
Lateralization of Visual Attention and Distractibility

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Abstract

An attempt was made to determine the cerebral loci of distractibility and impairment in visual search. Sample size consisted of eight right hemispheric lesion cases, nine left hemispheric lesion cases and nine healthy controls. A battery of auditory tasks and another task based on visuomotor scanning were used to assess distractibility and impairment in visual search. Results evidenced greater distractibility in right hemisphere lesion cases and provided some evidence for right cerebral dominance in visual search.

Key words -

**Visual attention,
Distractibility,
Lateralization**

Visual attention has been proposed to differ between left and right hemispheres of the brain. Available reports [1] provide a strong support for lateralization of visual attention to the right cerebral hemisphere. Support for lateralization of visual attention has come from findings of hemi-inattention in unilateral lesion studies. Left-sided neglect following right-hemisphere lesions is more common, more severe, and longer lasting than right-sided neglect following lesions in the left hemisphere [2], [3]. Weintraub and Mesulam [4] in a study used tasks based on visuomotor scanning and tactile exploration to quantify neglect behavior in patients with unilateral brain damage. In a part of this study a shape cancellation task was used. Eight patients with unilateral right cerebral lesions, eight with unilateral left cerebral lesions and nine normal control subjects were studied. The results, besides showing a marked contralateral neglect in the right lesion group, also provided evidence of ipsilateral inattention which was significant only in the right lesion group. The results support a model of right hemisphere dominance for the distribution of visual attention within the extrapersonal space.

Hemisphericity of distractibility is, however, not well-established. Clinical observations and experimental studies have found frontal lobes to be important in inhibiting responsiveness to irrelevant stimuli [5], [6], [7] and there is some recent suggestion that distractibility is found more with right frontal rather than left frontal lesion patients [8], [9].

The aim of the study reported here was to confirm the right hemisphere dominance for visual attention and to elicit evidence to further support the role of right hemisphere in producing distractibility. Dichotic listening studies have provided ample evidence of right ear preference in word-recognition which is considered to support left hemisphere superiority in language processing. The present study aims to investigate if the same holds true with respect to distractibility in auditory modality or whether a right hemisphere modality-nonspecific role is present.

Sample and Method

The sample selected for the study consisted of 3 groups of subjects - 8 right hemisphere lesion cases, 9 left hemisphere lesion cases and 9 normal controls. Patients were selected on the basis of CT scan reports of unilateral lesion. Inclusion criteria were - circumscribed lesion within the right or left hemispheres, age range between 15 and 50 years, and right handedness. Excluded from the study were patients with aphasia. The normal controls did not have a history of any neurological or psychiatric disorders. They were also not social users of alcohol. There were no significant group differences on variables of age and education.

The right lesion group consisted of one meningioma and 7 glioma (all tumor) cases and the left lesion group comprised of 2 meningioma, 5 glioma, 1 arterio-venous malformation, and 1 aneurysm cases. The two groups also did not differ significantly with respect to clinical severity (judged by the frequency of hemisensory loss, hemi-paresis and hemianopia in each group). Prior to testing subjects were informed about the nature of tasks and an informed consent was obtained.

Two sets of hypotheses were obtained for verification. The first set related to lateralization of visual attention and the other set referred to distractibility of attention.

These hypotheses were:

1. Right cerebral lesion patients will manifest greater contralateral neglect than those with left hemisphere lesions.
2. Right cerebral lesion patients will have significantly greater difficulty repeating/recalling target stimuli in the presence of distracting stimuli compared to left cerebral lesion cases. It is further postulated that right lesion cases will show significantly greater number of responses to irrelevant stimuli when they are instructed to respond to relevant stimuli, compared to left cerebral lesion cases.

Visual Exploration Task

In order to test the first hypothesis, a shape cancellation task similar to the one used by Weintraub and Mesulam [4] was designed on a sheet of paper (23.5 × 27.5 cms). The sheet contained randomly arranged shapes. Each quadrant of the sheet contained 90 shapes. 15 of which were target stimuli. Control subjects were allowed 2 minutes to complete the task. A time limit was not imposed on the patients since several either had weakness in the preferred hand or had to use the non-preferred hand. The midline of the test sheet was aligned with the midline of the subject's body and the subjects were asked to circle all the targets. The subjects were merely asked to hand over the test sheet once they had completed the task.

Auditory Tasks

This set of tasks was specifically devised to assess distractibility. There were 5 conditions in this set of tasks:

Condition I

A list of 20 three or four letter words was presented to subjects' both ears. Subjects were asked to repeat the words as and when they occurred at a frequency of every 5 seconds.

Condition II

Another list of 20 target words occurring with the same frequency was presented in one ear and a neutral passage was continuously presented in the other ear. The subject was instructed to call out the target words as and when they were presented. The procedure was repeated alternating the ears of presentation and using different target words..

Condition III

A list of 20 words was presented without the distracting passage to both the ears. At the end, the subjects were asked to recall the words contained in the list.

Condition IV

A list of 20 words was presented in one ear and a neutral passage in the other ear. At the end of the presentation subjects were asked to recall the target words. This procedure was repeated alternating the ears of presentation using different target words.

Results

On visual exploration task, the number of omissions in the left and the right hemispaces constituted 2 sets of scores. These have been summarised in Table I.

