Changes of Body Schema in Middle Childhood

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The main aim of our work is to provide updated norms for the Body Schema Test of Daurat-Hmeljak, Stambak and Bergès (1978) in children 6 to 11 years old, after three decades from his previous Italian standardization (Lis, Tallandini, 1981). Besides its Piagetian origin, this test is used in clinical practice, both in the pathology of body schema development and in traumatic pathology of adults. The variance analysis yielded main effects of gender, age and tasks, as well as an interaction between age and tasks. These data confirm that the body schema is a mental representation tied hand in glove with those aspects of cognitive development that are typical of middle childhood. Compared with the normative data provided by Lis and Tallandini (1981) our sample reached higher scores in all the test tasks and age except for the Evocation-Choise, Evocation-Placement and Construction-Choise by oldest children. The better performance of the girls in our sample could be explained by the higher interest of women for the body features; the similarity of the tasks with puzzles or other ordering plays could also have motivated them more than boys.
Key words: *body schema*, *representation*.

The individual's knowledge of his/her body began to attract scholarly interest as long ago as the sixteenth century, with the observation of patients who, as a result of serious traumas or neurological diseases of the sensory or motor system, were unable to recognize their body parts or the relationships between them. By *body schema* we mean the individual's representation of spatial characteristics of his/her body, based on information from sensory organs, on observations of other human beings, as well as on explicit teaching (e.g. the names of body parts).

Body schema is not the same as *body image*, i.e. the way in which the individual feels and evaluates his/her body in relation to experience. The body image is linked to the individual's emotional life and personal history, including relationships with significant others and, on a larger scale, social environment, its aesthetic and values (Molinari, Riva, 2004). As Cash states (as cited in Sakuma, Tanaka, 2004), body image is a "vision from within". Unfortunately, this is also an elusive notion which, according to de Vignemont (2009), seems to have hosted all those aspects of body representation that escape the concept of body schema. In

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fact, since the classic work of Schilder (1935), the two concepts of "schema" and "image" of the body have been used almost interchangeably, with neurologists typically preferring the first and psychiatrists or psychologists the latter (Fabbrici, 1984).

Most of the recent studies on body schema have been conducted from a neurological or neuropsychological perspective (Pernigo, Moro, 2008), with a focus on the neural components of the body representation. These studies suggest that there are different and independent levels of body representation interacting with each other (for a recent review, see de Vignamont, 2009). For example, Schwoebel and Coslett (2005) identify three types of body representation. The first is precisely the "body schema", a dynamic representation of the spatial position of each body part, based on sensory-motor information and interacting with the motor system to generate actions. The second (labeled "structural description") is a topological map in which the body parts are located, delimited and related to each other by means of the visual input. Finally, the "body image" is the semantic-lexical representation of the body and its parts (names, functions and relationships with the objects in the world). Each of these components seem to be related to specific brain systems: the body schema to the parietal and dorsal-lateral prefrontal areas, while the structural and lexical-semantic representations to the left temporal hemisphere (McCrea, 2007; Urgesi, 2006). Somatosensory inputs that reach the brain, especially from proprioceptors, are undoubtedly essential for body awareness, and so is visual perception which allows locating one's own body in relation to the external physical world (Paillard, 1990). Delays or anomalies in the individual's body schema can be clinically significant as indication of a specific disease (Denes *et al.*, 2000), or as a semeiological aid in many neurological, cognitive and personality disorders which can affect individuals throughout a lifetime (see Buxbaum, Giovannetti, Libon, 2000).

Although the majority of the existing literature is on adults, the development of body schema in children has also received some attention. Authors of different orientations have investigated the origin and changes of children's knowledge about the structure of the body (Calamoneri, Guzzetta, 1979; Christie, Slaughter, 2007; de Ajuriaguerra, 1974; Lis, Venuti, Basile, Finesso, 1988; Piaget, 1936; Piaget, Inhelder, 1948; 1966; Slaughter, Heron, 2004) as well as the contribution that this knowledge gives to the development of the bodily self (Geangu, 2008). However, the studies of the developmental processes underlying the construction of body schema are not numerous, as the changes in body representation are often reduced to the same developmental principles that apply to the knowledge of any object (Laicardi, Picone, Mancinelli, 1985).

Compared with the paucity of theoretical works, we can find a wide range of assessment tools of children's body schema: some typical procedures consist in asking the child to name his/her own body parts, on another person or on a doll; another approach asks the child to represent a human body by drawing or

assembling the parts of a figure. The first group of procedures require only the recognition of each part and the use of appropriate linguistic labels, while the tasks involving a figure representation, albeit more difficult, are more revealing of the body schema, as they can detect the child's ability to organize bodily parts in space.

