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BODY SCHEMA AND LATERALIZATION[1]

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Summary.—To study some aspects of the relationship between body schema and lateralization, 44 female subjects between 19 and 39 yr. of age were measured using a test of accuracy of perception for the right and left halves of the body. Analysis gave three different groups: subjects with larger indexes of deviation on the left (56%), those with larger indexes of deviation on the right (31%), and others with no difference between right and left halves (11%).

Body schema are constructed on the basis of information from the body; this information is visuo-spatial, vestibular, proprioceptive, etc. (Hecaen, 1976). Proprioceptive information depends on both basic tonic activity and phasic activity deriving from contractions. The fact that normally one part of the body, for example, the right hand in right-handers is used more than the contralateral one, leads us to believe that body schema are partly constructed asymmetrically. The problem of body schema and body image can be approached from at least three different points of view: (a) as extending from the pathology of body schema associated with cerebral lesions (anosognosia, hemisomatoagnosia, etc.), (b) by examining the most typical psychological aspects which refer to body image (Fisher, 1968, 1970), and (c) by examining several more typically perceptual aspects which are at the basis of the construction of body schema of subjects without cerebral lesions. Shontz (1963, 1969) studied the subjective evaluation of the physical property of the body considered as an object in space.

In previous research (Ruggieri, *et al.*, 1979) it was shown that hemispheric asymmetry for one function (tickle sensibility) can be modified by somatic variations (pregnancy) which contemporaneously change body schema. Research on lateralization of ocular dominance (Ruggieri, *et al.*, 1980) has shown that cerebral dominance cannot be viewed only in a categorical sense but must be interpreted along a continuum. In addition to right- and left-dominant subjects, there are also others who show no dominance and those who manifest fluctuating dominance (one time right, another time left). Thus we must consider a phenomenon of dynamic balance between two hemispheres. Returning to body schema in relation to lateralization, several authors (Varni, *et al.*, 1975) have shown that there are bilateral differences in body awareness, in tonic skin conductance, and in perception of the body (Friedlander, 1964).

Neuropathological research on laterality has indicated that lesions in the

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right posterior parietal region are responsible for disturbances in body schema (Hecaen, 1976), specifically in the case of contralateral hemisomatoagnosia, with a much greater frequency of lesions in the corresponding left hemisphere. For this reason there is a tendency to hold that the organization of body schema is a right-lateralized function (Luria, 1976).

It is necessary to study body schema of subjects without cerebral lesions. In the present study essentially perceptual aspects were examined. To carry out our procedures we utilized a test with an approach similar to that of F. Shontz (1963, 1969) but focused the perception of opposite areas, half on the right and half on the left side of the body. The measures of subjective perception were then compared with measurements of the actual dimensions of the part perceived. We assume subjects' responses represent a synthesis of kinesthetic and visuo-spatial perceptions converted into visual quantified size. Our hypothesis was that a functional asymmetry exists in the perception of symmetric parts of the body and that such differences can be arranged along a continuum.

METHOD

Subjects

The experimental group included 44 female undergraduates in psychology; their ages were between 19 and 39 yr., with a median age of 27 yr. All subjects verbally declared themselves right-handed.

Materials

The study of body schema was carried out using a test of body perception based on an approach similar to that of F. Shontz (1963, 1969). In our test we focused particularly on the perception of areas, half on the right and half on the left side of the body. The accuracy of perception was derived from the comparison of subjective evaluation with the corresponding actual measurements of the following parts of the body: (1) width of face (from the root of the nose to the top of the ear), (2) length of face (from the chin to the center of the eyebrow), (3) length of the shoulder (from the base of the neck to the beginning of the arm), (4) trunk (from the middle portion of the shoulder to the point where the thigh begins at the height of the groin), (5) trunk (from the center of the sternum to the center of the armpit), (6) thorax (from the nipple to a corresponding point on the back), (7) arm (from the shoulder to the wrist, discounting the hand), (8) hand (from the wrist to the tip of the middle finger), and (9) length of the body (from the shoulder to the heel).

The extents were measured for both the right and left sides of the body. The subjective evaluation was carried out by the subject who moved two sliding rules along a horizontal board to indicate a judgment. A vertical bar was attached to each sliding rule. The subjective evaluation was the distance in centimeters between the two vertical bars. The actual measurement of the body was carried out using a compass. Before making measurements of the

body, each subject was asked to estimate the size of three wooden bars (9.5 cm, 30 cm, and 90 cm) to identify any perceptual difficulties. Index of deviation was obtained by calculating subjective estimation/size $\times$ 100. If the index equaled 100 the perception was correct, if it was greater than 100 the error was in overestimation, if less than 100, of underestimation.

Procedure

The measurements were carried out between 9:30 a.m. and 12:30 p.m. The environmental conditions were standard. The subject, fully clothed, was asked to sit in front of the apparatus. A sheet was stretched from the lower edge of the horizontal board of the apparatus so that it covered the entire body other than the head. The subject could move the sliding rule of the apparatus without seeing any part of her body. The female experimenter was in front of the subject and the apparatus from which she was separated by a vertical screen. Unseen, the experimenter could survey the distance between the sliding rules through a horizontal opening in the screen. The subject was given the following instructions: "This apparatus is used to make linear measurements. From time to time I will ask you to approximate the size of a part of your body. By moving these two bars you can make a visual representation of the bodily measurements requested. To become familiarized with the test, we will start by estimating sticks of wood."

