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Original Article

Spatial navigation cognitive strategies, perspective taking and Special Educational Needs: re-thinking orienteering sport in complexity

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Abstract:
In orienteering competitions, the athlete's brain can select a spatial reference system based on the task to be performed, and, during a movement, can change the referent. The multiplicity of the reference systems allows to choose the most suitable system. The hypothesis presented here, according to Alain Berthoz, is that manipulation of spatial referents is an essential form of vicariance: depending on the context and the task, the brain decides to take as a reference an element of the body or of the environment rather than another. Apparently, the management of the different references is a further complexity, a detour, but it really simplifies the development of interactions with the environment. In this framework, at the basis of higher cognitive functions there is the vicariant use of the solutions developed by the living beings to the problems posed by the need to move forward in space.
This paper argues that the sport of orienteering directly and primarily involves cognitive processes that are critical in the acquisition of the ability to take the perspective of others and, therefore, takes the form of an effective teaching practice in an educational context oriented to inclusion of pupils presenting Special Educational Needs.
Key Words: - : Orienteering, Perspective taking, Empathy, Complexity, Vicariance, Spatial reference frames, Special Educational Needs

Introduction

The *avoidance* that often the so-called normal manifest against those who are disabled is an expression of the lack of breadth of vision, of open-mindedness (Murphy, 2001). In this passage from "The Body Silent", Murphy puts in explicit relation disability with the "breadth of vision", with the rigidity of the perspective of the actors in a social context.

This paper argues that the sport of orienteering involves directly and primarily cognitive processes that are critical in the formation of the 'breadth of vision', in the acquisition of the ability to take the perspective of others.

In practice, skills involved in the elaboration of cognitive strategies for spatial navigation are skills that allow us to see the world from different points of view, leaving the egocentric perspective.

The simultaneous manipulation of multiple spatial reference systems is an essential form of vicariance, through which the body solves local complexity - formulated in terms of problems posed to being living on each relevant level of analysis (physical-chemical, molecular, synaptic, cognitive, behavioral) - through the introduction of an ancillary complexity, a "simple" complexity reduced and recoded ad function of action (Petit, 2012).

The theoretical framework of this perspective has its roots in the reversal of the classical description of the mechanisms of perception and action which "places the intentional and goal-oriented subject at the origin of the process. The subject builds his world according to his basic needs and action tools. This view has also been promoted by Bergson and Husserl" (Berthoz, 2008).

In this context, the work develops describing perceptual-cognitive skills in orienteering sports, and providing a review of the literature on the cognitive processes involved in spatial navigation and management of spatial reference systems, in the light of the contribution made by the neurosciences to this specific field of study.

In particular, the work focuses on the classification of cognitive strategies for spatial navigation, made by Alain Berthoz in La Vicariance: Le cerveau créateur de mondes, in four main types: egocentric strategy, allocentric strategy, heterocentric strategy and maquette3d strategy (Berthoz, 2013).

The work then concludes with a proposal for the spread of orienteering as an effective teaching practice in an educational context oriented to inclusion of students with Special Educational Needs.

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Dicussion

Orienteering

Golden, Levy and Vohra provides a detailed definition of activities and procedures to which is called the athlete who takes part in an orienteering event:

"Orienteering is an outdoor sport that is usually played in heavily forested areas. Located in the forest are a number of "control points" each with an associated score. Competitors armed with compass and map are required to visit a subset of the control points from the start point (node 1) so as to maximize their total score and return to the end point (node n) within a prescribed amount of time" (Golden, Levy, & Vohra, 1987)

Given the type of activity, it is easy to imagine how a scientific approach to orienteering involves a wide variety of fields of knowledge (cartography, geography, medicine, sport sciences, education, psychology, neuroscience) which are sometimes regarded as distant from each other

From the educational point of view, this sport has established from the very beginning a tradition of exchange and interaction with school activities:

"The educational value provided by orienteering's blend of navigational and physical skills has given it a permanent place in the primary and secondary school curriculum in the United Kingdom" (McNeill, Cory-Wright, & Renfrew, 1998).

In Italy, orienteering is officially recognized by the Ministry of Education with different ministerial documents, including the circular dated 12 November 1998 (ref. 4015 / A1) that indicates the terms of cooperation between the Inspectorate of Physical Education and Sport and the Federazione Italiana Sport Orientamento (Italian Orienteering Federation). This sports activity could be taught in preschool, primary and lower secondary school according to documents of Ministry of education (Raiola 2011ab, Gaetano, 2012) and to be developed according to theory on ecological dynamic approach (Raiola 2014a) by heuristic learning (Guetano et al, 2015, Raiola & Tafuri, 2015). Orienteering is fundamental also for people with special needs, such as for inclusion aspect and mental disease (Raiola 2015ab); it has a significant role in childhood for the free expression of own emotions and to help the development of childhood and adolescent age (Gaetano et al 2015ab).

This relationship is not surprising, considering that the National Guidelines for the kindergarten and the first cycle of education, among learning objectives that students should achieve by the third year of secondary school, mention the ability to orient in the natural environment through the reading and decoding of maps.

