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Stimulus context in hemineglect

Randolph S. Marshall,[1] Ronald M. Lazar,[1,2] John W. Krakauer[1] and Ruchey Sharma[3]

Departments of [1]Neurology and [2]Neurological Surgery, Neurological Institute of New York, Columbia-Presbyterian Medical Center, New York and [3]Northwestern University, Evanston, Illinois, USA

Correspondence to: Randolph S. Marshall, MD, Neurological Institute of New York, 710 W 168th Street, New York, NY 10032, USA. E-mail: rsm2@columbia.edu

Summary

Rightward deviation on bisection of a horizontal line is well described in patients with right brain injury and left hemineglect. Because of the observation that hemineglect patients may bisect very short lines to the left of the true midpoint (the so-called crossover effect), additional models have been proposed to incorporate this finding into existing theories of hemineglect. We investigated a line-length effect in six patients with left hemineglect. When presented with any set of lines of uniform (reference) length, percentage rightward deviation on line bisection remained constant across different line lengths. When lines of a second length were mixed into any uniform set of lines, bisection performance on the reference lines changed. A rightward shift in the perceived midpoint of the reference line occurred if the added lines were shorter than the reference lines; a leftward shift occurred if the added lines were longer. Leftward shifts included shifts across the true midpoint, reproducing the crossover effect. Shifts in the perceived midpoint occurred both on a manual line bisection task and on a line bisection discrimination task in which no manual response was required. We propose that the crossover effect may be part of a more general stimulus-context effect in which the perceived midpoint of a line is related not to absolute length, but to the line's length relative to other lines with which it is presented. Such a context effect has not hitherto been described in the neglect syndrome. A possible mechanism for the effect is a generalization of length estimation produced by the combined influence of the focal stimulus and all stimuli that precede it.

Keywords: hemineglect; line bisection; crossover effect; visual–spatial processing

Introduction

Patients with right brain injury who are asked to bisect a horizontal line often transect the line to the right of the true midpoint. When this manifestation of hemineglect occurs, a systematic error may be seen such that longer lines are transected further to the right than are shorter lines (Bisiach *et al.*, 1983; Riddoch and Humphreys, 1983). A complexity in the characterization of a line length effect is the observation, first reported by Halligan and Marshall, that patients with left hemineglect may transect lines to the left of the true midpoint when presented with very short lines (Halligan and Marshall, 1988; Marshall and Halligan, 1989). This counterintuitive 'crossover effect' has been replicated by several investigators, using both manual line bisection (Tegnér *et al.*, 1990; Tegnér and Levander, 1991; Anderson, 1997) and non-motor tasks requiring right—left spatial judgements (Milner *et al.*, 1993; Chatterjee, 1995; Anderson, 1997).

The crossover effect has been problematical for behavioural theorists to date because it is not readily encompassed by current models of hemineglect (Bisiach *et al.*, 1996). Most theories of hemineglect, including decreased attention within the contralateral hemispace (Heilman and van Den Abell, 1980), diminution of a hemispheral attentional 'vector' (Kinsbourne, 1987), inability to disengage from stimuli on the right (Posner *et al.*, 1984), ipsilesional compression of spatial representation (Milner *et al.*, 1993) and 'directional hypokinesia' towards the contralesional side (Heilman *et al.*, 1985), can explain rightward deviation on line bisection, but do not account for what appears to be a reversal of a rightward bias when very short lines are presented.

To date, there have been three conceptual explanations for the crossover effect. Marshall and Halligan (1989) hypothesized that, whereas perception based on a larger Weber fraction for longer lines would allow an acceptable bisection further to the right of the midpoint in hemineglect patients whose attentional focus approached the perceived midpoint from right to left, very short lines could be encompassed within foveal vision. With the whole line visualized, hemineglect patients would switch to a 'normal' left-to-right attentional approach and perceive the Weber fraction for the noticeable difference between two halves of the line slightly left of the midpoint (Marshall and Halligan, 1989). Alternatively, Anderson (1996) created a mathematical model of attentional 'saliency' that simulated the crossover effect at very short line lengths without requiring a change in attentional strategy. The model requires specific input functions for the magnitude, breadth and spatial position of the attentional fields of the two hemispheres, and is based on Heilman and Van Den Abell's (1980) theory of hemispheral attentional asymmetry. A third explanation for the crossover effect comes from Chatterjee (1995), who noted that patients with left hemineglect confabulated letters at the beginning of short words and pronounceable non-words read aloud. He proposed that a region of disinhibition existed at the leftward edge of neglect patients' 'attentional window' which would promote completion or confabulation of the left end of a short line, and thereby enable them to perceive shorter lines as longer than their objective length.