Based on one or another of these procedures, several standardized instruments have been created, such as the Goodenough-Harris Draw-a-man test (Italian adaptation by Poláček and Carli, 1977) for children 3 years old or more; the technique of Monniez (1982) which asks children to reconstruct the outline of a human body on a sheet of paper by assembling various geometric shapes (trapezoids, circles, rectangles and squares); the Typical and Messy Body Figures (Slaughter, Heron, 2004) for children from 12-18 months of age. Among these tests, the Body Schema Test (Daurat-Hmeljak, Stambak, Bergès, 1978), is a well conceived instrument for the study of typical development across a wide range of ages, as well as for clinical evaluation; this test assesses the children's knowledge of human body shape, and their understanding of the relationships between its parts, by means of reconstruction tasks. The test has been inspired by Piagetian theory, according to which the development of body schema follows a stage sequence which mirrors the child's cognitive progress (Piaget, 1936; Piaget, Inhelder, 1948; 1966). In this perspective, the body schema can be gradually developed only when the child has developed symbolic means of representation. At the beginning of the pre-operational stage, the ability to coordinate the body parts is still incomplete and fragile (Martinelli, 1974). In the intuitive period (6-7 years old) children come to understand the correspondence between his/her own body parts and those of others (Molinari, Riva, 2004). With the transition to the stage of concrete operations, children become able of manage in various ways the abstract spatial properties of the body, e.g. evoking moving figures or representing figuratively bodily changes, an ability which will be perfected during the formal-operational stage (Piaget, 1936; Piaget, Inhelder, 1948; 1966).

Besides its Piagetian origin, the Daurat-Hmeljak and colleagues' test has some interesting features, which are lacking in other instruments. First of all, it includes different tasks that can be used to separately assess various cognitive abilities: visual perception and visual-spatial abilities involved respectively in recognizing the test items and positioning them in their right places; semantic memory involved in the naming of body parts; long-term memory and working memory needed to keep in mind the body structure while building its shape. Two versions are available: one with a frontal figure (for younger children) and another with a figure in profile, which is more discriminant for older subjects. Furthermore, in this test the verbal, grapho-motor and praxic components are minimized, and the way in which the various tasks are proposed helps to avoid undesirable playful behaviors.

Two Italian authors, Lis and Tallandini, completed in 1981 the translation and standardization of this test, which is still in use in clinical practice, both in the pathology of body schema development and in traumatic pathology of adults. After three decades, we thought it useful to upgrade this test with recent normative data. Since our study is focused on middle-childhood, the version with the profile figure was used.

1
Aim and hypothesis

The main aim of our work is to provide updated norms for the Body Schema Test of Daurat-Hmeljak, Stambak and Bergès (1978).

Our main hypothesis is that the developmental trends of our data would replicate those of the Italian standardization by Lis and Tallandini (1981); in particular, given the higher complexity of the constructive spatial tasks as compared to the recognition and labeling tasks, we expected a better performance in these latter. Moreover, after 30 years from the previous standardization, we expected that our subjects would obtain better scores for the well-known cohort effect.

Even though Lis and Tallandini did not find differences between boys and girls in the profile version, we will also check for gender effects.

2
Method

Participants. The study was conducted in 7 schools of Rome with 826 middle class and lower-middle class children (40 groups from first to fifth grade); 710 families granted their children permission to participate in the study, but 20 participants with cognitive problems were excluded from the analyses. TAB. 1 shows the final sample, divided by children's age and gender.

TABLE 1
Sample composition by age and sex

	Males	Females	Total
6	55	52	107
7	62	61	123
8	62	68	130
9	59	91	150
10	65	60	125
11	24	22	46
Total	327	354	681

Materials. A drawn model of a child in profile; 14 puzzle shaped pieces representing as many parts of the body, only 4 of which are in correct orientation; a work table with a mark where the figure's head should be put; a transparent squared sheet, used to score the exact placement of the body parts; a spreadsheet to record the results.

Procedure. Besides the second author of this paper, 11 students, previously trained, participated in data collection[1]. Each child individually has solved the following sub-tests:

1. Evocation: this sub-test asks the subject to position on the work table three parts of the body (one at a time), having as a reference points only the base line on which the imagined figure stands and the head of the figure (which the child has correctly located at the beginning of the trial, if necessary with the help of the experimenter). This sub-test involves three tasks:

1.a. *Recognition*: the child has to name three body parts presented by the experimenter (a leg, the trunk and an arm).

1.b. *Choice*: three groups of body parts are presented one after the other (3 legs, 3 trunks and 3 arms); each group includes three shapes of the same part in three different orientations; the child has to find the only shape fitting the representation in profile.

1.c. *Placement*: the child has to put the chosen shape in the right place on the work table; each piece is then removed after positioning.