The bodily stimuli were presented randomly; after the subjective measurements, the experimenter moved on to the objective measurements. For each subject we calculated an index of deviation for both right and left halves of the body.

RESULTS

In the group tested, 25 subjects presented a larger index of deviation on the left (L+), 14 a larger index of deviation on the right (R+), and 5 showed no differences between right and left halves (L = R). The distribution of the differences between right and left indexes of deviation for the whole group is shown in Fig. 1. As can be observed, the subjects are distributed along a continuum. The L+ subjects showed a mean deviation for the right half of the body of 124.69 ($SD = 15.08$) and for the left half of the body 132.15 ($SD = 15.59$). The difference between indexes of perceptual error of the two halves is statistically significant (Student's t for dependent means = 5.53, $df = 24$, $p < 0.05$).

The R+ subjects showed a global deviation score for the right half, mean values of 130.63 ($SD = 16.65$) and for the left half of 124.19 ($SD = 15.42$). The difference between the two mean scores is statistically significant (Student's t for dependent means = 3.40, $df = 13$, $p < 0.05$).

The subjects with a zero difference had a mean score for the right half of

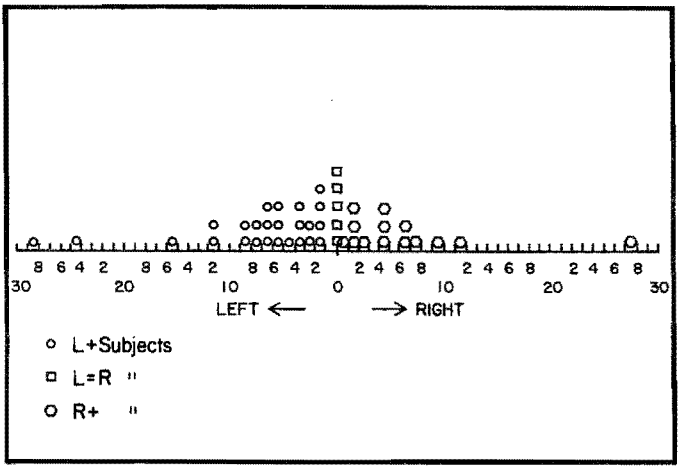

FIG. 1. Distribution of differences between right and left indexes of deviation for the whole group

121.19 ($SD = 9.33$) and for the left half of 121.28 ($SD = 8.95$); Student's t for dependent means $= 0.38$, $df = 4$, $p > 0.05$.

A comparison of the index of deviation for the left half for L+ subjects versus R+ subjects gave a t ratio of 1.53 ($df = 38$, $p > 0.05$). The mean score of the deviation index (perceptual error) for the whole group was, for the right half 126.19 ($SD = 15.15$) and for the left half 125.69 ($SD = 23.13$). The difference between estimates for right and left halves of the body for all subjects combined was not statistically significant ($t = 0.158$, $df = 43$, $p > 0.05$).

DISCUSSION

The results confirm the hypothesis of an asymmetry in the accuracy of perception of the two halves of the body. Such perception refers to various afferences (kinesthetic, visuo-spatial) that come from a particular area of the body. It can be pointed out that such differences are not all in the same direction, the majority of the subjects (56%) had a greater index of perceptual error for areas on the left side of the body but a rather consistent number of subjects (31%) showed a greater index of error for areas on the right side of the body. There was also a group of subjects (11%) who showed no significant differences in the perception of the two halves of the body. This group had a lower index of perceptual error relative to the other two groups, but the low numerical consistency did not allow us to make a thorough statistical comparison. The existence of these three subgroups (L+, R+, R = L) at opposite orientations makes it understandable that, considering the group as a

whole, no statistically significant differences emerged between perceptual errors for the right and left halves of the body.

It must also be pointed out that perceptual differences appear for a group composed exclusively of right-handers (verbal report). We are aware, however, that only a verbal report of functional preference is insufficient for clarifying the much larger problem of cerebral dominance. As we stated in the introduction, the phenomenon of dominance must be placed along a continuum which ranges from extremely lateralized subjects to subjects for whom such functional asymmetry is completely absent. But the most important confirmation of the hypothesis that there is a continuum can be seen by observing the distribution of the index of error for our group (see Fig. 1). A complete interpretation of this phenomenon must take into consideration several factors not considered in this study, such as (a) possible oscillations in degree of cerebral dominance for such oscillations could depend on variations which refer to the whole organism or to its parts. In this context, we wish to recall the variation in cerebral dominance observed during pregnancy (Ruggieri, *et al.*, 1979). (b) The literature has shown a high frequency of mixed forms of dominance, right ocular dominance can be associated with left-hand dominance, etc. In this context, it can be seen that the task carried out by our subjects essentially was a visual metric translation of kinesthetic information. Thus, it is possible that one type of dominance, such as visual dominance, is not in the same direction as kinesthetic dominance. For the construction of body schema, the organism tends to unify subfunctions of different lateralizations into a new synthesis. For example, take the global perceptions of the whole right and left halves of the body which precede the final unitary synthesis of the body.

These results show a difference in perceptions of the two halves of the body, but we do not know whether this difference is produced by (a) two qualitatively similar representations of body schema which have become differentiated only quantitatively or (b) a unique area of "body schema," localized only in one of the two hemispheres, which synthesizes the perceptions of the two halves of the body. On the basis of these results we feel it would be useful to study the relationship between this phenomenon of lateralization and other lateralized functions.

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