A central assumption in all three models is that there is some absolute line length below which a crossover will occur. We observed during clinical examinations that 'crossovers' appeared unexpectedly with relatively long lines (6 or 8 cm) in test sessions in which these lines were the shortest of those presented. This observation led us to consider the presence of the longer lines as an independent variable in line bisection performance of shorter lines. We began to investigate the effect of line length in context by asking our patients to perform bisections on a single line length, then in a set combining the reference length with one other length. In this study six patients with left hemineglect are reported. Each of the patients bisected shorter lines to the left of the true midpoint during some part of their testing. We hypothesize that the crossover effect may be part of a more general stimulus-context effect in which leftward or rightward shifts in the perceived midpoint of a line are related not to the absolute length of the line but to the line's length relative to other lines with which it is presented.

Method

Subjects

Six right-handed patients with right brain injury due to stroke were examined for the line length context effect between August and October 1997. During this period, three of the patients were within 1 week after stroke onset (Patients 1, 2 and 5) and three patients were 2–3 months after stroke (Patients 3, 4 and 6). All patients showed evidence of hemineglect on a standard line bisection (Schenkenberg *et al.*, 1980) or letter cancellation task (Weintraub and Mesulam, 1988). Patient characteristics, lesion location and initial hemineglect performance 1–7 days after stroke are shown in Table 1.

Protocol

Each patient was presented with a baseline set of reference lines of a single length, followed by a second set (combination set) containing the reference length lines intermixed with lines of a single other length. One or more mixed sets were used with any given reference set for each patient, depending on the clinical availability of the patient. Test sessions (reference line set followed by combination set) were separated from other sessions by a session with a distractor task (e.g. target cancellation) or by at least several hours. Two different line bisection tasks were used.

Manual line bisection

Eight horizontal lines of uniform length were presented as reference sets. The reference length could be 3, 4, 6, 9 or 12 cm. Immediately following the reference set, an experimental set was presented consisting of eight reference length lines pseudo-randomly mixed with eight lines of one of the other lengths (see Results section for specific length combinations used for each patient). Lines were 2 mm wide, drawn in black, and were presented individually on 21.5×28 cm (8.5×11 inches) white sheets of paper with the long axis of the paper orientated horizontally. Lines were centred on the page and the paper was centred on the patient's mid-sagittal plane. No restrictions were placed on head or eye movements. There were no time limits. Patients were instructed to make a mark across the centre of the line that would divide the line exactly in half. Deviations from the true midpoint were expressed in percentages, as in the method of Schenkenberg (Schenkenberg *et al.*, 1980), 0% denoting the true midpoint, +100% the right end of the line and −100% the left end of the line. Line bisection performance for reference sets was compared with performance on reference lines within mixed sets as described above.

Line bisection discrimination

In order to minimize the potential confounding effects of a manual component from the line bisection task, some patients performed a line bisection perception task similar to Milner's 'landmark task' (Milner *et al.*, 1993). This task was performed by Patients 4, 5 and 6. Patients viewed on a 25 cm computer screen a set of 30 consecutively displayed horizontal lines that were transected by a vertical black line placed either at the midpoint or eccentrically by 5%, 10%, 20%, 40% or 80% to the right or left. Patients were instructed to indicate which segment of the line was longer or if the segments were equal in length. Because we were concerned that responding verbally with the words 'right' or 'left' might bias subsequent responses, the segment of the line on either side of the transection was coloured red or blue, and patients were instructed to say 'red' if the red segment appeared longer, 'blue' if the blue segment appeared longer or 'equal' if the segments appeared to be of equal length. Red and blue segments were counterbalanced and randomly presented on the right or left of the transection. Patients were instructed to perform the task as accurately as possible. No time restriction was placed on them. Head and eye movements were not restricted. The 'perceived midpoint' for a given set of lines was calculated by tallying all erroneously judged bisections and averaging their percentage deviations from

Table 1 *Patient characteristics, lesion location and initial hemineglect assessment*

