Evaluation of Body Perception and Representation in Children with Hemiplegic Cerebral Palsy: Elaboration and Adaptation of a Neuropsychological Instrument

Fontes, P.L.B., Coutinho, K.C., Haase, V.G.

INTRODUCTION

The importance of perceiving and understanding one's own body seems universally evident. Motor control requires body perception. In order to plan muscle action, the brain must be informed of the initial position of the body (Goldenberg, 2002).

Mental representation of the body is progressively elaborated through sensory afferences that, since the beginning of life, are linked to motility (Goldenberg, 2002). Information on body configuration is provided by visual, vestibular and somatosensory afferences, and also by monitoring motor commands through proprioceptive feedback of motor execution (Tsakiris, 2010).

The terms "body schema" and "body image" are used to designate the mental representation of the body spatial structure (Goldenberg, 2002). In spite of being indistinctly used in the literature, it is convenient to distinguish between body image and body schema. The latter was first defined by Bonnier (1893, 1905, p. 147, cited by BENEDET, 2002) as static body schema. Next to the concept of static body schema, Head (1920, p. 147-8, cited by BENEDET, 2002) describes a dynamic body schema, which allows us to know in which direction we move body parts. Combining body schema with emotional and environmental data results in a representation of the body through a visual image, which is connected to one's self-concept (Hammar, Ozolins, Idvall & Rudebeck, 2009).

Studies such as those of Sirigu, Grafman, Bressler and Sunderland (1991) suggest that knowledge concerning one's own body involves several representations and that there are three different kinds of body representation: "Body Schema", that provides information on on-line representations of body parts; "Visuospatial Representation of the Body Structure", that enable the

individual to specify the position and limits of each body part; and the “Body Image”, which is composed of semantic and lexical actions, such as naming and defining body parts, as well as associating them to artifacts (Sirigu et al., 1991).

From a set of distinct representations, Sirigu et al. (1991) propose a neurocognitive model for body perception. Buxbaum and Coslett (2001) found a triple dissociation between different types of body representation.

There is enough evidence of multiple body representations (Berlucci & Aglioti, 2009). According to Goldenberg (2002), there is not one unique map that represents the body and the Central Nervous System employs different sensorial channels and different central representations for each type of representation.

Function neuroimaging studies will contribute to the neuroanatomic model of body representation proposed by Berlucchi and Aglioti (2009). These authors present three brain regions that have recently attracted more attention as possible specialized sites for body awareness: parietal posterior cortex (body schema), anterior insular cortex (body image) and lateral occipito-temporal cortex (structural description of the body). The innovation presented by these authors, when compared to the neurocognitive model of Sirigu et al. (1991), is the connection between insular cortex (neural substrate of body image) and anterior singular cortex, which is related to emotions and feelings. Therefore, body image, aside from providing semantic and lexical knowledge of the body, is also related to emotional components.

After this review we are able to understand that somatosensory processes contribute to continuous development of mental representation of the body. Lesions of immature brains, such as cerebral palsy (CP), evidently cause disorders of the different kinds of body perception.

Hemiplegic CP is characterized by unilateral paresis with muscle tone alterations and movement and posture disorders. Learning disorders, sensory perception disorders and cognitive deficits frequently accompany the motor deficit (Bax, Goldstein, Rosenbaum, Leviton & Paneth, 2005).

Body representation difficulties in many children with CP can be detected by clinical observation alone. Regarding sensory disorders, we may find that rehabilitation professionals that work with children with CP lack sufficient

knowledge (authors' personal observation). In clinical practice, the primary objective of rehabilitation is to facilitate the patient's independent mobility (Bax et al., 2005).

Considering these facts, we question if the little attention that has been paid to sensory disorders in CP can interfere in the rehabilitation process or in this group's social interaction with the community.

Gialanella, Monguzzi, Santoro e Rocchi (2005) found that anosognosia impaired recovery of hemiplegic adult patients. We could not find any similar findings involving children, nor instruments intended for this sort of evaluation.

Without developing an adequate instrument for the evaluation of body representation disorders in children with CP, it is hard to investigate the interference of these disorders in rehabilitation and the collaboration of their recognition to the rehabilitation success.

OBJECTIVE

To develop and adapt an instrument for neuropsychological evaluation, considering sensory and body representation disorders in children with hemiplegic cerebral palsy.

RELEVANCE

The importance of this study consists in evaluating body representation perception in children with hemiplegic cerebral palsy, contributing to their rehabilitation process and their integration in the community.

METHODS

The neuropsychological tests developed in this study aim to explore each type of body representation. Classification criteria for the tests were created after the neurocognitive and neuroanatomical models proposed by Sirigu et al. (1991) and by Berlucchi and Aglioti (2009).

In the first part of the study, we created stimuli for the tests, which were evaluated by judges. The internal consistency of the items was tested and a preliminary study was conducted, in order to confirm if the first version of the instrument was capable of adequately evaluate body representation.

Seven tests were developed. Tests are computerized and the child must follow orientations given by the examiner:

BODY SCHEMA EVALUATION

1. Imitating gestures (gestures with and without meaning)
2. Deciding on laterality of hands (right/left, oral/motor)

BODY STRUCTURAL DESCRIPTION EVALUATION

3. Pointing isolated body parts (figures/words)
4. Continuity (combining body parts)

BODY IMAGE EVALUATION

5. Evaluation of function of specific body parts
6. Association of body parts with objects
7. Naming body parts

Next, a pilot study was conducted. A group of healthy children and another of children with hemiplegic cerebral palsy were tested. This examination of criterion validity intends to verify the precision of the instrument to distinguish between the groups. The instrument is composed of seven tests, which are taken in a single session of 60 minutes.

This study was approved by the Comitê de Ética em Pesquisa da UFMG, in June 24, 2009 (Document number ETIC 250/09). Informed consent was obtained from all the participants.

RESULTS

The Shapiro-Wilk test was used for data analysis. For analysis of differences between groups, non parametric tests were used (Kruskal-Wallis test, Mann-Whitney U test). The significance level was $p < 0,05$.

Until this day, 23 children, paired by age and affected side of the body, were evaluated. The results here shown are preliminary data of an ongoing study.

The group of children with cerebral palsy performed more poorly in tests that evaluate body schema. In tests of deciding on hand laterality (oral/motor) and

imitating gestures without meaning, the groups of children with left and right hemiplegia had significantly worse performances than control groups ($p<0,05$).
In evaluations of body structural description, both tests of continuity and pointing body parts resulted in significantly worse performance of the groups with left and right hemiplegia ($p < 0,05$).
In the test of naming body parts (evaluation of body image) only the group with right hemiplegia performed significantly worse than controls ($p<0,05$).
There was no significant difference between children with CP and controls in other tests. There was no significant difference between children with right and left hemiplegia.

CONCLUSIONS

Despite working with only preliminary data, we could already observe that the developed tests were able to detect body perception and representation disorders. We also found worse performances of children with cerebral palsy when compared to controls.

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