

WE investigated copying of simple contours by a patient with left neglect after right hemisphere lesion. The stimuli were rectangles or circles with one or two internal boundaries defined by a black–white or a two-colour contrast. On each trial, the patient attempted to copy the contour of one of the (prespecified) sub-figures defined by a boundary contrast. Copying was accurate when boundaries were the right edges of sub-figures; when physically identical boundaries were the left edges of the sub-figures, accurate copying was impossible. These results held even when, prior to copying, the patient traced the outline of the figure (and ground) with his finger. A ‘representational’ account of object-centred neglect is supported.

Key words: Visuo-spatial neglect; Right parietal lesion; Spatial parsing; Figural perception

Figural perception and parsing in visuo-spatial neglect

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Introduction

Driver *et al*¹ have recently reported a novel technique that seems to confirm other evidence² for the existence of object-centred left visuo-spatial neglect. Their patient (who had suffered an extensive right hemisphere stroke) could recognize the shape of a boundary between a small (nonsense) figure (in one colour) and the (laterally larger) ground (in another colour) when the entire figure was in left space relative to the display as a whole; in this condition, the dividing contour that segregated figure from ground was thus on the right of the figure. By contrast, when the figure as a whole was in right space and the contour that marked the boundary of figure and ground was now accordingly on the left of the figure, recognition of the shape of that contour was at chance.

The method employed by Driver *et al*¹ was elegant and their results were compelling. The design of their experiment, however, involved two distinct steps with the consequent involvement of visual short-term memory. The two-colour stimulus configurations were first presented briefly (2 s); this display was then succeeded by an outline contour positioned below but at the lateral centre of the original stimulus configuration. This latter contour had to be judged as the same as, or different from, the (colour-determined) boundary of the stimulus configuration.

The current study was a constructive replication and extension of this finding. We wished to know whether analogous effects could be obtained in a direct copying task with unlimited viewing time in free vision.

Materials and Methods

Subject: R.B. is a 51-year-old man who has shown severe and stable left visuo-spatial neglect over the 3 years

since he sustained a large right middle cerebral artery infarct. The major neurological impairments were a dense left hemiplegia, left homonymous hemianopia, and left sensory loss. Visual acuity (glasses corrected) was 6/9 in each eye (in the good field). Further details of the case, including substantial testing of neglect, have been reported previously;^{3,4} the latter paper⁴ includes the CT scan showing an extensive right parietal infarct.

Procedure: Stimulus drawings of the type illustrated at the top of Figures 1, 2 and 3 were produced. In some instances, the figures contained a black–white contrast, in others a two-colour contrast. The overall size of the rectangular displays was A4 (298 mm × 208 mm); the diameter of the circular display was 192 mm.

Each drawing was individually placed on the desk-top in front of the patient and centred on the midsagittal plane. Immediately below each stimulus, either a blank sheet of A4 or a sheet of A4 that contained the circular outline of Figure 2 was placed. On two testing sessions (separated by a year), R.B. was requested to copy these displays (onto the blank or partially blank page) in free vision and without a time limit.

For Figures 1 and 2, R.B. was (verbally) required, on any given trial, to copy either the right half or the left half of the display. For figures of type 3, he was required to copy the leftmost sub-figure, the central sub-figure, or the rightmost sub-figure. On half the trials, R.B. was first required to trace with his finger the outline of the A4 page (Figs 1 and 3) or the outline of the circle (Fig. 2), and (for all figures) the internal contour of the figure on the stimulus page. He then performed the relevant copying task, with a pen held in the right hand, immediately afterwards; he was told to stop only when he was fully satisfied with his copy.