Patient	Sex/age	Lesion location	Target cancellation*	Line bisection†
1	M/48	Frontal, parietal	30, 2	20% right
2	M/69	Medial occipital, posterior thalamus	30, 18	13% right
3	M/73	Temporo-occipital, lateral thalamus	30, 23	3% right
4	F/41	Superior parietal	27, 3	20% right
5	M/75	Frontal and parietal	30, 23	51% right
6	F/74	Temporoparietal	30, 25	14% right

*Targets missed out of 30 (left, right).
†Average error on mixed set of 6 and 12 cm lines

the true midpoint on a scale from −100% (left end of the line) to +100% (right end of the line). As in the manual line bisection test, patients were presented with a reference set followed by the experimental set containing reference length lines pseudo-randomly mixed with lines of one other length.

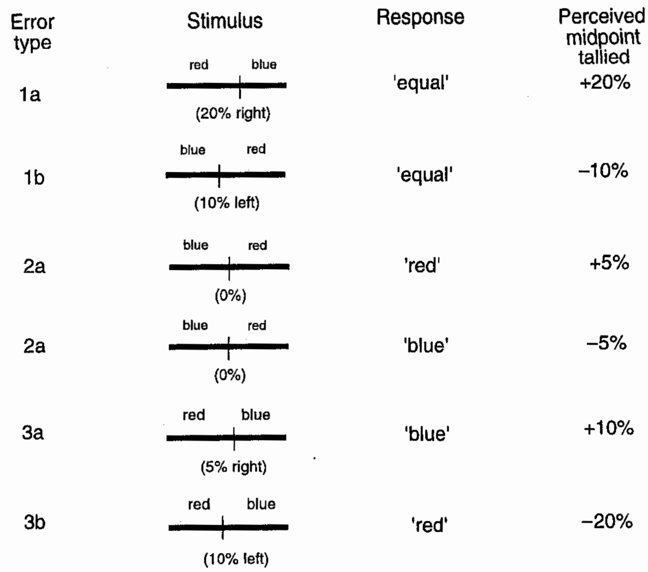

Fig. 1 Perceived midpoint calculations for the line bisection discrimination test. Stimulus presented, response made by patient and perceived midpoint tallied for three error types (see text). Lines of subtype 'a' represent rightward errors; lines of subtype 'b'represent leftward errors.

Statistical methods and scoring

To determine whether bisection performance on reference length lines was influenced by the introduction of a second line length, individual percentage deviations (or 'percentage misjudgements' on the line length discrimination test) for the reference lines were grouped by the comparison line length with which they were presented. The percentage deviations for a set of 6 cm lines presented in isolation, for example, would be compared with the percentage deviations on the 6 cm lines which were presented within the set mixed with 12 cm lines. Comparisons were done using Student's *t*-test for two group comparisons or ANOVA (analysis of variance) for more than two groups.

Scoring method for the line bisection discrimination test

In tallying the misjudgements of the transected lines, three error types were possible (Fig. 1). The first error type was one in which an eccentrically transected line was judged as 'equal.' For errors of this type, the percentage deviation of the line presented was tallied. For example, for a line transected 20% to the right that was called 'equal,' the perceived midpoint was tallied as +20% (example 1a in Fig. 1). In example 1b in Fig. 1, a line transected 10% left called 'equal' was tallied as −10%. The second error type was one in which an equally bisected line was reported as one side being longer, as in the response 'red' in example 2a in Fig. 1. In this case the perceived midpoint for that line must lie somewhere between the bisection and the right end of the line. We chose as a conservative estimate for the perceived midpoint the transected line in the set with the smallest rightward deviation. For the line shown in example 2a, the equally bisected line called 'red' (right longer) would be tallied as +5% since the next rightward transection in the set of lines was 5%. This hypothesized perceived midpoint would eventually be tested by the actual presentation of a line transected 5% right. Example 2b in Fig. 1 represents the same type of error, but to the left rather than to the right. A third type of error is represented in Fig. 1 as example 3a (rightward) and 3b (leftward). In example 3a, a 5% right line was called 'blue' (right longer). The next greater deviation in the set was 10% right; therefore, +10% would be tallied as the estimated perceived midpoint. In a subsequent trial, if a 10% rightward transection was then called 'equal' when it was presented, the hypothesis that the perceived midpoint was 10% right of centre would be confirmed and another +10% would be tallied. If, instead, the patient correctly identified the left side as longer, no error would be tallied, leaving a +5% perceived midpoint previously tallied from an error type number 2, and the 10% perceived midpoint tallied from an error type number 3 to be averaged, resulting in a calculation of +7.5% as the perceived midpoint. By presenting the whole spectrum of transected lines, from 80% leftward to 80% rightward, and tallying all errors in this way, the patient's perceived midpoint for a given set of lines could