The selection of the route, in fact, is clearly one of the success factors in orienteering: "There is no doubt that good route selection and proper execution of the five techniques along your route are keys to success in orienteering"(Ferguson & Turbyfill, 2013).

In the practice of orienteering are involved not only the cognitive processes linked to the spatial navigation, but also the "combined task (as well as subtasks) of map reading and navigation" (Lobben, 2004).

These tasks are not discrete and separate moments, but represent operations that are managed simultaneously by the brain of the athlete.

The contribution of neuroscience in the investigation of this specific field of study is filling a gap due to the hybrid nature of the research. This gap had already been identified and reported years ago. Robben, in 2004, emphasized how "research into cognitive processes in map reading has been conducted primarily in the fields of psychology and cartography. […] Cognitive studies and spatial ability measures have been conducted for more than 100 years by psychologists and for more than 30 years by cartographers. However, while some studies provide insight into the cognitive processes and strategies associated with specific map-reading tasks, many of these tasks, strategies, and processes have yet to be identified and, possibly more importantly, understood" (Lobben, 2004).

Spatial reference frames

Spatial reference frames are the coordinate systems through which the central nervous system represents the relative positions of objects in space, including that of the body itself (Gaunet & Berthoz, 2000).

In the allocentric reference system (object-object), the information relating to the position of an object in space are coded according to the position of other objects. In other words, the position of an object is relative to the position of other objects.

In the egocentric reference system (subject-to-object), information relating to the position of an object in space are encoded according to the body axes of the subject. In other words, the position of an object is relative to the location of the subject (Di Tore, 2014).

Spatial information provided by an allocentric representation are referred to a space outside the perceiver; while spatial information provided by an egocentric representation are referred to a subject who perceives with a given orientation axis.

The egocentric representation uses a special polar coordinate system whose origin is the ego (the perceiving subject) and the reference axis is the orientation axis of the subject, by encoding the position of a point in terms of distance and angle to the subject (Di Tore, 2014).

The human being switches from one coding to another, giving preference to one or another system on the basis of the task to be performed, of sex, age or culture, of context, and more. (Berthoz, 2013).
Berthoz points out that a necessary condition to take advantage of the multiplicity of spatial references is a consistent perception of the body in relation to the environment:
"the necessary condition to use the repertoire of spatial reference systems of the ways of equivalent actions, choosing one, or to simultaneously deal with a problem from different points of view, is to have a coherent, unique, stable sense of our body and its relationship with the environment" (Berthoz, 2013).

The concept of space, in this context, must be understood abandoning Euclidean perspective and adopting the idea of space as a potential for action: "the space is divided into zones corresponding to actions you can perform in" (Berthoz, 2013).

Orienteering, complexity, vicariance: a brain-centric perspective

"The molecules in the room I'm now sitting in as I write this chapter are maximally chaotic, and to describe them would require the documentation of the position and activity of every one of them. No simpler description is possible. […] That kind of complexity did not interest me" (Lewin, 1999).
The quote from Lewin explains how the approach to complexity can be linked not only to description and analysis, but also to decision and action (Carlomagno, Di Tore, & Sibilio, 2013).

"La perception d'une forme ou d'un objet n'est jamais passive, elle est toujours décision. Quand je regarde les objets et les formes ici, que ce soit la salle, vos visages, vos corps ou les objets, mon cerveau ne se contente pas de les analyser, il décide, il anticipe" (Berthoz, 2011a).

If our brain, in order to decide how to act in a certain situation, is forced to process all the information that the perception of the outside world provides him, the task would be too costly and complex to allow for timely decision making: we would consistently late and we could never make effective decisions (Rivoltella, 2014).

Faced with insurmountable difficulties posed by a multidimensional reality, the typical activity of living beings proceeds addressing complexity simply playing in advance.
Activity of living beings is therefore characterized by a significant reduction of complexity and by the introduction of a "simple" complexity linked to local situation.

Berthoz defines this reduction of complexity as simplexity. According to Berthoz, "the brain solves the complexity of the outside world by producing perceptions consistent with the intentions regarding the future, the memory of the past and the laws of the outside world that has internalized" (Berthoz, 2012).
In the case orienteering, the brain can select a reference system based on the task to be performed, and, during a movement, can change the reference. The multiplicity of the reference systems allows to choose the most suitable system. In the retina, for example, the space is encoded by "retinotopic" coordinates, in the parietal cortex the spatial coding is egocentric: its reference is the body of the observer. In hippocampus, spatial coding is allocentric, as a in a map (Hartley, Lever, Burgess, & O'Keefe, 2014). We ignore, for the most part, how the brain coordinates all these spaces and uses them to change the point of view.

The hypothesis of Berthoz is that manipulation of spatial referents is an essential form of vicariance: depending on the context and the task, the brain decides to take as a reference the feet to the ground, the head, if the ground is uneven, or even only the simple support of a finger on a stable element of the environment. Apparently, the management of the different references is a further complexity, a detour, but it really simplifies the development of interactions with the environment.

In this framework, at the basis of higher cognitive functions there is the vicariant use of the solutions developed by the living beings to the problems posed by the need to move forward in space.

