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SHAPE, SIZE AND RELATIVE SPACE POSITION PERCEPTION IN NEGLECT PATIENTS

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Shape, size and relative position in space perception were tested in 17 right brain damaged (RBD) patients with neglect symptoms, 10 RBD patients without neglect and 11 controls. Simultaneous pair comparison task in free vision was used. Two arrangements of the visual display were used: side by side and top-bottom. Neglect patients' performance was comparable to RBD and controls in the shape and size test, but was below the other groups in the relative space position test. The selective failure of neglect patients in the position task did not depend on the spatial arrangement of the visual display, which may indicate a general perceptual deficit, rather than a deficit restricted to the neglect hemifield.

Keywords: hemi-neglect, space perception

Patients with spatial neglect fail to look actively for objects or people located in the space contralateral to the cerebral lesion. However, a number of studies show that the loss of information on the stimuli in the neglect hemispace is not complete. In particular, several studies showed that the information presented to the neglected field are perceived as whole entities but do not reach the level of more elaborate cognitive organization in a variety of reading tasks (Kinsbourne & Warrington, 1962; Hillis & Caramazza, 1989; Bisiach & Vallar, 1984; Ellis, Flude & Young, 1987). A clear example of this kind of research was performed by Volpe, Ledoux and Gazzaniga (1979). Neglect patients were able to indicate whether two words tachistoscopically presented one to the left and one to the right of a fixation point were the same or different. However, they were unable to report the words actually presented in the left hemifield. In this case, it seems clear that the stimuli arriving at the intact hemispace reach higher levels of processing, while the information sent to the neglected field only reach the preliminary stages.

Recently, Riddoch and Humphreys (1987) examined the RTs of three neglect

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patients in visual search tasks of a single disjunctive feature (such as color change or figure inversion). Interestingly, detection latencies of two neglect patients did not vary with the hemifield of presentation of the visual targets, indicating that these patients can manifest preattentive processing of stimuli on both the intact and the neglected side of space.

The reviewed evidence is based on comparatively complex stimulus material (e.g., words) or visual displays (such as in the search tasks requiring the analysis of a large number of targets). One way to examine further the characteristics of the visual elaboration in neglect patients may be to evaluate their ability to solve simple perceptual comparisons which vary along a few basic figural properties. Following this approach, the present work examined the performance of neglect patients in visual comparisons based on figural properties which appear critical for perceptual organization, such as shape, size and relative position in space (hereafter called position).

In studying basic perceptual processes, a number of methodological choices were made. First, simple configurations and large modifications of the stimuli were used in order to avoid a general difficulty factor. Second, an elementary task was adopted, namely, the simultaneous pair comparison of stimuli presented in free vision under no time limit constraints. Finally, in order to account for the possible role of the exploratory movements of the head and the eyes, the stimuli to be compared were presented either side-by-side (horizontal display) or in a top-bottom arrangement (vertical display).

METHOD

Subjects

Twenty-seven CVA patients with unilateral right hemispheric lesions were examined in a rehabilitation clinic. In all patients the neurological examination, supplemented in the majority of cases by CT scan, indicated a unilateral lesion in the right hemisphere. No patient had history or evidence of psychiatric diseases, dementia or previous brain damage. The following tests for the assessment of neglect were given, according to standard procedure: (1) Albert Test (Albert, 1973): (2) Letter Cancellation Test (Diller, Ben-Yishay, Gerstman, Goodkin, Gordon, & Weinberg, 1974): (3) Sentence-Reading Test (Pizzamiglio, Judica, Razzano, & Zoccolotti, 1989); (4) Wundt-Jastrow Area Illusion Test (Massironi, Antonucci, Pizzamiglio, Vitale & Zoccolotti, 1988). On the basis of this battery patients were identified as with or without neglect disorder. All neglect patients failed in at least three tests according to the standard cut-off points (Pizzamiglio et al., 1989). There were 17 patients with neglect (8 M and 9 F). Mean age was 71.1 (sd = 7.7); on average they had 6.1 (sd = 4.1) years of schooling. There were 10 patients without neglect (6 M and 4 F). Mean age was 67.7 (sd = 8.1); on average they had followed 4.7 (sd = 4.3) years of schooling.

Eleven controls with no CNS lesions served as control group. The group was composed of 5 males and 6 females: mean age = 66.6, SD = 4; mean years of schooling = 6.3, SD = 3.5.

Materials

The experimental stimuli consisted of 72 white cards (cm 21 × 21). Two figures were drawn in black ink on each card, with a 1 mm line width. The two figures were presented in two conditions: horizontal (side-by-side) and vertical (top-bottom).

