Eur Arch Psychiatr Neurol Sci (1990) 239:309–313

European Archives of Psychiatry and Neurological Sciences

Interhemispheric Transfer of Information and Schizophrenia

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Received July 21, 1989

Summary. The interhemispheric transfer of stereognostic information was investigated in four groups of subjects: paranoid schizophrenics, non-paranoid schizophrenics, non-schizophrenic psychiatric patients, and normals. Previous work has raised the possibility that schizophrenia is characterised by a dysfunction of the corpus callosum, but there are several methodological problems associated with this research. A comparison of inter-manual and same-hand conditions on the experimental task revealed no evidence for impaired transfer of information in the schizophrenic groups. However, the performance of the non-paranoid schizophrenic group was markedly inferior to all other groups on the right hand/right hand no transfer condition, consistent with a left hemisphere dysfunction. Possible reasons for the failure to replicate previous findings are discussed.

Key words: Interhemispheric transfer – Information – Schizophrenia

Introduction

It has long been recognised that the two hemispheres of the brain are functionally different, the left being specialised for linguistic and the right for visuospatial material, the corpus callosum providing the means for information exchange. Since the 1960s the effects of cerebral commisurotomy have been intensively investigated, thus enhancing understanding of both hemispheric and interhemispheric functioning. These studies have demonstrated that although the "split brain" subject appears unchanged there are, in fact, subtle impairments in intellectual functioning, with difficulties in integrating visual, tactile and auditory information (e.g. Gazzaniga et al. 1975).

That a dysfunction of the corpus callosum may be present in schizophrenia was first suggested by a post-mortem study comparing cerebral pathology in schizophrenic and non-schizophrenic subjects, with the finding that the corpus callosum was significantly enlarged in the former group (Rosenthal and Bigelow 1972). The functional significance of this finding was quickly investigated. Beaumont and Dimond (1973) demonstrated that schizophrenic subjects experience difficulty in transferring visual material between the hemispheres – a difficulty not shown in the control group. Further evidence in support of a transfer deficit has been provided by a series of studies using tactile and auditory discrimination tasks (Green 1978; Green and Kotenko 1980).

Using both binaural and monaural presentation of material, Green and Kotenko (1980) demonstrated that schizophrenic subjects show a deficit in the comprehension of material presented to the left ear relative to right or both ear presentation – a deficit not found in the control groups. They argue that this is due to the impaired transfer of the verbal material across the corpus callosum to the left hemisphere, where it is processed. That this difficulty may predate the development of the disorder was suggested by the finding that children of schizophrenic parents experience deficits in speech comprehension not seen in children of non-schizophrenic parents (Green et al. 1983).

Using both meaningful and non-meaningful shapes Carr (1980) also found that schizophrenic subjects experienced a significant difficulty in manual, shape discrimination tasks when both hands were involved in the task as opposed to only one hand. This difficulty was more apparent with the use of the non-meaningful shapes and also a longer time interval before recognition testing. Sucessful performance on such tasks is said to require an intact corpus callosum.

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However, much criticism has been levelled at such research, one suggestion being that the results are evidence only of a general deficit in the performance of schizophrenic subjects (cf. Newlin et al. 1981). It is also unclear whether such deficits in functioning are present in an acute episode or whether they are only associated with older, chronically ill subjects. Further, replication has only infrequently been reported and many results do not corroborate earlier findings (e.g. Magaro and Page 1983). Research in this area has produced contradictory findings (cf. Hatta et al. 1984; Schrift et al. 1986), and the most recent report "failed to support an interhemispheric transfer deficit interpretation of schiziphrenia" (Raine et al. 1989, p. 35).

Finally, it has been suggested (Magaro 1980) that treating schizophrenia as an homogeneous condition for research purposes is misleading. He cites evidence that paranoid and non-paranoid schizophrenics utilise different information processing strategies and should, therefore, be considered as separate groups; Magaro further argues that these are related to differences in hemispheric functioning.

