SHORT REPORT

Right sided hemispatial neglect and bilateral cerebral lesions

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Abstract

This study compared the frequency with which unilateral and bilateral cerebral disease gives rise to right sided visual hemispatial inattention. A retrospective survey identified brain injured patients for whom target omissions on visual target cancellation tasks significantly exceeded control values. Subjects consisted of 40 right handed patients referred for clinical evaluation or research study of hemispatial inattention. Right sided visual hemispatial inattention occurred with greater frequency and severity in patients with bilateral lesions than in patients with unilateral left sided or right sided lesions. All eight patients with bilateral lesions manifested right sided hemispatial inattention and failed to detect more targets overall than patients in the other two groups. Of the 13 patients with left sided lesions, seven ignored more targets on the right and six ignored more targets on the left. All but one of the 19 patients with right sided lesions ignored more targets on the left. The association of severe right sided visual hemispatial inattention with bilateral cerebral disease extends previous findings and showed that, in this sample, the most common setting for right sided hemispatial neglect occurred in patients with bilateral cerebral lesions.

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Acute cerebrovascular lesions in the right cerebral hemisphere often result in severe contralesional neglect for the left hemispace. Contralesional neglect for the right side after unilateral left sided lesions occurs less often and the deficit is usually transient and less severe (see Weintraub *et al*¹ for a review). We had previously reported severe, persistent, and multimodal right sided neglect in a group of patients with bilateral lesions.² In the present study we compared patients with unilateral and bilateral lesions to confirm the relation between bilateral lesions and severe right sided hemispatial neglect.

Patients

We examined 49 records of right handed patients who had participated in previous studies of neglect or who had been referred for clinical evaluation of neglect. All but two patients had received at least one form of a visual target cancellation task.^{3,4} Two had been given line cancellation tests. For each case, we selected the form on which the patient had failed to detect the greatest total number of targets. Patients were included for further study if target omissions exceeded 8% in either hemispace, two SD beyond the average percentage of omissions for a sample of control subjects of comparable age. Forty patients met these criteria, 19 with right sided cerebral damage, 13 left sided, and eight bilateral.

PATIENTS WITH UNILATERAL LESIONS

All unilateral lesions were the result of cerebrovascular events. All patients had abnormalities on an elementary neurological examination, nine with visual field defects (five right lesion, four left lesion). Right sided lesions involved at least one of five regions constituting the cortical and subcortical sectors of a proposed neuroanatomical network for the spatial distribution of attention (frontal eye fields, posterior parietal region, cingulate area, thalamus, caudate) and their interconnections.^{5,6} Patients with left sided lesions had damage in one or more of these analogous areas in the left hemisphere. The variety of lesion sites was similar in each group. There was insufficient information available to compare lesion size between groups.

PATIENTS WITH BILATERAL LESIONS

Five patients had simultaneously occurring bilateral cerebral infarctions. In the remaining three, aetiologies consisted of multiple bilateral small grey and white matter lesions in the context of lupus cerebritis; selective atrophy in the parietal regions bilaterally as a consequence of presumptive focal degenerative disease; and bilateral metastatic lesions. With the exception of the patient with lupus, all had an abnormal elementary neurological examination (five with visual field defects) and all had aphasia or alexia.

Brain CT or MRI were available for all the patients in this sample. The bilateral lesions involved one or more of the following regions:

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parietal, occipital, and temporal regions, the basal ganglia, and the thalamus. In general, the larger of the two lesions was in the left hemisphere, posterior to the central sulcus. In one patient with progressive visuospatial dysfunction, the relatively focal bilateral parieto-occipital abnormalities seen on CT were attributed either to selective atrophy or to old infarcts.

Analyses and results

SEX, AGE, AND DURATION OF ILLNESS

There was a similar distribution of men and women within each of the three subject groups (extended Fisher's exact test, $P = 0.13$). Analysis of variance (ANOVA) showed that the subject groups did not differ by age (right lesions mean 61.05 (SE 2.38) years; left lesions mean 62.77 (SE 2.86) years; bilateral lesions mean 68.75 (SE 4.15) years; $F(2,37) = 1.49$, $P = 0.239$). The median onset to test duration for patients with right sided lesions was 21 (range 3–280) days; for those with left sided lesions, 28 (range 3–126) days; and for those with bilateral lesions, 31.5 (range 7–1920) days (Kruskal-Wallis statistic = 1.98, $P = 0.370$).

DISTRIBUTION OF PATIENTS ACCORDING TO

HEMISPHERE OF GREATEST % TARGET OMISSIONS
Of the 19 patients with right sided lesions, 18 omitted more targets from the left hemisphere than the right and one showed the reverse pattern. Of the 13 patients with left sided lesions, six omitted more targets from the left and seven from the right side of the page. All eight patients with bilateral lesions omitted more targets from the right side of the page than the left. This subject distribution with regard to hemisphere of most omissions was highly significant at $P < 0.0001$ (extended Fisher exact test).

