all, score more goals than the other team (Costa et al., 2002; Cuello & Silva, 2000).

Furthermore, we confirm through the ecological approach (Gibson, 1979), that exploring the medium and detecting the action possibilities are exclusive for each athlete. For example, in football, a forward with the ball in front of an opponent, will try to discover the best solution to get passed him. This means that, more than trying to memorise and execute a preconceived "ideal" technical or tactical model, the player must focus on functional relations with the surroundings that enable him to effectively reach the foreseen objective (Araújo et al., 2004). From this perspective, the information that allows each player to decide and act is available in the resulting relationship from the interaction between the practitioner and the medium. Therefore, the problems faced by each player occur as a result of their interaction with the surroundings, which, on many occasions, is unpredictable (Passos et al., 2008).

Practical implications

This work establishes that the contextual information is available in the surroundings and that athletes detect and use this information to direct their motor behaviour towards achieving the objective in the action. Thus, they do not need to store all the information in their memory to succeed during training or in competition (Araújo, 2006). As expressed by Gibson (1979), people have direct access to the environment, that is, the information is "public", so it is not compulsory to resort to internal mediators and to mental representations in order to act.

Likewise, this work shows that actions are immersed in specific performance contexts, where the action cannot be considered as a "thing", but as a direct relationship between the athlete and the context (Araújo et al., 2004). Thus, athletes must train and adapt to the enormous variability of actions that the context provides, as their evolution will be more effective if they experience problematic situations in training that will also appear during competition. That is why we consider that the training process must be urgently guided so that athletes can directly and independently solve the situations that await them in competition (Davids et al., 2008).

To better detect the information needed to achieve the objective of the task, it is also important for athletes to make a good adjustment in their perceptive systems. Namely, the athlete's training can focus on functional relations with the environment that will allow him to effectively reach the objective. Thus, it is not advisable to train stereotyped behaviours that may arise from a markedly analytical and fractioned training process. Consequently, training must favour training players to achieve autonomy in the resource of *know-how*, where the main objective is to solve problems derived from their participation in the task (Araújo, 2010).

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