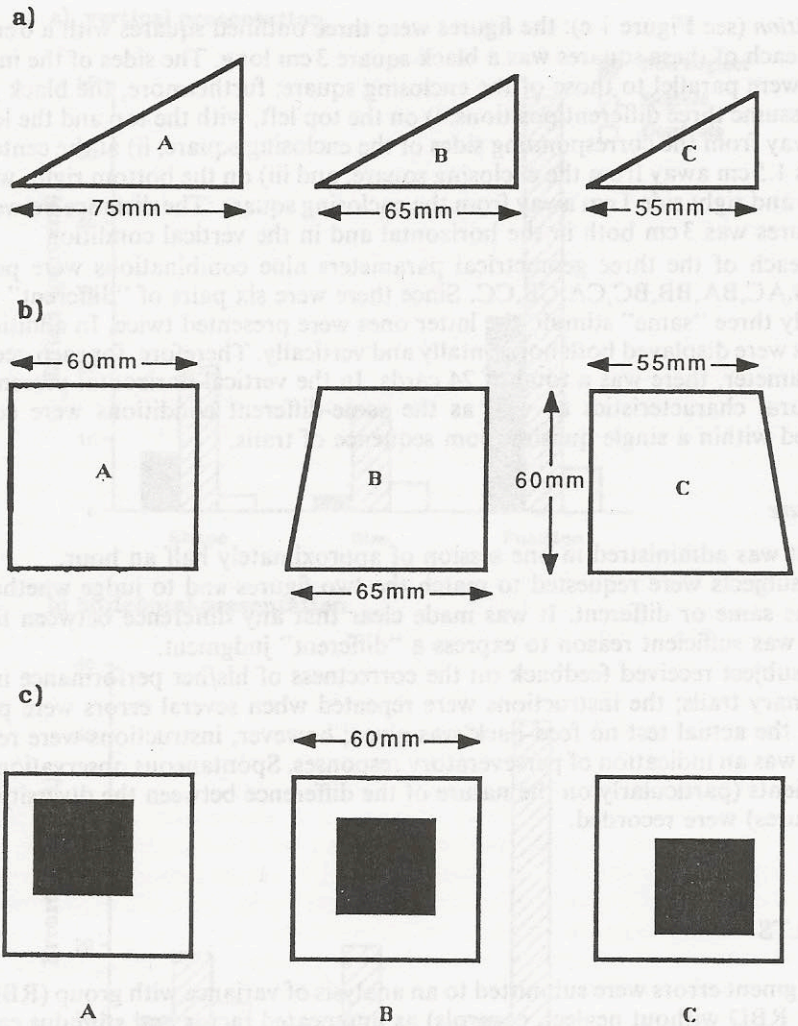

FIGURE 1 Stimuli for the size (1a), shape (2b) and space position (1c) conditions

The geometrical parameters considered were the following:

- *size* (see Figure 1 a): the figures were three right-angled triangles. The basis of the triangles was the major cathetus which formed a 30° angle with the hypotenuse. The length of the basis varied assuming the following values: 7.5,6.5 or 5.5 cm. The minor cathetus was placed on the right side. The distance between the two triangles was 2.5 cm both in the horizontal and in the vertical condition. In the former case, the bases were aligned, in the latter one, the vertical catheti were aligned.
- *shape* (see Figure 1 b): the figures were three equivalent quadrilaterals. A square with a 6 cm side; two right-angled trapezia 6 cm high, the major base of 6.5 cm and the minor one of 5.5 cm. One of the two trapezia had the tilted side oriented to the left and the other one to the right. When they were presented in the top-bottom arrangement the two figures were drawn with vertical axis aligned. The distance between the two quadrilaterals was 3 cm.

- *position* (see Figure 1 c): the figures were three outlined squares with a 6 cm side. Within each of these squares was a black square 3 cm long. The sides of the included square were parallel to those of the enclosing square: furthermore, the black square could assume three different positions: i) on the top left, with the top and the left side 1 cm away from the corresponding sides of the enclosing square; ii) at the center with all sides 1.5 cm away from the enclosing square; and iii) on the bottom right, with the bottom and right side 1 cm away from the enclosing square. The distance between the two figures was 3 cm both in the horizontal and in the vertical condition.

For each of the three geometrical parameters nine combinations were possible: AA,AB,AC,BA,BB,BC,CA,CB,CC. Since there were six pairs of "different" stimuli and only three "same" stimuli, the latter ones were presented twice. In addition, the 12 pairs were displayed both horizontally and vertically. Therefore, for each geometrical parameter, there was a total of 24 cards. In the vertical-horizontal presentation, the figural characteristics as well as the same-different conditions were counterbalanced within a single quasirandom sequence of trails.

Procedure

The test was administred in one session of approximately half an hour.

The subjects were requested to match the two figures and to judge whether they were the same or different. It was made clear that any difference between the two stimuli was sufficient reason to express a "different" judgment.