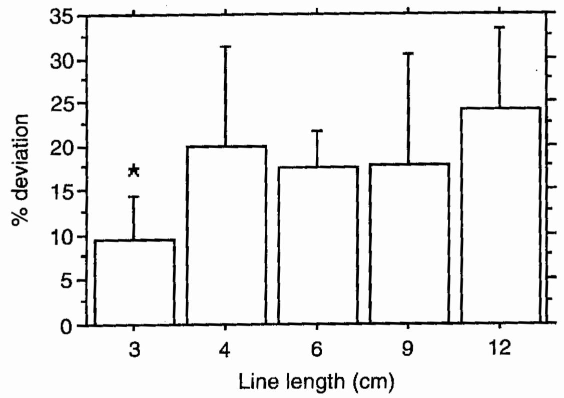

Fig. 2 Bisection performance of different length lines by Patient 1. Each set contained lines of a single length. Transections of 4, 6, 9 and 12 cm lines were not significantly different from each other, whereas bisection of 3 cm lines was significantly closer to the true midpoint than longer lines. *$P < 0.01$.

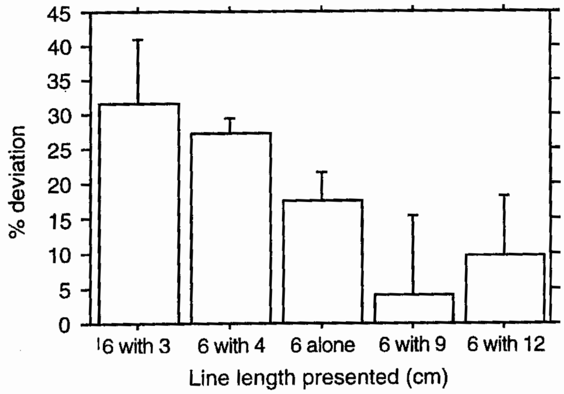

Fig. 3 Bisection performance on 6 cm lines when 6 cm lines were presented alone or in a mixed set with lines of one other length.

Performance on the 3 cm line alone showed a lower rightward percentage deviation.

be derived. Lines of 4, 8 or 16 cm were used as reference line sets, followed in each case by a mixed set of reference length lines pseudo-randomly mixed with lines of one of the other lengths. The perceived midpoint for the reference set was compared with the perceived midpoint of the reference lines within the mixed set (see Results section for specific combination sets used for each patient).

Results

The addition of longer lines to a set of reference lines shifted the perceived midpoint of the reference line leftwards. The addition of shorter lines shifted the perceived midpoint rightwards. This effect of line length in context was demonstrated in all six patients on the manual line bisection test, the line bisection discrimination test or both tests. The specific tests performed by each patient depended on clinical availability for testing and the duration of the hemineglect syndrome. All patients except Patient 5 performed the manual line bisection task. Individual patients' performances are reported below.

Patient 1

Patient 1 was tested for a context effect using 3, 4, 6, 9 and 12 cm lines. The patient was given sets of reference lines 3, 4, 6, 9 or 12 cm alone, in each case followed by a mixed set of lines containing the reference lines and one other length line.

Bisection performance without context

When the average percentage deviations were compared for each reference set prior to the presentation of comparison length lines, the percentage deviation from the true midpoint was not significantly different for the 4, 6, 9 and 12 cm lines tested alone [$F(4,67) = 0.681$, $P = 0.57$] (Fig. 2).

Bisection performance with context

The greatest number of comparison lengths was done with 6 cm lines as a reference set. Average percentage deviation with 6 cm lines alone was 17.6% to the right of the true midpoint (represented by the middle bar of Fig. 2). When mixed with 3, 4, 9 or 12 cm lines, 6 cm lines were bisected an average of 31.6, 27.3, 4 and 9.6% right of the true midpoint, respectively (Fig. 3). We grouped each set of 6 cm bisections by the comparison line length with which it was mixed and compared the percentage deviations using factorial ANOVA. The influence of the comparison line lengths on performance with the 6 cm lines was highly statistically significant [$F(4,67) = 9.525$, $P < 0.0001$].