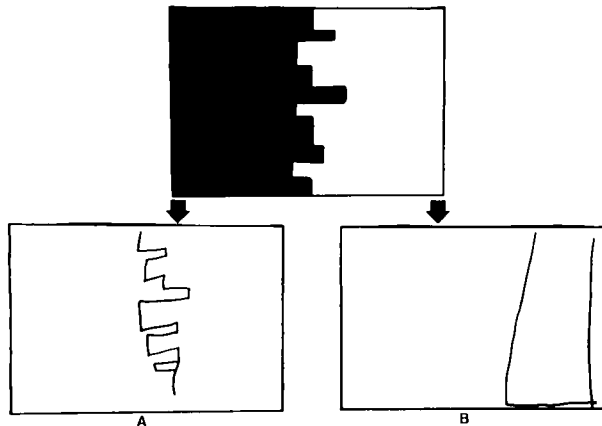


FIG. 1. Stimulus configuration and R.B.'s copy of the black sub-figure (A) and the white sub-figure (B).

Results

A representative sample of the results is shown in Figures 1a and b, 2a and b, and 3a, b, and c. The findings are reliable in that each one was replicated at least four times (across the two testing sessions). The effects were consistent irrespective of whether the boundary was a colour contrast or a black-white contrast (and irrespective of whether the black area was on the left or the right). Exactly the same effects were found in the con-

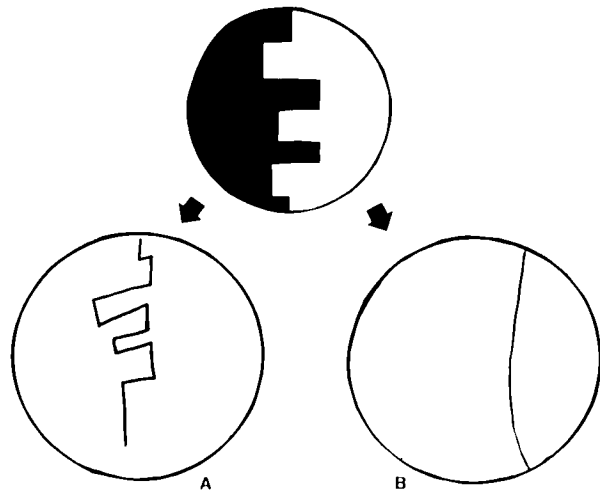


FIG. 2. Stimulus configuration and R.B.'s copy of the black sub-figure (A) and the white sub-figure (B).

ditions where R.B. was first required to trace around all relevant contours immediately before making his copy. On half the trials, R.B. copied the left sub-figure before copying the right sub-figure with the stimulus display constantly in front of him. Even in these circumstances when the right contour of the left sub-figure was accurately drawn, he still reliably failed to reproduce the same contour when it was now the left contour of the right sub-figure.

It is apparent that R.B.'s performance was good when the dividing contour was on the right side of the left figure and extremely poor when the physically identical contour was on the left side of the right figure. His responses in the latter conditions show that a contour was perceived although its actual shape could not be reproduced.

Discussion

The results clearly show that the figural parsing effect reported by Driver *et al*¹ can be obtained in free vision and unlimited time: the detailed configuration of the right boundary of an object is adequately perceived (and reproduced); the same left boundary is not. We emphasize again that (unlike the displays used by Driver *et al*¹), the boundaries in question are, in all physical respects, identical across the figurally defined conditions. These results provide strong evidence that what is (accurately) 'seen' in neglect depends not solely upon the character and objective position of the external stimulus, but more critically upon the representation of that stimulus in particular spatial co-ordinates.

We are inclined to suggest that in both our experiment and that of Driver *et al*¹ those co-ordinates are object centred.⁵ That our experiment was conducted in free vision does, however, raise the possibility that our patient's eye fixations were (in the main) directed toward (the centre of) the specific sub-shape to be

