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Embodied Cognition influence Sport Performance: a brief review

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Abstract

Concentrarsi su come il proprio corpo influenza la propria percezione rappresenta un tema centrale dell'embodied cognition. L'idea inizia con il riconoscimento che attraverso la pratica continua, i corpi degli atleti diventano più abili nell'eseguire determinate abilità. A loro volta, il cervello di questi atleti, e in particolare i loro neuroni specchio, si sintonizza per riconoscere azioni di un tipo particolare. Questa messa a punto consente agli atleti di percepire i movimenti, o modelli di movimento, che rimangono invisibili ai novizi.
Questo accoppiamento tra prestazioni atletiche e percezione ha implicazioni anche per la psicologia dello sport. Gli psicologi dello sport hanno notato l'importanza di queste idee per comprendere le prestazioni atletiche, contribuendo così ad espandere e sviluppare programmi di ricerca nell'ambito dell'embodied cognition.

Focusing on how one's own body influences one's perception is a central theme of embodied cognition. The idea begins with the recognition that through extensive practice, the bodies of athletes become more skilled at performing certain skills. In turn, the brains of these athletes, and in particular their mirror neurons, tune in to recognize actions of a particular type. This setup allows athletes to perceive movements, or movement patterns, that remain invisible to novices.
This coupling between athletic performance and perception has implications for the psychology of sport. Sports psychologists have noted the importance of these ideas in their efforts to understand athletic performance, thus helping to expand and develop research programs in the field of embodied cognition.

Keywords

Embodied Cognition; Sport Performance; Psychology of Sport

Embodied Cognition; Performance Sportive: Psicologia dello Sport

1. More frequent themes preset in the embodied cognition

At today as "embodied cognition" is a research program comprising an array of methods from diverse theoretical fields including philosophy, neuroscience, psychology and more. Perhaps, "Embodied Cognition" is best understood as a label for a diverse research program that spans work across the cognitive spectrum, including memory (1), perception (2), language (3), and emotion (4,5). Additionally, it takes as its subject matter not just human beings, but simple organisms such as crickets (6), simulated agents (7), and robots (8).

Knowing that over the centuries a close link has been established between mind and body, a natural question arises if embodied cognition is able to describe a new or novel connections between mind and body.

Various "themes" appear repeatedly in the various areas investigating cognition researchers: conceptualization, constitution, replacement.

Conceptualization

Research that supports conceptualization (9-11) reveals that the properties of a body constrain and therefore influence the way an organism conceives its world (12). Indeed, different kinds of organisms have different kinds of bodies, and different kinds of bodies interact with the world in different ways, differently embodied organisms perceive, and thus conceive, of the same world in different ways. (2,13).

Constitution

Research that supports constitution focuses less on the actual contribution of the body to cognition than it does on the use of external objects to improve cognition (14). Supporters of the Constitution idea try to show how parts of the world could be recruited to become (constituent) parts of a cognitive system. These researchers defend the claim that parts of the world qualify as actual constituents of cognition and not just simple causal influences on cognitive processes that remain completely "brain-bound" (15,16).

Replacement

Research that supports substitution advances the idea that thought processes do not involve representational states at all and therefore do not need computational processes (17). In summary, substitution advocates see the body as "taking a step" to do a job that would once have been attributed to computational processes.

2. The motor program

Psychologists interested in bodily movement supported the idea that emotions were under the control of a motor program (18,19). To date it is believed that the program contains a set of memories preprinted centrally muscular commands able to perform movements without feedback information on achieving the environmental objective. Therefore the motor program must determine which muscles contract, in what order, with which force, and for how long. (20).

The motor program is, in a literal sense, a computer program. It contains instructions written in a language of thought that the nervous system must first read and then exhibit.

If the advocates of embodied cognition assert, muscle control is not under the direction of a program executed by the nervous system. They indeed reject the idea that control must come from a controller. Various research programs in the context of embodied cognition try to show that muscular control emerges from close interactions between the body, the nervous system and the environment.

Well-studied in this context is the development of stepping behavior in infants. A behavior such as walking requires delicate coordination between two legs. There are many more ways for stepping. One leg might move at a slower frequency than another, or with a larger amplitude. Moreover, each leg contains more than a dozen muscles. There are joints at the hip, the knee, and the ankle. Designing a motor program that maintains control of all of these factors, coordinating them with the precision necessary to produce a fluid gait, would be no easy task.

Thelen and Ulrich stated that the nervous system reaches this difficult task, starting with the awareness that a leg can be treated like a spring with a certain tension and weighted by a specific mass (21). Just as a spring balances to the same length, given any initial elongation or compression, so too does the leg's musculature ensure that it will tend towards a particular orientation, regardless of its placement.

This hypothesis is supported by the theory previously described in the replacement. In this case, the replacement involves the elimination of the computational processes in favor of simple mechanics. Considering, as we said earlier, that the leg contains over a dozen muscles and three joints, a motor program that could control the behavior of these components and synchronize them with the same number of components in the other leg would, no doubt, require sophisticated and elaborate neural elaborations. If instead the legs are conceived as simple springs, these springs behave as they do by virtue of their tension and mass, it is not necessary that the motor program guide their behavior. Therefore, an approach focused on cognition could contribute to a understanding of athletic performance.