The influence of a second line length on performance with other reference lines produced the same effect as that observed with the 6 cm lines, although we tested only one or two combinations for other reference lengths. Lines of 9 cm were bisected 18% to the right when viewed in isolation, but 32% to the right when viewed in combination with 6 cm lines. Lines of 4 cm were bisected 20% right in the reference set, but only 6% rightwards when combined with 12 cm lines. Lines of 12 cm were bisected 22% rightwards when presented alone and 28% rightwards when combined with 9 cm lines. Of particular note were the 3 cm lines, which were bisected 8% right of the midpoint when viewed in isolation but 2% to the *left* of the midpoint when combined with 6 cm lines. When we combined all reference sets by normalizing for line length, any line shorter than a reference line shifted the reference line bisection rightwards and any longer line combined with the reference line shifted the bisection leftwards (Fig. 4). These results were highly statistically significant [$F(2,141) = 19.324$, $P < 0.0001$].

Patients 2–6

Five other patients with left hemineglect were tested in a similar manner, although they were available for fewer testing

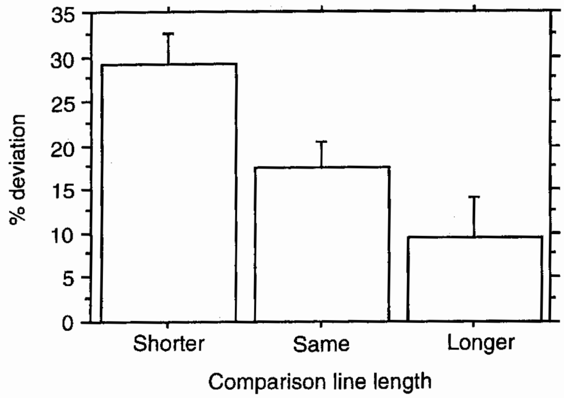

Fig. 4 Influence of any shorter or longer comparison line on bisection of a reference line.

sessions. The protocol was the same: reference lines were given in isolation, followed by presentation of a mixed set with lines of a second length (Fig. 5). Patient 2 bisected 6 cm lines 21% to the right of centre when given 6 cm lines in isolation. When 12 or 3 cm lines were mixed in, bisection was shifted to 6 and 27% to the right of the midline, respectively. Lines of 3 cm were bisected 2% right of the midline when viewed in isolation, but 23% to the left of the midline when 6 cm lines were added. Patient 3 bisected 6 cm lines 5% to the left of the midpoint when viewing 6 cm lines alone, but 11% left of the midpoint when 12 cm lines were added. Patient 4 bisected 6 cm lines 44% to the right of the midpoint when viewed in isolation, then 28% to the right of the midpoint when 12 cm lines were added. On the line bisection discrimination task, the perceived midpoint of 4 cm lines was 9% to the right of the true midpoint for a set of 4 cm lines but 3% to the left of the true midpoint when 8 cm lines were added. Patients 5 and 6 were also given the line bisection discrimination test. Patient 5 perceived the midpoint of 8 cm lines to be 2% to the left of centre when viewing 8 cm lines alone, but 8% left of centre or 9% to the right of centre when 16 or 4 cm lines, respectively, were added. Patient 6 showed a context effect on the line bisection discrimination task but not on the manual bisection task. On the line bisection discrimination test, the midpoint of 8 cm lines was perceived to be 5% to the left of the true midpoint when viewed in isolation and 8% left of the midpoint when viewed in a mixed set with 16 cm lines.

