Chapter 2
Space Representation in Children:
From Piaget to Neuroscience

ABSTRACT

With "Spatial Reference Frames" we refer to systems of coordinates by which the central nervous system encodes the relative positions of objects in space, including that of the body itself. A reference system is a way of representing the positions of the subjects / objects in space. The spatial position of an object can be represented in the brain with respect to different classes of reference points, which may be related or not to the position of the subject. In a nutshell, we can say that there are two types of transformations of space imagery: the allocentric spatial transformations, that involve a system of representation from object to object and encode information about the location of an object or its parts in relation to other objects, and egocentric spatial transformations that involve a system of subject-object representation. The human being switches from one code to another, depending on the contingent requirements, giving preference to one or another system according to a set of heterogeneous factors. The gender difference (male / female), for example, plays a key role. Even the individual cognitive strategies make use of different representations in a significantly different way. Manipulation of spatial reference systems constitute a "transnosographic trait" in various neurological and psychiatric disorders. Each of these diseases (autism, schizophrenia, epilepsy, spatial anxiety, Parkinson) reaches some of the structures involved in the manipulation of referential of different spaces. The chapter illustrates Piaget's study on the representation of space in the child and the use of different spatial coding systems, and provides a brief overview of the scientific debate following the Piagetian position.

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SPATIAL FRAMES MANIPULATION

A key concept in the field of spatial processing concerns the definition of the reference systems used by the central nervous system to interpret sensory information and locate objects in space. With reference systems locution we refer here to coordinate systems through which the central nervous system encodes the relative positions of objects in space, including that of the body itself (Gaunet & Berthoz, 2000). In other words, a reference system is a way of representing the positions of the subjects / objects in space. The spatial position of an object can be represented in the brain with respect to different classes of reference points that can be related or independent from the position of the subject. In summary, we can say that there are two types of spatial image transformations: the allocentric spatial transformations, which involve system of representation from object to object and encode information about the position of an object or its parts in relation to other objects, and egocentric spatial transformations that involve a subject-object representation system.

The allocentric and egocentric spatial representations considerably differ. Spatial information provided by an allocentric representation are referred to an space external to perceiver; the information provided by an egocentric representation refers to a person who perceives with a defined orientation axis. In particular, the allocentric representation encodes the positions of the points in the space in the internal equivalent of a system of Cartesian or polar coordinates. The egocentric representation makes use of a special polar coordinate system whose origin is the ego (the perceiving subject) and the reference axis is the axis of orientation of the subject, by encoding the position of a point in terms of distance and angle to the subject.

In the allocentric reference system, the information relating to the position of an object are encoded according to the position of other objects. The location of an object is relative to the position of other objects. In the egocentric reference system, the information relating to the position of an object are encoded on the basis of body axis of the subject. The location of an object is relative to the position of the subject. You can represent the egocentric system using the Cartesian plane derived from crosses of the frontal plane and the sagittal plane.

The two types of representation coexist. The human being switches from one code to another, depending on the contingent requirements, giving preference to one or another system according to a number of heterogeneous factors. The gender difference (male / female), for example, plays a key role. Even