2. Construction: this sub-test asks the subjects to choose and coordinate the 4 pieces suitable for building a human figure in profile. The sub-test includes two tasks:

2.a. *Choice*: the child has to find first the head, and then the other parts of the body in order to construct a figure in profile; he/she has to choose among 12 pieces representing 4 parts of the body (head, legs, trunk and arms) in three different orientations.

2.b. *Placement*: the child has to assemble the pieces on the work table.

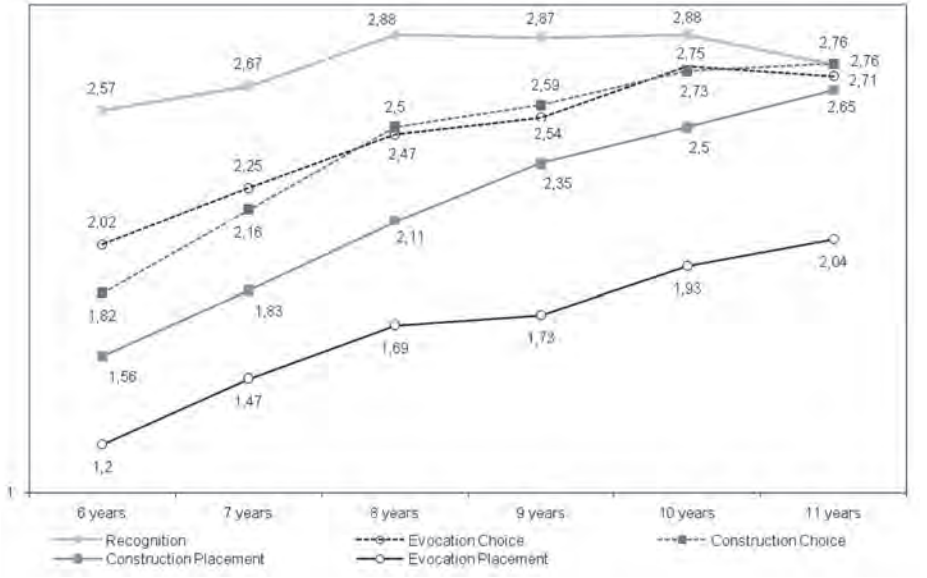
Scores. In each of the five tasks described above, 1 point is assigned for each piece recognized and/or placed correctly. Since the head is always considered an item of familiarization or provided as a point of departure, the maximum score in each task is 3.

Data analysis. A multivariate analysis of variance for repeated measures was conducted, having as dependent variables the five scores of the Profile test (1a: Recognition, 1b: Evocation-Choice, 1c: Evocation-Placement, 2a: Construction-Choice, 2b: Construction-Placement) and as independent variables the participants' age and gender. Post hoc comparisons of the means were performed with the Duncan test for independent measures (on age and gender) and with the Student's T test for repeated measures (on the five scores of the test). We then analyzed the developmental trends of our sample with those of the previous Italian standardization by comparing means with the One sample T-Test.

3
Results

The variance analysis yielded main effects of gender [$F_{(1,668)} = 5,39$; $p < 0,05$] with girls obtaining a better score than boys (11,61 vs. 11,14), of age [$F_{(5,668)} = 38,56$; $p < 0,001$] and of tasks [$F_{(4,2672)} = 295,57$; $p < 0,001$], as well as an interaction between age and tasks [$F_{(20,668)} = 4,34$; $p < 0,001$], shown in FIG. 1.

FIGURE 1
Mean scores in each of the five tasks by age



The post-hoc comparison between tasks with the Student's T showed that, at any age, the task of Recognition and two tasks of Choice, whose solution is based almost entirely on perceptual abilities, are easier than the two Placement task, which involve working memory, praxic abilities and visuo-spatial abilities. Accordingly, the five task show different progressions: while at 6 years of age all the scores are significantly different, by the age of 11 years all the scores approach a ceiling, except for Evocation-Placement, which remains the most difficult task.

The post-hoc comparisons between ages with the Duncan test showed significant improvement in the two Choice tasks and in Construction-Placement between 6 and 7 years, followed by a general improvement between 7 and 8 years. Then the progress slows down for the two Evocation tasks and for Construc-

tion-Choice, so that significant differences can be found only between groups two years apart (9 year olds > 7 year olds, 11 year olds > 9 year olds). Only the Construction-Placement shows a significant progress at each age. This pace of development is similar with that found by Lis and Tallandini (1981). However our subjects have reached better scores in all tasks[2]: the differences between means were all significant for each age and each task ($p < 0,05$) except for the scores in the Evocation-Choise, Evocation-Placement and Construction-Choise obtained by 11 year-old.

4
Discussion and conclusions

The data from the Body Schema Test (Daurat-Hmeljiak, Stambak, Bergès, 1978) allow us to understand how children from 6 to 11 years of age progress in their understanding of the spatial properties of the human body.