Discussion

We showed that in patients with left hemineglect the perceived or marked centre of a given set of horizontal lines shifted leftwards when the lines were presented in a set mixed with lines of a longer length and shifted rightwards when presented in a set mixed with lines of a shorter length. The influence of the context within which a given line was presented was demonstrated in patients performing either a manual line bisection task or a line bisection discrimination task which eliminated a motor response. In all six patients, the crossover effect was observed, in which transections were made to the left of the true midpoint. Three patients started slightly left of the midpoint and shifted further left when longer lines were introduced; three patients started right of the midpoint and crossed over to the left when longer lines were mixed into the set. Our results suggest that the crossover effect may occur as a specific manifestation of a more generalized stimulus-context effect, in which the introduction of lines of one length influences responses to lines of another length. Such a context effect has not hitherto been reported as part of the hemineglect syndrome. Because studies of a line length effect have to date used sets of randomly intermixed line lengths—typically to obtain parametric data about correlations between line length and degree of rightward deviation (Bisiach *et al.*, 1983; Riddoch and Humphreys, 1983; Marshall and Halligan, 1989; Chatterjee *et al.*, 1994)—specific effects of one line length upon the judgement of another were not assessed. We would argue that other mechanisms contributing to the crossover effect cannot be fully characterized until the influence of stimulus context is adequately understood.

How and why does the context effect occur? In our experiment, there appeared to be a robust influence of one line length on the judgement of another. We do not believe that a manual response contributed to the context effect since it was demonstrated in three patients in the line bisection perception task in which no manual response was required. Furthermore, we have previously reported a high correlation between performance on the line bisection discrimination test and performance on manual line bisection (Binder *et al.*, 1992). Our data show that patients perceived the comparison lines in our experiment as different from the reference lines because line bisection performance changed when new lines were introduced. Because the lines were presented consecutively and not simultaneously, it cannot be argued that there was a visual illusion or direct contrast effect being created by a more complex stimulus. One must conclude, therefore, that the patients were influenced by information about lines they saw previously in making a judgement about lines they viewed later. Such a strategy would seem unnecessary under normal circumstances since the line itself should provide sufficient information to complete the task (e.g. the line has a measurable length; the ends of the line are located in specific points in space; there is a measurable distance from the middle to either end; etc.). The behaviour we observed appears to have involved some carry-over of information from one line to the next.

Determining the features of a line that influence the judgement of other lines may help clarify the mechanism of the context effect. One possibility is a generalization of estimated length. To explain this mechanism one must assume that the bisection mark made by a patient divides a perceived line exactly in half, and that the perceived line length equals twice the length of the segment from the bisection point to the right end of the line (Bisiach *et al.*, 1983; Chatterjee *et al.*, 1994; Chatterjee, 1995). It is not difficult to accept