The subject received feedback on the correctness of his/her performance in three preliminary trails; the instructions were repeated when several errors were present. During the actual test no feed-back was given; however, instructions were repeated if there was an indication of perseveratory responses. Spontaneous observations from the patients (particularly on the nature of the difference between the diversity of the two figures) were recorded.

RESULTS

The judgment errors were submitted to an analysis of variance with group (RBD with neglect, RBD without neglect, controls) as unrepeated factor and stimulus category (size, shape, position), modality of presentation (horizontal-vertical) and type of comparison (same, different) as repeated factors.

The group effect was significant ($F_{(2,35)} = 13.47, p < .0001$): neglect patients made more errors (32.3%) than right brain damaged patients without neglect (17.3%) who made more errors than the controls (10.8%) ($p < .01$ in both cases, Duncan test). A significant effect of the type of comparison factor was present ($F_{(1,35)} = 4.11$, $p < .05$): there were more errors for same (25.5%) than for different (14.8%) stimuli. The other main effects were not significant.

The interactions group x stimulus category ($F_{(4,70)} = 4.01, p < .01$) and group x stimulus category x type of comparison ($F_{(4,70)} = 3.46, p = .01$) were significant. Post hoc analyses of the latter showed that for "different" trails no reliable differences were present in the shape and size categories across the three groups; in the position category, the neglect patients showed a performance decrement as compared to the other groups ($p < .01$, Duncan test). For the "same" trials the three groups were not different in any of the categories. The means for three categories of stimuli in the "different" trials are presented in Figure 2, separately for horizontal and vertical

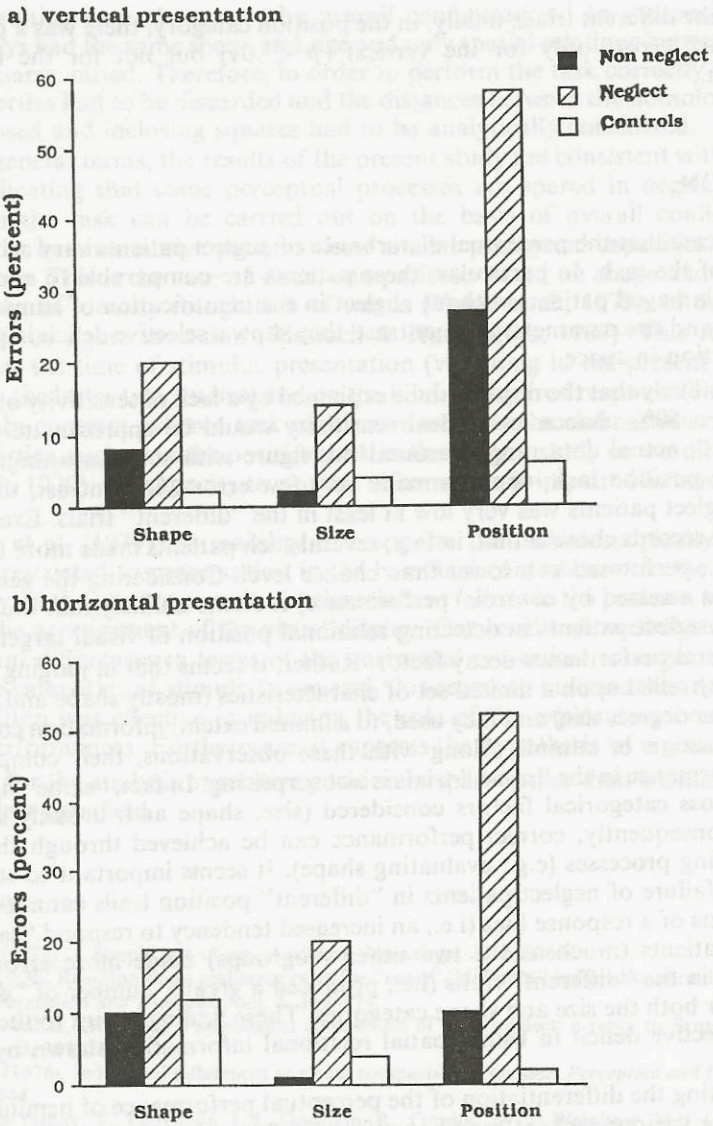

FIGURE 2 Means for three categories of stimuli in the "different" trails: 2a) vertical and 2b) horizontal presentations

presentations. Note that the selective impairment of neglect patients in the position category is independent of arrangement of the visual display.

