FROM MOVEMENT TO ACTION: NEW PERSPECTIVES IN MOTOR LEARNING AND SPORT TRAINING

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Review paper

Abstract
How to teach a child to kick or throw a ball and how to teach an athlete to manage the same motor gesture within a sports performance? What are the differences? In order to find answers to these questions, a deep reflection on the theoretical presuppositions of motor learning is necessary, in order to conform to new scientific acquisitions. To teach movement, be it a child or an athlete, it is necessary to understand motor function as an emerging property of a complex system where movement, through motor experience, becomes action and then motor performance.

Key words: *Motor learning; Dynamic Systems Theory; Complex Systems; Sport Training.*

Introduction

Almost naturally, when we refer to the concept of movement we think of a function that allows us to move something or someone in space. It is certainly true that every motor act involves a muscular contraction, which in chemical-physical terms consists of an energetic transformation and it is also true that the muscle is able to transform chemical energy into mechanical energy. But if the motor system were limited only to producing mechanical energy, the movement would be devoid of the extraordinary adaptive power it possesses. In fact, the absolutely extraordinary aspect of human movement lies not only in the production of force, i.e. the mechanical energy produced, but in the coordination between the numerous muscle contractions responsible for the single movement, even the simplest. In fact, a simple muscle contraction, if it did not have mechanisms that program it, induce and verify the execution and above all that coordinate it together with all the other thousands of contractions (and decontractions) that occur in sequence, would be finalistically meaningless. The description of *a motor action phenomenology* is therefore necessary, declining the epistemological questions and the implications of method related to motor learning and sports training.

Motor learning: from movement to action

Such a point of observation cannot ignore considering human movement in terms of *motor action*, or even better in terms of *motor function* as an emerging property of a complex system. The motor function represents the result (emergent property) of the variable organization of the relationships existing between the elements of the system, with regard to a specific purpose. The purpose, in this case, is represented by *learning* movement. In a schematic way, it is possible to affirm that the motor system, with its various components, performs the function of coordinating the individual contractions/decontractions in a temporal and spatial sequence predetermined by it, according to the purpose to be achieved; at the same time, having verified the possible failure (partial or complete), motor system is able to make the appropriate corrections during the same or subsequent movements. This is how our nervous system manages to reorganize itself into new neural connections, which are the anatomical modification themselves leading to a modification of the motor behavior; this is how a motor learning takes place, this is how movement becomes action(Edelman & Tononi, 2000).In this context, the *motor function* and the *cognitive function*, often erroneously identified as "body" and "mind", represent aspects of the motor organization whose mutual relations could reconstruct a dichotomy. The latter can be read by adopting *different interpretative keys*: *dualism*, *reductionism* and *emergentism*.

The first, *dualism*, is certainly the oldest. It was Descartes who first focused on this problem by solving it with the existence of res *cogitans* clearly separated from a *res extensa*, identifying the first with thought and the second with what we would now call brain activity. This is not the place to approach this theme philosophically, with the contradictions that this conception brings with it. However, we can say that this vision, subject to strong criticism, cannot be an approach to the problem with scientific rigor. Another way of approaching the study of motor organization is the so-called *reductionist* one. According to reductionism, by understanding the functioning of the units that make up the human body, it is possible to understand the body as a system: very often, however, in nature, a function is not the simple sum of the individual parts or better, of the elements of the system. The typical human functions are not the result of an ever increasing quantitative complexity of the structure but are

linked to mechanisms not yet fully understood. It is from this consideration that the third methodological approach originates, the so-called *emergentism*. The progressive organization of matter often produces real fractures: molecules are made up of atoms, but they have characteristics that go beyond those possessed by atoms; the molecules constitute complex structures, the cells, with different characteristics from the molecules that compose them; and again, multicellular organisms in terms of functions go well beyond those possessed by cells (Wang, 1992);finally, the characteristics of a society are something other than a multitude of organisms. Human movement is therefore not reducible to the sum of its components, as different and unpredictable properties are expressed based on the variability of the individual units that compose it (Maturana& Varela, 1985; Varela et al., 2017).

Each of these interpretative keys has led over the years to different ways of organizing teaching/learning models, including in sports training, which today require a radical overhaul. Traditional models follow a logic according to which to pursue motor learning, a series of exercises must be performed, from *easy to difficult*, in order to build a methodical sequence of exercises(Davids et al., 2005).A similar logic supports the interpretation of traditional pedagogical principles, linked to a reductionist vision of the movement. The logic of perspective must instead propose itself with respect to modern pedagogical principles, intimately connected with the systemic vision of human movement where *movement* becomes *action*; according to this logic, in order to pursue motor learning, it is necessary to break down the motor gesture, and also the sports gesture, into certain anatomical phases or focuses, which are all trained separately and put together at the end, from *simple to complex* (Schöllhorn et al., 2012).In order for there to be motor learning, the human being, whether he is a child but also an athlete, must be understood as a *complex dynamic system* and through situations in constant change in order to create mechanisms such as to adapt to change(Chow, 2016).Adaptations are forms of evolution, and this is where the term self-organization, understood as the ability of the system to evolve, comes into play. In this perspective it will be necessary to prepare the future towards an approach that sees the human being (athlete) inserted in his own environment (sports context), a perspective that we could define as *ecology of training*: "it is a science that does not yet exist as an organic corpus of theory or knowledge"(Bateson, 1977).