Scores of Subjects on Visual Exploration Task

Condition V

Words belonging to 3 different categories were presented at random to both the ears. Subjects were instructed to say yes to one category and no to the other two. Words occurred with a frequency of one every 3 seconds. A total of 45 words were used with 15 words in each category.

For the auditory tasks, 3 sets of scores were obtained. These are:

1. TW scores consisted of the number of target words correctly repeated or recalled.
2. DW scores consisted of words from the distracting passage or other words repeated or recalled (incorrectly).
3. NTW scores were specific to condition V and consisted of the number of non-target words responded by yes added to the number of target words responded to by no.

All three sets of scores for the conditions have been summarized in Table II.

Table II

Table II

2.55

Showing application of Post - Hoc Newman - Kaul's statistic to differentiate between pairs of mean scores of the 3 groups on various auditory task conditions

Showing application of Post - Hoc Newman - Kaul's statistic to differentiate between pairs of mean NTW scores of the 3 groups on various auditory task conditions

Discussion

Taking up the first hypothesis and the results obtained on the task employed to verify it we find that, in the left hemisphere, mean number of omissions of the right lesion group were significantly greater than that of either the left lesion or the normal control group (Table I). Such a result implies the presence of significant contralateral neglect in the right cerebral lesion group.

Absence of a significant difference between the mean omissions of the left lesion and the healthy control groups in the right hemisphere implies a lack of evidence for significant contralateral neglect in the left lesion group.

Weintraub and Mesulam [4] in their study, in addition to finding significantly greater contralateral spatial neglect in right cerebral lesion patients (as compared to left lesion patients), also found that the right lesion cases evidenced ipsilateral neglect whereas left lesion patients did not. In our study, though the scores of the two groups showed a similar trend, they did not show a statistically significant difference.

A set of auditory tasks was employed to test out hypothesis concerning distractibility. The aim of the experiment was to see the nature and magnitude of the distracting effect which a series of irrelevant stimuli will have on the recall of relevant target words.

Taking up the first set of scores (i.e. TW), in condition II where target words were presented in one ear along with a distracting passage in the other ear with instructions that subjects were to repeat only the target words as and when they occurred, performance of right lesion group was significantly poorer ($p < 0.05$) than that of either the left lesion or the control group. Such a result indicates increased distractibility in right hemisphere lesions.

In condition III, where target words were presented unaccompanied by a distracting passage, post-hoc statistic showed no significant difference between the right and the left lesion groups as also between the right lesion and the control groups. Significant difference was, however, found between the left lesion group, and the control group, left lesion group's performance being poorer than that of the controls.

It is interesting to note that when words were presented to both ears without any other source of distraction the left lesion group performed poorly in delayed recall. This may reflect the material-specific left hemisphere dominance of verbal functions. It is also possible that difficulty in continuous directed attention resulted in impaired performance which was not seen in the right lesion patients. It could be that influence of the right hemisphere is seen when simultaneous processing of both relevant and irrelevant information is called for. Thus the right hemisphere may have a specific role and distractibility may be present only when a barrage of irrelevant information is also simultaneously present while the individual is processing relevant pieces of information.

Taking up the second set of scores (i.e. DW) we find that, in condition II, where target words were accompanied by a distracting passage, though the means of right and left lesion groups (9.94 and 0.67 respectively) were in the expected direction, difference between them was not found statistically significant. This was largely due to a large variance (s.d.=15.92) found within the right lesion group. The review of studies suggested greater distractibility in right frontal lesion patients (e.g. Woods and Knight [8]). Our right lesion group consisted of 4 tumour patients whose major mass lay in the right frontal area and 4 right parietal tumour patients. Now, the mean score of the 4 right frontal patients was 18.0 and that for the right parietal tumour patients was 1.87, suggesting greater distractibility for

the right frontal lesion patients. Considering the wide variation of performance within the right lesion group, a statistically significant difference failed to emerge when the group was taken as a whole and compared with the left lesion group.

In condition IV, where subjects had to recall words presented in distraction condition, right hemisphere lesion patients responded with more distracting/other words (mean DW score=5.87, Table II) than the left cerebral lesion patients (mean DW score=1.77). This difference, however, was not statistically significant. The earlier argument about the differing performances of right frontal and right parietal groups may also hold good here. In this condition, right frontal patients had a mean distractibility score (DW) of 10.12 whereas DW score for the right parietal patients was 3.5.

In condition V where subjects were required to respond to one category of words by saying Yes and to other categories by saying No, post-hoc Newman-Keul's statistic showed a significant difference between the mean NTW score of right lesion and the control groups whereas the left lesion and the control groups' scores did not differ significantly. Again, mean scores of right and left lesion groups, though in the expected direction, did not show a statistically significant difference. Such a finding is, again, most likely due to the heterogeneity of performances within the right lesion groups; right frontal patients being more distractible than right parietal patients (NTW scores of 4 frontal patients averaged 13.50 whereas the average scores of 4 parietal patients averaged 1.50).

In conclusion, it is seen that the original findings of Weintraub and Mesulam [4] are partially confirmed in this study. Results point towards right hemisphere possessing superiority in tasks requiring visual search. Results on auditory tasks also indicate a greater role of right hemisphere (particularly right frontal lobe) in inhibiting responsiveness to irrelevant stimuli. The above imply that the right hemisphere has a non-modality-specific role in regulating attention.

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