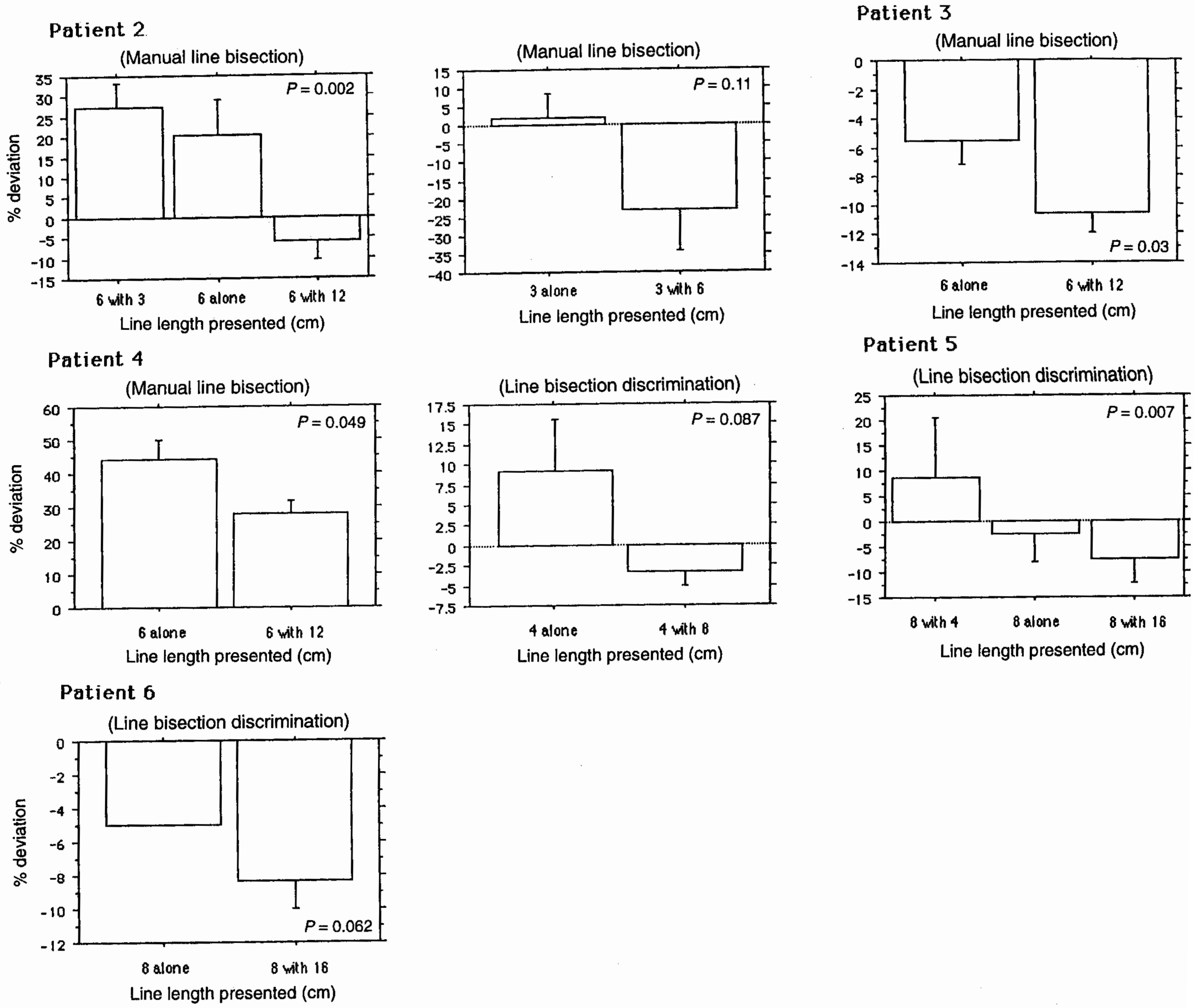

Fig. 5 Context effect in Patients 2–6. Significance values based on *t*-test or ANOVA.

that left hemineglect patients might misperceive, misrepresent or in some way 'neglect' the leftmost portion of a line and therefore underestimate the line's total length and, consequently, mark to the right of the midpoint. Our findings, however, necessitate a more encompassing explanation for why a hemineglect patient would overestimate a line's length when longer lines are introduced into a set of uniform lines, shifting the perceived midpoint leftwards, and further underestimate a line's length when shorter lines are introduced, shifting the perceived midpoint rightwards.

Systematic errors in line length estimation have been reported in hemineglect patients and in normal individuals. Tegnér and Levander (1991) observed that hemineglect patients, when asked to draw vertical representations of horizontal lines, underestimated the length of longer lines and overestimated the length of shorter lines. Anderson (1996) also noted that hemineglect patients underestimated the length of longer lines and overestimated the length of shorter lines on Bisiach's 'end point' task. Finally, Werth and Pöppel (1988) showed that, when normal subjects were asked to estimate how far a previously viewed line would extend to the left or right of a given mark and then to bisect the estimated line, overestimation errors were made with greater frequency on shorter lines and underestimation errors made more frequently with longer lines. Since all of these studies, which reported systematic length estimation errors, presented different length lines in mixed sets, the under- and overestimations may have occurred due to relative differences in line length. To extend this argument, reports of the crossover effect implicate 'very short lines' as the operational performance variable, but because these short lines were also the shortest lines relative to all others in a mixed set of lines, it may be that 'relative shortness' was the important stimulus variable in producing the crossover effect.

Although Chatterjee's confabulation hypothesis, Anderson's attentional salience model and Marshall and Halligan's hypothesis of shift in attentional approach provide possible explanations of why left hemineglect patients bisect a line to the left of the true midpoint, these theories would not seem to account for our finding of a systematic alteration in the perceived line length based solely upon the introduction of a new length line. An explanation may lie in a psychophysical model, the 'adaptation-level theory' developed and explored by H. Helson in the 1960s (Helson, 1964). The basic premise of the theory is that an organism continually adjusts and adapts to its environment based on spatiotemporal pooling of all stimuli presented. Specifically, the response to any given stimulus depends on the weighted geometric mean of the stimulus itself and all other focal and background stimuli that have preceded it. The adaptation-level theory, for example, explains why a series of weights between 100 and 300 g are subjectively judged as relatively lighter when normal subjects are asked to rate them after lifting a 50 g weight, but judged subjectively as heavier when asked to rate them after lifting a 200 g weight. The 'adaptation level' is shifted in either direction along a stimulus continuum with the addition of new stimuli because a new geometric mean is generated with each subsequent stimulus. Judgement of weight, hue, illumination, loudness and size were all demonstrated by Helson to be influenced by the context within which the specific stimulus was presented.