All the first order interactions between the stimulus category, modality of presentation, and type of comparison factors were significant (at least $p < .05$) as well as the second order interaction between these factors ($F_{(2,70)} = 3.15, p < .05$). Regardless of group, for the shape category, the errors were more marked for the stimuli "same" independent of the (horizontal-vertical) modality of presentation of the stimulus pair (in both cases, $p < .01$, Duncan test); for the size category, there were more "same" errors in the horizontal than in the vertical presentation ($p < .01$) no difference being

present for the different trials; finally, in the position category, there was a prevalence of "different" errors only for the vertical ($p < .01$) but not for the horizontal presentation.

DISCUSSION

Results indicate that the perceptual disturbance of neglect patients vary according to the nature of the task. In particular, these patients are comparable to controls and right brain damaged patients without neglect in the identification of stimuli varying along shape and size parameters. In contrast, they show a selective deficit in perceiving relative position in space.

It seems unlikely that the results can be explained by a lack of sensitivity of the tasks used. Given a 50% chance level, ideal sensitivity would be approximately 25% of error. Overall, actual data ranged around this figure with some meaningful exceptions. In the position task, controls made very few errors. In contrast, the performance of neglect patients was very low at least in the "different" trials. Examination of individual records showed that, in fact, several such patients made more than 50% of errors, i.e., performed at a lower than chance level. Considering the general ease of the test (as assessed by controls' performance) it seems unlikely that the derangement of the neglect patients in detecting relational position of visual targets may be due to a general performance decay factor. Rather, it seems that in judging the pairs of figures they relied upon a limited set of characteristics (mostly shape and, presumably to a lesser degree, size) and they used, to a limited extent, information concerning relational position of stimuli. Along with these observations, their comparatively normal performance in the "same " trials is not surprising. In fact, "same" figures are coherent across categorical factors considered (size, shape and, broadly speaking, position). Consequently, correct performance can be achieved through the use of different coding processes (e.g., evaluating shape). It seems important to stress that the selective failure of neglect patients in "different" position trails cannot be interpreted in terms of a response bias (i.e., an increased tendency to respond "same"). In fact, these patients (much as the two other subgroups) made more errors in the "same" than in the "different" trails (i.e., produced a greater number of "different" responses) for both the size and shape categories. These findings point to the reliability of the selective deficit in using spatial relational information shown by neglect patients.

In interpreting the differentiation of the perceptual performance of heminattentive patients in the various tasks it may be useful to refer to the distinction of different processes mediating visual elaboration proposed by the cognitive literature. One line of thought segregates holistic versus analytic processes in visual recognition (Bamber, 1969; Cooper, 1976; Krueger, 1978). On the basis of this distinction we can propose that the comparison of stimuli varying in shape and size requires the first type of perceptual processing, while the comparison of stimuli varying in relational position requires more analytical and sequential processing of the stimulus properties. In fact, the difference in the stimuli for the shape comparisons was produced by dichotomous properties of the stimulus-figures. Squares were compared either with themselves or with trapezia; and trapezia were also compared either with themselves or with their mirror images. In all these cases, the two figures of the couple differed for an on-off feature without any intermediate step. In the case of size comparisons, the difference between the two figures was produced by a change in the length of all sides of the

triangles resulting in a change in the overall configuration.[1] In the position task, stimuli always had the same shape and size and only spatial relations between the two enclosed squares varied. Therefore, in order to perform the task correctly configurational properties had to be discarded and the distances between the homologous sides of the enclosed and inclosing squares had to be analytically considered.

In more general terms, the results of the present study are consistent with previous findings indicating that some perceptual processes are spared in neglect patients. Thus, when the task can be carried out on the basis of overall configurational properties the heminattentive patients show similar perceptual capacities across the external space. This is the case of visual comparisons based on shape and size in the present study, of identity recognition of words (Volpe et al., 1979), of detection of color change or figure inversion (Riddoch & Humphreys, 1987). This result is independent of the time of stimulus presentation (very long in the present study and very brief in the latter two studies) and on the kind of required response (either verbal or motor). In contrast, when a task requires more than the elaboration of dichotomous properties, such as in the position task in the present study or word recognition (Volpe et al., 1979), the capacity to process information is impaired in heminattenive patients.

In Volpe et al. (1979) the inability to recognize the tachistoscopically presented words was restricted to presentation in the hemifield contralateral to the lesion. On the contrary, in the present experiment the selective failure in the position task did not vary with the arrangement of the visual display. Our results showed that there were no significant differences in terms of the horizontal or vertical arrangement for any of the three categories of stimuli. In general, this seems to indicate that the modality of presentation was effective in reducing the role of the exploratory component in patients' performances. Furthermore, it suggests the hypothesis of a general perceptual deficit for the analysis of relative position in space rather than a deficit restricted to the neglect hemifield.

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[1] Size modifications are not dichotomous, like shape modifications. However, when size modification is large, the global transformation of the figure produced is perceived as a whole and does not require analysis of single elements of the figure.

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