COMPARISONS AMONG THE THREE GROUPS FOR DIRECTION AND SEVERITY OF HEMISPATIAL TARGET OMISSIONS

The direction of asymmetry of target omissions was measured by the simple difference

between the left and right sides of the page (figure). Patients with bilateral lesions had an average difference of -39.13 (SE 7.24)%, those with right sided lesions had an average difference of $+33.63$ (SE 6.04)%, and those with left sided lesions showed an average difference of -5.69 (SE 6.03)%. ANOVA showed a highly significant group difference ($P < 0.0001$) and post hoc pairwise comparisons using Tukey's procedure were all significant beyond the $P < 0.01$ level.

Paired t tests showed that patients with right sided lesions omitted significantly more targets from the left hemisphere than the right (mean 54.26 (SE 7.79)% *v* mean 20.63 (SE 4.26)%, $P < 0.0001$) and that patients with bilateral lesions omitted more from the right than from the left hemisphere (Mean = 68.25 (SE 11.33)% *v* 29.13 (SE 9.73)%, $P = 0.012$). Although patients with left sided lesions omitted more targets from the right hemisphere (mean 21.85 (SE 5.07)% *v* mean 16.15 (SE 3.82)%), the comparison was not significant ($P = 0.364$).

Severity of inattention was evaluated by comparing omissions in the hemisphere containing the largest number of omissions for each group (the right hemisphere for the bilateral lesion group and the left lesion group and the left hemisphere for the right lesion group). A significant group difference ($P = 0.002$) was shown by ANOVA. Post hoc comparisons showed that the bilateral and right lesion groups did not differ from one another but both groups omitted significantly more targets than the left lesion group ($P = 0.003$ and $P = 0.011$, respectively).

Discussion

In a retrospective review of visual target cancellation test performance in a sample of 40 right handed patients with either unilateral or bilateral cerebral lesions, we have shown that severe right sided visual hemispatial neglect occurs most often in patients with bilateral lesions. In patients with left sided lesions, target omissions occurred as often on the left as on the right side of the page. These patients also omitted fewer targets overall than either patients with right sided or with bilateral lesions and showed non-significant hemispatial asymmetry. Patients with right sided lesions almost all showed left sided hemispatial inattention.

Right sided hemispatial neglect has been reported previously but many of these observations seem to have been made in patients with bilateral cerebral disease. In some cases, the bilaterality of brain damage is clearly stated,⁷ in others, it is strongly suspected on the basis of trauma (for example, penetrating missile wounds) or mass lesions.^{8–11} In other case reports of unilateral left hemispheric lesions and right sided hemispatial neglect, aphasia has not been reported, raising the possibility of anomalous hemispheric dominance patterns.^{12–15}

According to the available medical literature, left sided hemispatial neglect is generally

Simple mean difference (95% CI) between left and right hemispaces in the three subject groups, showing the direction of asymmetry in target omissions. Negative direction indicates more right sided target omissions. Patients with bilateral lesions have more right sided omissions whereas those with right sided lesions have more left sided omissions. Patients with left sided lesions show only a slight tendency for more right sided omissions.

more frequent, persistent, and severe than right sided neglect after unilateral cerebral lesions (see Weintraub *et al.*¹ for a review). This finding has contributed to theories that ascribe a dominant role to the right cerebral hemisphere for the control of the spatial distribution of attention.^{5,6,16} One model that we and others have proposed to account for this finding postulates that the right cerebral hemisphere can direct attention to both the ipsilateral and contralateral hemispaces whereas the left hemisphere directs attention almost exclusively to the contralateral right hemisphere.^{5,6,16}

There is considerable support for this model from studies reporting visual neglect of the contralateral hemisphere only after right hemispheric inactivation during the intracarotid amytal procedure,¹⁷ ipsilateral as well as contralateral target detection failures after right sided lesions,¹⁸ and activation of the left hemisphere only by contralateral stimulation but of the right hemisphere after either contralateral or ipsilateral stimulation.^{19–22}

According to our model of right hemispheric dominance for the distribution of spatial attention, a single lesion in the right hemisphere results in severe contralesional inattention because the intact left hemisphere does not have sufficient ipsiversive attentional capacity. A lesion in the left cerebral hemisphere, on the other hand, can acutely give rise to some contralesional neglect but this is usually compensated for by the ipsiversive attentional machinery of the right cerebral hemisphere. According to the predictions based on this model, bilateral lesions may give rise to one of four possible outcomes: (1) a severe bilateral disruption of visual attention leading to Balint's syndrome, in which there is bilateral involvement of the attentional network; (2) left sided hemispatial neglect, when the attentional network is involved only in the right hemisphere; (3) no major neglect, when the attentional network is involved only in the left; (4) right sided hemispatial neglect, in patients in whom the lesion damages the attentional network on the left and also involves the network on the right but in a patchy fashion, therefore interfering with its compensatory attentional functions in the right hemisphere while preserving at least some of its attentional function in the left hemisphere. Our results do not imply that severe and persistent right sided neglect is a necessary outcome of bilateral lesions. However, they suggest that bilateral lesions represent the

most likely setting for the emergence of this unusual symptom.

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