Around 6 years of age children are already able to recognize and properly name the different parts of the body (Recognition). However, they still find some difficulty in selecting the right pieces and especially in positioning them in the right place. To do so, they should have a mental representation of the body in profile (an unfamiliar, non canonical orientation); they should be able to apply the left-right distinction outside their own body; and finally they should appreciate the spatial relationships between different parts of body. This task requires the understanding of projective relations, which according to Piaget (Piaget, Inhelder, 1948) are not easily understood before 7 years of age.

Moreover, 6 year-olds are in trouble when asked to position a piece at a time, when they have only the figure's head as a reference point (Evocation-Placement). To accomplish this task, one should have a mental representation of the body and should be able to recover it from long term memory in order to operate on it with visuo-spatial working memory (Imbo, Vandierendonck, 2007). It is this type of memory that allows to keeps in mind the body structure and to set a puzzle piece in its correct place, imagining the location of the missing elements. We know that from 6-7 years, when the knowledge of one's body is extended to the bodies of other people, the body schema begins to structure itself in a coherent way (Piaget, 1936; Piaget, Inhelder, 1948; 1966). From this moment on, the concept of body schema is strengthened and enriched, as it is shown by the children's progress in each task of the test, especially from 7 and 8 years of age, when the knowledge of the body is refined in terms of vocabulary, as well as visual perception and visuo-spatial properties. The development of body schema seems then to slow down and reach a ceiling around 11 years of age, when the differences between the subtests are no longer significant and the test looses its discriminant power.

These data confirm that the body schema is a mental representation tied hand in glove with those aspects of cognitive development that are typical of middle

childhood. In fact, understanding the schematic properties of the human body involves the same mental processes which lead to the concept of conservation, and in particular the ability to disregard irrelevant perceptual variations to understand that some features of the objects remains the same across time and space: in the case of body schema, to recognize the body parts and their reciprocal position independently from the figure posture and from the point of view from which it is observed.

Compared with the normative data provided by Lis and Tallandini (1981) our sample reached higher scores almost all the test tasks. Almost thirty years after the first Italian study, the average level of children's intelligence has improved enough to make inappropriate the previous standards. Since our sample is much larger than that of the previous standardization, the differences should not be disregarded as casual.

The better performance of the girls in our sample could be explained by the higher interest of women for the body features (documented by numerous studies, e.g. Feingold, Mazzella, 1998); the similarity of the tasks with puzzles or other ordering plays could also have motivated them more than boys. This finding however, was not expected, and should be further investigate using different instruments.

Notes

[1] Namely: Lucietta Amorosa, Stefania Caragnano, Martina Civino, Giovanni Garufi Bozza, Sara Gori, Natasha Mengozzi, Antonella Panico, Carla Pantaleone, Elisa Piccinni, Simona Rattà, Alice Solenghi.

[2] In the Recognition task, Lis and Tallandini (1981) report scores above the maximum of 3, perhaps including also the responses to the familiarization item ("Head"). We preferred to follow the original instructions: «The highest score will be 3 for the body [...]» (Daurat-Hmeljak, Stambak, Bergès, 1978, p. 33). The reader should take into account these different criteria when comparing our data with the Lis and Tallandini standardization.

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Riassunto

Questo lavoro si propone principalmente di fornire norme aggiornate per il Test dello schema corporeo di Daurat-Hmeljak, Stambak e Bergès (1978) su un campione di bambini dai 6 agli 11 anni, essendo trascorsi circa trent'anni dalla sua precedente standardizzazione italiana (Lis, Tallandini, 1981). Al di là delle sue origini piagetiane, il Test è utilizzato nella pratica clinica per valutare sia le patologie dello sviluppo dello schema corporeo sia le patologie traumatiche degli adulti. L'analisi della varianza effettuata ha rilevato un effetto principale del genere, dell'età e del compito e un'interazione tra età e compiti. Questi dati confermano che lo schema corporeo è una rappresentazione mentale legata a doppio filo con gli aspetti dello sviluppo cognitivo più tipici della media fanciullezza. Confrontando i nostri dati con quelli di Lis e Tallandini (1981) si osserva come in tutti i compiti del Test e a tutte le età, fatta eccezione per le prove Evocazione-Scelta, Evocazione-Piazzamento e Costruzione-Scelta nei bambini di 11 anni, i nostri soggetti abbiano ottenuto punteggi più elevati. Infine, la migliore prestazione ottenuta dalle bambine del nostro campione potrebbe essere spiegata, da una parte, con un maggiore interesse femminile per la corporeità e, dall'altra, con una maggiore motivazione per il tipo di compito proposto.
Parole chiave: *schema corporeo*, *rappresentazione*.

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