3. Mirror neurons as a means for coordinate our actions with the actions of others in sport

Many sports involve interpreting and anticipating the behavior of other athletes. In basketball, for example, an athlete must not only perform actions in light of his immediate goals and general strategy of play, but he must also coordinate his actions with the complementary actions of his teammates and the disruptive and incompatible actions of his opponents. This dynamic interaction happens very quickly, and superior athletes are more highly skilled at coordinating their behavior with teammates and opponents' behavior. Coordination between executing one's own actions and anticipating others' actions is not unique to team sports. Even in so-called individual sports, such as running, boxing, and karate, the athlete's actions are influenced by what she takes other athletes to be doing.

This ability to coordinate our actions with the actions of others in sport has been explained by neuroscientists with research on mirror neurons. These researches have shown that parts of the sensorimotor system responsible for the production of planned actions are also partly responsible for the interpretation and anticipation of the actions of others, which suggests that the execution of a given action and the perception of that action are abilities closely related, realized by the same neural mechanism (22-24).

The action mirror neuron system consists of the premotor cortex and parts of the posterior parietal cortex. These areas are involved in sensory guidance of movement and the production of planned movements. Scientists have discovered two kinds of mirror neurons in these areas: strictly congruent and broadly congruent mirror neurons (25).

Each kind of mirror neuron provides different information about the observed action, and this information facilitates action interpretation and anticipation of others' actions (26). Naturally, the patterns of neural activation for action execution and observation do not completely overlap. For example, the observer's brain exhibits various inhibitory responses that prevent the observer from actually performing the action, the actor's brain receives and processes proprioceptive information that the observer's brain does not, and the neural activity in the actor's mirror neuron system is stronger than in the observer's mirror neuron system.

Although motor mirror neuron activity may be strong enough to produce covert, unconscious movements, in normal cases the observer does not act exactly as the observed target acts. Nevertheless, the discovery that action observation and execution recruit the very same neurons is an intriguing finding, and it has significant implications for sports psychology.

Putting all of this together, the neuroscientific research on mirror neurons suggests that action observation and execution share a common neural basis, the mirror neuron system. Thus, we have at least a partial answer to our question about how action coordination occurs: the same system underlies both production and observation of action. Mirror neurons are deployed one way (in conjunction with other neural systems) when executing an action, and they are deployed another way (in conjunction with other neural systems) when observing others execute that action. For example, these findings imply that expert golfers should be better at putting, but they also should be better at perceptually discriminating and predicting the trajectory of others' putts.

As it turns out, the ability to perceive athletic behaviors differs according to one's experience in producing those behaviors (27). Expert athletes are better than novice athletes and mere spectators at interpreting and predicting the outcome of athletic behaviors that are similar to the ones they perform. For example, a professional basketball player can judge more accurately whether or not a player is faking a drive to the basket and whether or not a shot will go in the basket than a novice or spectator can. In both of these examples, the motor expertise seems to bring about perceptual expertise. And this is just what one would expect given that the same neural system underlies action production and perception.

Focusing on how one's body influences one's perception illustrates a central theme of embodied cognition we introduced above, namely Conceptualization. The idea begins with recognition that through extended practice, athletes' bodies become more adept at executing particular skills. In turn, the brains of these athletes, and in particular their mirror neurons, become tuned to recognizing actions of a particular kind. This tuning enables athletes to perceive movements, or patterns of movement, that remain invisible to novices.

Importantly, this coupling between athletic performance and perception has implications for sports psychology, as well. The effects of this tight coupling between motor and perceptual processes explain why novice athletes and spectators substantially overestimate their own athletic abilities, a phenomenon known as the Dunning-Kruger effect. The Dunning-Kruger effect is a cognitive bias in which the more knowledgeable and competent one is, the more accurately one assesses one's knowledge and competence. Individuals who are not knowledgeable or competent with respect to some issue egregiously overestimate their own knowledge and competence and fail to recognize others' equal or superior knowledge and competence (28).

In most sporting events, however, athletes must interpret and anticipate others' behavior while at the same time executing their own athletic behaviors. The coupling between motor and perceptual processes also helps us to understand what happens when athletes interacting in an athletic competition have to balance motorically producing their own behavior and perceiving others' behavior.

In this interactive context, because motor and perceptual processes are realized in part by the same neurological system, action perception and production compete for the same neurological resources. The skills that are disrupted will depend on the skill level of the athlete.

Final remarks

The body contributes to cognition in surprising ways – ways that more standard computationally-oriented approaches to cognition often fail to appreciate.

Sports psychologists have been quick to notice the significance of these ideas in their efforts to understand athletic performance. Indeed, some sports psychologists have been instrumental in expanding and developing research programs within embodied cognition (29). We believe that continued erosion in the disciplinary boundaries between embodied cognition and sports psychology will bring tremendous benefits to both fields.

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