Sport training: from action to performance

From the above, it is clear the need to propose a "discourse on the method", in order to start a profound epistemological reflection on the theory and methods of motor learning but also of sports training. The latter must be understood, as Platonov et al. define (2018), as "*part of a complex, individualized and bioetically founded pedagogical-educational process, which develops over long periods of time, possibly starting from childhood, and which - after an initial absolutely indispensable phase of training and initiation, founded essentially on the motor game as spontaneous as possible - it is completed, by free choice, with the systemic organization of physical exercise, repeated in quantity, with intensity and density, according to forms and levels of difficulty and with degrees of effectiveness such as to produce loads always diversified but progressively growing interiors, stimulating the biological processes of adjustment, adaptation and real structural transformation of the particular organism and favoring the increase of the physical, psychic, technical and tactical abilities of each athlete, in order to improve, consolidate and to enhance, reasonably, the competing performance*". Although this definition describes the "container" in a modern key, with clarity and detail, it does not provide any indication of the "contents", probably because these are evolving. The need then lies not in defining a training theory but in a training science, so that the theory can be used in practice.

Frans Bosch (2015) makes a first attempt in this direction. A reductionist approach is not suitable for understanding a complex biological system such as training and even more the adaptation to this of the human being. The theoretical training models that are described and used to date all refer to a reductionist approach, which looks at the organization of motor performance as a linear phenomenon, where central control directly affects the organization of the enslaved elements, influencing exclusively the macro processes of motor action. Actually, the organization of motor action, even more if inserted in a context of sports training and specific sport performance, must be read, interpreted, constructed and proposed considering also the minor variables, i.e. the processes that are responsible for the self-organizational level of the system, that makes it adaptable and variable; in terms of sports performance, the processes that make a movement unique. Bosch (2015) continues this interesting analysis by giving concrete examples of its impact on practice; it is concerned with the physiological aspects of performance but also with the basic motor properties, strength, coordination, stability, all the elements of the action that are crucial for motor control.

Jia Yi Chow (2016) describes an interesting ecological approach to learning motor skills, both in children and in the élite athlete. The human body is an adaptive and complex system, without a "central controller" which determines specific motor behaviors; the latter are instead determined by a complex interaction between the performer and the performance environment. These person-environment interactions lead to a "bottom-up" approach, in which the brain and cognitive processes are constantly reshaping and where the motor function is enriched with the perceptual

function to create a specific-motor act suitable for the context (Agosti &Tafuri, 2020). A good example could be the walking: each of us must be able to perform this motor performance adapting it from time to time at different speeds, or to different weather conditions or even to different ground conditions, to obstacles present on the way, etc. We cannot therefore think that a motor action or a sporting performance can be taught starting from the "one-size-fits-all" formula and even more we cannot think of proposing exercises having stereotyped experiences and motor solutions to the child or athlete. It is so necessary a detailed pedagogical structure, based on a model of the human being understood as a non-linear dynamic system, be it a child or an athlete, and built *ad hoc* for learning action and motor control.

René Wormhoudt (2018) proposes a structured training system called Athletic Skills Model (ASM) which, starting from the Theory of complex biological systems, subverts the classic schematization of Sensitive Phases of motor learning (Weineck, 2009), giving a systemic interpretation. Up to 6 years of age, the child must use the tool of free play, unstructured and structured, because through this he will have the opportunity to experience all the basic motor skills. Subsequently, five periods are distinguished where, starting from a first phase called "Basic athletic skills" (between 6 and 9 years), and arriving at the last defined "Elite athletic skills" (from 19 years), specific priorities and accents are established, from a both practical and theoretical perspective. Along the path of the five phases, the "Transition athletic skills" is the one that deserves more attention. In fact, it is between 12 and 14 years that the game becomes training and a leap takes place transiting the child towards the future athlete; a leap that is not predetermined but is certainly mediated by the motor learning model that is proposed: it could be an example the passage from walking to running, a sudden passage in which there are no intermediaries except previous motor experience (Bosch, 2015). Javier Mallo (2020), athletic trainer for prestigious national rugby teams as well as important football clubs, has recently described a specific training design model for team sports. Applying complexity principles, ecological psychology, non-linear pedagogy and the constraints-led approach, considering the stochastic and highly dynamic nature of the game action, elements that seem to be overlooked both in the scientific literature and in the training environment, his ultimate goal is to build a learning model in the context of specific team sports training. If the systemic approach to motor learning is necessary for motor activities in general and for individual athletes, it is even more so for team sports where, in addition to creating a learning environment that triggers and facilitates a dialectic between player and game, it is necessary to create a dialogue between the player and the environment. In team sports, the environment is mainly made up of the same team members that are elements that enrich the complexity of the system itself.

Conclusion

At this point, considering motor learning in terms of motor action and motor control seems to be a due act. This step is necessary not only to codify a new pedagogy of motor learning but also to create a real transition from training theory to training sciences. The scientific approach to motor learning and sports training cannot be separated from a holistic approach which, observing the phenomenon in terms of complexity, adaptability and variability, builds a learning environment useful for the construction of a motor experience; the set of motor experiences will be the prerequisite for the emergence of a perceptual-motor function and to have, with respect to the specific context, a motor-able child or a motor-evolved athlete. The scientific literature has taken a first theoretical step, some authors and researchers are taking practical steps but we are still at the beginning. Furthermore, it will be necessary that this new approach also conforms to the thought and didactic action of physical education teachers, instructors and coaches, in a design vision that is still unexplored but that is expected from a great perspective.

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