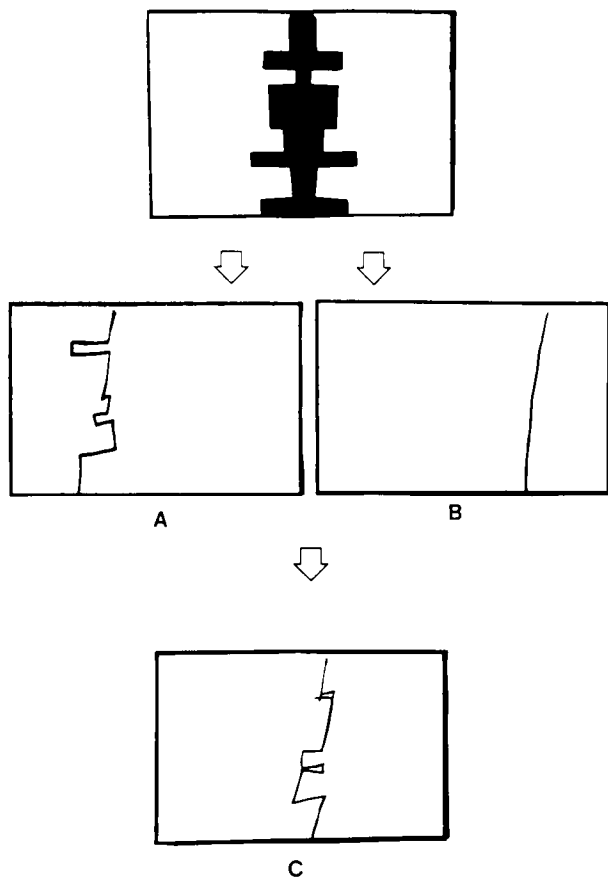


FIG. 3 Stimulus configuration and R.B.'s copies of the left sub-figure (A), the right sub-figure (B) and the central (black) sub-figure (C).

copied on each trial. If this were so, the left of each fixated figure would then fall to the left in purely retinal co-ordinates. This same possibility exists in the experiment of Driver *et al.*¹ an exposure duration of 2 s is more than sufficient to direct a saccade to the figure on the left of their displays. In order to rule out such retinal readjustments, Driver *et al.* required central fixation of the display as a whole, and they excluded from their data set those early trials on which there were obvious leftward (or rightward) saccades; unlike R.B., their patient did not have a visual field deficit.

This leaves in play the hypothesis that in the experiment of Driver *et al.*, there has been an 'attentional' shift directed toward the cued global shape (but without any overt eye movements thereto). Such an attentional shift would suffice to realign a figure within internal ego-centric co-ordinates. But at this point, the logical distinction between object-centred and ego-centred neglect vanishes. One could therefore call the effect a form of 'representational neglect'.⁶

Our own effect (in free vision) is a very strong form of representational neglect in that it is observed when the only difference between the contour details that can and cannot be reproduced is determined solely by how the figure is spatially represented. The internal representation relevant to copying performance is furthermore not affected by the prior tracing task; details of the left contours of figures cannot be copied despite the fact that the patient had, immediately before, traced that contour accurately.

There is always a trade-off between the respective virtues of performing a task in free vision and with fixation controlled. The study of Driver *et al.* has the virtue that no purely retinotopic explanation of their results is possible; the methodological drawbacks

include the brief inspection time of the display and a temporal lag between presentation of that stimulus configuration and the (isolated) contour to be judged against the original stimulus. Our study in free vision cannot exclude the influence of retinotopic factors; the corresponding methodological virtue is that a dramatic effect is obtained despite there being no present time limits on any aspect of the procedure. The patient is free to inspect the stimulus configuration in any manner that he is capable of so doing. It is, of course, gratifying that the results from the two techniques seem to converge upon the same interpretation.

Conclusion

Our new copying technique adds significantly to the range of methods for investigating visuo-spatial neglect in free vision. The technique yields the result that left neglect is determined by how a configuration is internally represented in spatial co-ordinates that are not derived purely from the objective characteristics of the stimulus display.

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ACKNOWLEDGEMENTS: This work was supported by the Medical Research Council. We also gratefully acknowledge the time that Dr Jon Driver took to discuss his and our results with us.

**Received 4 November 1993;
accepted 5 December 1993**