Behaving according to adaptation-level theory, our hemineglect patients might be expected to maintain the same line bisection performance as long as the lines presented are repeatedly of the same length. With the introduction of shorter lines, a patient would then underestimate the length of the longer lines and bisect them further to the right of the true midpoint, altering length judgement because of the inclusion of the shorter lengths in the geometric mean of the stimuli in the set. The introduction of longer lines to a set of shorter reference lines would for the same reason induce overestimation of the shorter lines and result in a bisection mark to the left of the original mark. With regard to the crossover effect, if a great enough overestimation were made of a shorter line, particularly if the baseline perceived midpoint was not far right of centre, the leftward shift in the perceived midpoint could carry the perceived midpoint left of the true midpoint.

Normal subjects make minimal errors in line bisection and do not change significantly with different length lines (Stevens and Gurao, 1963). Because hemineglect patients appear to be influenced by comparison lines whereas normal subjects are not, there must be something intrinsic to the neglect syndrome or to right brain injury that allows the influence to occur. Helson's adaptation-level effects were produced under experimental conditions in which stimuli were presented sequentially and responses required comparison with stimuli that were presented before. In his model it is the memory or representation of prior stimuli that is averaged into the perception of subsequent stimuli. We hypothesize that hemineglect patients are responding not to the complete line but to a representation of the line. If stimuli are only representations, the line bisection task is transformed from a task in which the stimulus is completely specified for each subsequent trial to a representational task in which the dimensions of the line are not completely specified, inducing spatiotemporal pooling of information from previous stimuli. Patients therefore act on any given line based not solely on the stimulus before them, but on a weighted average of all stimuli in the set.

An alternative explanation to adaptation-level theory for the context effect is a cueing effect provided by the left extent of the line. If a longer line induces some leftward shift in attention as the patient perceives more of a line to the left, a subsequent presentation of a shorter line might allow persistence of an attentional shift and result in a relative shift leftwards of the perceived midpoint when the shorter line is viewed in a mixed set with the longer lines. Cueing effects have been well documented in hemineglect patients, using distinctive stimuli such as a number placed to the left of the line (Riddoch and Humphreys, 1983). Although the cueing effect mechanism may appear to be a simpler explanation, in our study it would require assumptions that have not been tested: first, that cueing can be carried temporally from one line to the next; secondly, that a cue can draw the perceived midpoint leftwards beyond the true midpoint (to explain the crossover effect); and thirdly, that a shorter line can act as a 'negative cue' to cause a rightward shift in the perceived midpoint of a subsequently presented, longer line.

Our data do not exclude the presence of other mechanisms to explain some aspects of our patients' performance. The context effect, for example, does not explain why patients bisect to the right of the midpoint for any given line presented in isolation. We hypothesize that the mechanism that produces rightward deviation for isolated lines is orthogonal to the process that causes shifts in the bisection location in the context of comparison lines. That patient 1 bisected 4, 6 and 9 cm lines viewed in isolation with nearly identical percentage rightward deviation supports the notion that the brain can generate consistent, non-linear transformations from actual line length to perceived line length across at least a mid-range of lengths. That 3 cm lines viewed alone were bisected at a significantly lower percentage deviation and 12 cm lines were bisected at a higher, though non-significant, percentage deviation suggests that length in absolute terms may influence bisection performance. Finally, the fact that the baseline perceived midpoints were slightly to the left of the true midpoint in patients 3, 5 and 6 could suggest some asymmetrical influence of hemispheral attentional fields, as postulated by Anderson (1996).

In conclusion, the hypothesis that hemineglect patients alter their estimation of line length due to the influence of previous length information seems most compatible with our data to explain the context effect. A greater tendency to generalize spatial information from one stimulus to the next may represent a unique characteristic of the hemineglect syndrome that may help to explain otherwise counterintuitive phenomena such as the crossover effect. Confirmation of our hypotheses may emerge from further exploration of other ways hemineglect patients treat novel stimuli. For now, we offer our observations of the context effect as evidence of a new variable to consider when studying visual–spatial processing in the hemineglect syndrome.

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