Cognitive strategies for spatial navigation

The vicariant ability to simultaneously use different references allows us to solve a problem by using different combinations of the reference systems and their neuronal networks, through the use of "cognitive strategies".Berthoz identifies four different cognitive strategies. The first of the cognitive strategies can be defined as an "egocentric path strategy", and consists in remembering movements and deviations, and in associating them to visual landmarks or to experienced events. This is a "first-person" strategy, in which the world is constructed from the brain as a sequence of points of view.

The second strategy is to draw a mental map of the environment, on which we can follow a route as on a real map. This is clearly an allocentric strategy, and has been the subject of detailed research in neuroscience (O'Keefe & Nadel, 1979). This strategy is important when we try to plan a route, among the many possible. Our ability to develop the geometry rests on this basis. This strategy appears late in the child, when he develops structures such as the hippocampus and the prefrontal cortex (Berthoz, 2013).
Berthoz defines the third strategy as heterocentric. This is the strategy we adopt when we provide directions, putting us from the point of view of those who ask for information. In this strategy, we take as reference who asked us about road.

According to Berthoz, when, during an altercation, we try to understand the point of view of litigants, we adopt the same strategy.

Finally, a fourth strategy takes place when the brain processes a mental model of a three-dimensional structure. Berthoz calls this strategy "Maquette3D".

In "La vicariance", the french neurophysiologist argues that the manipulation of spatial referents would be a "transnosographic trait" in various neurological and psychiatric disorders: “ I mean that each of the following diseases - autism, schizophrenia, epilepsy, anxiety spatial, Parkinson's disease - affects structures involved in the manipulation of the referents of different spaces. Therefore, we will notice in these diseases the symptoms of deficits specific to each: some will produce problems of perceptive and motor nature, other orientation problems, others a difficulty to change the point of view. These deficits in vicariance generate stereotyped behaviors or the difficulty of interaction with each other” (Berthoz, 2013).

Spatial reference systems and intersubjective relationships: towards a spatial theory of empathy

Berthoz proposed a spatial theory of empathy, based on the human ability to manage perspectives. According to Berthoz, “empathy is essential to rational thinking, because it allows to examine the facts and arguments from different points of view.” (Berthoz, 2011b).

The ability to assume an allocentric perspective is subordinated to the possibility of making a “mental rotation on ourselves, in relation to the environment, or to an object in the environment, maintaining a main perspective of the environment in question” (Berthoz, 2011).

In practice, it is to be both themselves and the other. Precisely this is the fundamental characteristic of empathy. Empathy is a dynamic process, which requires a doubling. It is, in short, to adopt an egocentric point of view, but after an allocentric handling, while inhibiting the emotional contagion (which is rather typical of sympathy).

The empathic processes require the contribution (albeit not exclusively) of different brain mechanisms involved in spatial perception, in the mental manipulation of the reference systems and in perspective taking (Berthoz & Thirioux, 2010). At the basis of empathy, in this case, we find kinesthesia, since it contributes to intersubjectivity, as understanding, for analog transfer in the body of another agent, of intentional actions performed by the subject and intentions that precede and accompany these actions.

In essence, as in spatial navigation we find useful to change spatial references and even the same reference systems, so in the social life we change often referent taking others as a reference.

Conclusions

According to Dovigo, "in Italy, in recent years, the word ‘inclusion’ has gradually started to replace, in documents and in formal and informal speeches, that of ‘integration’ ". [...] The two expressions refer to two very different educational scenarios " (Dovigo, 2008).

The paradigm underpinning the idea of integration is based on adaptation of disabled to school organization that is fundamentally structured according to 'normal' pupils, and where the planning for 'special' pupils still plays a marginal or residual role. Viceversa the idea of inclusion is based not on the measurement of the distance from a supposed adequacy standard, but on the recognition of the importance of full participation in school life by all parties.

The degree of potential inclusiveness of an education system, in this view, is directly proportional to the "breadth of vision", to the rigidity of the perspective of the actors in to social context. In the scientific literature, several times orienteering was listed as a learning resource with an undisputed potential for integration and inclusion. Reasons for this "inclusive potential" have gradually been identified in non-peculiar orienteering features (outdoor activities, competition) in general or in relation to particular types of disabilities (eg, orienteering as a tool for inclusion of the blind child).

The orienteering as a sport, however, goes well beyond these features. Orienteering involves directly and primarily cognitive processes that are crucial in the acquisition of the ability to take the perspective of others.

Cognitive processes involved in peculiar orienteering activities (map reading, route selecting, spatial thinking) are involved in the management of intersubjective relationship. In essence, the skills involved in reading maps and in developing strategies for spatial navigation are skills that allow us to see the world from different points of view, abandoning the egocentric perspective, and are therefore involved in educational inclusion-oriented paths. “To get out from egocentrism means to be able to see the (not just the spatial reality, but also a mental reality, linguistic reality or otherwise) from several points of view, however, other than our own” (Trisciuzzi & Zappaterra, 2011).

Orienteering, therefore, takes the form of an effective teaching practice in an educational context oriented to inclusion of pupils presenting Special Educational Needs.

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