Short report

Interhemispheric disconnection effects in multiple sclerosis

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SUMMARY Patients with multiple sclerosis reported less left ear numbers but more right ear numbers than controls in a dichotic listening test. The multiple sclerosis patients were also relatively impaired on three learning tasks; one of these, a test for paired-associate learning of names and faces, correlated with left ear findings; the results are interpreted as supporting a hypothesised disconnection mechanism.

Two recent studies1,2 have demonstrated a lowering of left ear performance in verbal dichotic listening by patients with multiple sclerosis. Rubens et al2 proposed that this effect is caused by destruction of pathways connecting the cerebral hemispheres. Three of the questions which can be raised were addressed in this study. First, is the left ear suppression independent of general factors associated with invalidity? Second, what is the role of attentional strategies in the dichotic listening performance? Third, do the alleged disconnection effects extend to the visual sphere?

Subjects

The subjects were volunteers, recruited in a rehabilitation institute and an institute for chronic invalids. All subjects were right handed and met the audiometric criterion for inclusion (less than 10 dB ear difference at 500, 1000, 1500 and 2000 Hz).

The experimental group consisted of 26 patients with multiple sclerosis (12 male, 14 female). The mean age was 45-9 years; the mean education level (rated on a 7-point scale) was 4-8. The mean Kurtzke disability score was 5-8, ranging from 1 to 7. The control group consisted of 23 patients (11 male, 12 female) with chronic invalidity due to extracerebral disease (spinal lesions 18, muscular dystrophy 5). The mean age was 45-5, mean education level 4-2.

The groups showed no significant differences in composition with regard to sex, age or education.

Method

Dichotic listening The dichotic listening tape was designed by D J Bakker and A Bouma. The items consisted of four number pairs, presented bilaterally. In Condition 1 (Free Recall) the subject was instructed to report orally as many numbers as possible after each trial. In Condition 2 (Ordered Recall) each trial was preceded by a signal specifying the ear that was to be reported first. Two rehearsal trials and 16 test trials were given in both conditions.

Name learning To detect visual disconnection effects, a task for paired-associate learning of names and faces was designed. The subject was shown four pictures of male faces, with a common first name printed underneath. After this, the subject was asked to name the photographs as they were presented in a semi-random order. Errors were corrected by the examiner. The test score was the number of correct responses in 28 trials.

Additional learning tests Two additional learning tasks were given, one predominantly verbal and the other predominantly nonverbal. The first was the IPALT,3 which tests the paired-associate learning of three sets of unrelated words. Administration is similar to the Name Learning task. The score was the number of correct reproductions out of 39 trials.

The nonverbal task was the Oxford Recurring Faces Test, an unpublished test designed by F Newcombe. The subject must indicate by a yes-no response whether each out of 60 photographs of male faces belongs to a previously shown set or not. The test score was the number of correct responses, corrected for guessing.

Hypotheses It was predicted that:
1 Multiple sclerosis patients would report less left-ear numbers than controls, in Condition 1 as well as Condition 2.
2 Multiple sclerosis patients would show a lower performance than controls on all three learning tasks.
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Name Learning scores earsclerosis patients multiple recognition controls, this the multiple one-sided, except those for right ear scores.

![Table Mean scores (per cent of maximum) of patients with multiple sclerosis and controls. All significance levels are one-sided, except those for right ear scores.](https://group.bmj.com/group/bmj)

<table>
<thead>
<tr>
<th>Multiple sclerosis</th>
<th>Controls</th>
<th>t ratio</th>
<th>p &lt;</th>
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<tbody>
<tr>
<td>Dichotic Listening</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Cond. 1, left ear</td>
<td>36</td>
<td>46</td>
<td>2.41</td>
</tr>
<tr>
<td>Cond. 1, right ear</td>
<td>73</td>
<td>59</td>
<td>3.53</td>
</tr>
<tr>
<td>Cond. 2, left ear</td>
<td>44</td>
<td>52</td>
<td>1.83</td>
</tr>
<tr>
<td>Cond. 2, right ear</td>
<td>70</td>
<td>58</td>
<td>3.62</td>
</tr>
<tr>
<td>Learning tasks</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Name Learning</td>
<td>64</td>
<td>76</td>
<td>1.96</td>
</tr>
<tr>
<td>IPALT</td>
<td>52</td>
<td>62</td>
<td>2.06</td>
</tr>
<tr>
<td>Recurring Faces</td>
<td>52</td>
<td>77</td>
<td>3.64</td>
</tr>
</tbody>
</table>

3 The left ear score of multiple sclerosis patients would correlate with Name Learning performance.

**Results**

**Group differences** All predicted group differences were confirmed, as is shown in the table. Surprisingly, the multiple sclerosis patients did not only show lower left ear scores, but also higher right ear scores. The Ordered Recall condition did not appear to alter the results except for some regression toward the mean. An analysis of variance (MANOVA) yielded significant effects of Ear (left vs right, F = 50.4, p < 0.001), Condition (Free vs Ordered, F = 7.0, p < 0.005) and their interaction (F = 11.8, p < 0.01).

However, the only significant effect involving groups (multiple sclerosis vs Controls) was the Group by Ear interaction (F = 15.7, p < 0.001).

Of the three learning tasks, the Oxford Recurring Faces showed the largest group difference. As 46% of the multiple sclerosis group scored lower than all controls, this is a clear exception to the rule that multiple sclerosis patients do not show deficits of recognition memory.

**Correlations** In the multiple sclerosis group, the left ear scores of both conditions correlated significantly with Name Learning (r = 0.52 and 0.56 respectively, p < 0.005). There was also a high correlation between Name Learning and Recurring Faces (r = 0.58); when this is partialled out, the correlations between left ear report and Name Learning remain significant (r = 0.48, t = 2.62, df = 23, p < 0.01 for both conditions).

There were no other significant associations between dichotic variables and learning performance, except for the correlation between left ear results (Free Recall only) and the IPALT in the control group.

The combination of left ear results and Name Learning differentiates a sizeable part of the multiple sclerosis group. A canonical discriminant function derived from these measures distinguished 35% of the multiple sclerosis patients from all but one of the controls (or 46% of the multiple sclerosis group from 91% of the controls, depending on the cutting point used).

**Discussion**

The finding of left-ear suppression in multiple sclerosis is replicated in this study, and the effect seems to be independent of general factors of invalidity or a tendency to direct attention toward the right ear. Nor did numbers prove to be a less effective type of stimulus material than the consonant-vowel syllables used by Rubens et al.

The association between left ear findings and Name Learning performance (two quite dissimilar behavioural measures) lends mutual support to their explanation as disconnection effects. However, conclusive proof must be awaited from correlation with anatomical data.

The rationale behind the Name Learning task is that a verbal stimulus must be associated with a Gestalt perception, presumably requiring the cooperation of the left and right hemispheres. Levy et al. noted that split-brain subjects show a spectacular deficit in learning such associations. Their patients were said to take more than 10 minutes to learn a name to three pictures of faces, succeeding only by connecting the name to easily verbalised features like a moustache or glasses. The same mechanism appears to underlie the fact that patients with visuo-verbal disconnection syndromes of vascular origin can often recognise, but not name, famous faces. Our main reason for avoiding the more usual tachistoscopic procedures for the detection of visual disconnection effects was that the visual impairments accompanying multiple sclerosis would render such techniques unreliable. As our results suggest, the Name Learning task might even be more sensitive; effects found with tachistoscopy tend to be exceedingly subtle unless the pathways through the splenium of the corpus callosum are totally interrupted.

An alternative explanation of our results would be that right hemisphere damage, disconnection or not, might account for both the left ear suppression and the Name Learning deficit. This seems improbable in view of the absence of a significant correlation between left ear findings and the Oxford Recurring Faces. Although its validity in detecting right hemisphere dysfunction is not yet known, the type of material and manner of administration are known to be effective in this respect.

A surprising result was that the multiple sclerosis patients were superior to the controls in the results of right ear dichotic stimuli. A logical explanation would be that the right ear score is raised by a decrease of interference from left ear stimulation. However, the right ear superiority was not restricted to multiple
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sclerosis patients with clearly diminished left ear scores. Thus we are forced to assume that the release from interference precedes the decrease of left ear report. This matter needs clarification.

The authors thank Dr Anke Bouma for help with the analysis; Dr Freda Newcombe for her kind permission to use the Oxford Recurring Faces.

References

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doi: 10.1136/jnnp.51.11.1445

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