This study investigated the interhemispheric transfer of stereognostic information following the experimental design of Carr (1980) but with the following modifications. (i) use of a psychiatric in-patient control group as well as a non-patient group; (ii) screening for intelligence using two subtests of the WAIS-R (Silverstein 1982); (iii) subdivision of the experimental group into paranoid and non-paranoid subgroups by use of the Maine scale (Magaro et al. 1981).

Subjects and Methods

Schizophrenic Group

Twenty in-patients in the Bethlem and Maudsley Hospitals were selected according to the following criteria: (i) established diagnosis of schizophrenia by an independent psychiatrist according to the International Classification of Diseases; (ii) age 18–60 years; (iii) no evidence of brain damage; (iv) no ECT in previous 2 years; (v) no history of drug or alcohol abuse; (vi) right handed. Of the subjects, 13 were male and 7 female.

The group was divided into a paranoid ($n = 9$) and non-paranoid ($n = 11$) group with the Maine Scale, using the criteria suggested by Magaro et al. (1981). This rating of schizophrenic symptomatology was made by the psychiatrist responsible for the patient, and results in scores on two subscales of paranoid and non-paranoid symptoms.

For the paranoid group, mean subscale scores were: paranoid 14.1, non-paranoid 8.1. For the non-paranoid group, mean subscale scores were: paranoid 7.5, non-paranoid 12.3.

Psychiatric In-patient Group

Ten hospital in-patients, all with a primary diagnosis of depression, were selected using the criteria ii–vi above.

Control Group

Ten employees of the joint hospital (ancillary staff) acted as controls. All were right handed.

Subject Characteristics

The mean age of the schizophrenic group was 29.25 years, of the depressed group 38.6 years and of the control group 29.5 years. These differences were not significant ($F = 1.84$, df (3,36) $P > 0.05$). The mean IQ of the three groups was 91.2, 97.1 and 98.6 respectively. Again this was not a significant difference ($F = 1.36$, df (3,36) $P > 0.05$).

Apparatus

Box. An open-topped hardboard box ($48 \times 23 \times 13$ cm) was constructed following the description given by Carr (1980). It was divided into two equal compartments by a partition and a handle was cut into each compartment on one of the long sides of the box.

The base was padded, to reduce sound cues, and the top was covered with a black cloth which extended over the sides of the experimenter to allow for ordering of the shapes beneath it.

Shapes. Fifty-four meaningless shapes, all easily manipulable with one hand, were cut from 1 cm plywood. These were randomly sorted into nine groups and placed in separate envelopes, which were then numbered (again at random). Three shapes were then drawn blind from each envelope and marked A, B or C – thus identifying the three shapes for initial presentation. Groups 1–8 were the experimental trials: the 9th was used as a training trial.

Retention Interval

Immediately after the presentation of shape C one of two retention intervals immediately came into operation: (i) immediate recognition: no timing took place – the experiment proceeded immediately; (ii) delayed recognition: a 30-s time interval elapsed before proceeding with the experiment; the subject was asked to count backwards from 100 to prevent rehearsal of the shapes.

Procedure

All subjects took part in the practice trial using a right hand/left hand transfer and a criterion of 100% success on this task was employed before proceeding.

On each trial the subject was given the three test shapes (A, B and C) consecutively to one of his/her hands in the box. Each item was handled for 10 s, the subject being asked to try and remember the shape without commenting on it. Immediately after the presentation of shape C one of the two retention intervals came into operation as described. The three test shapes and three new ones were than presented in random order to either the same or opposite hand (no transfer/transfer condition) in the box and again handled for 10 s each. Finally, the six shapes were once again presented, in the same order, to the subject, who was asked to say "yes" if he/she thought it was one of the test shapes and "no" if it was one of the new shapes.

Each subject participated in eight trials representing all combinations of the two variables in question (transfer/no transfer and retention interval). The order of presentation of the trials was randomised for each subject.

Results

The mean number of errors per trial for the three groups of subjects is shown in Table 1 and for the schizophrenic subgroups (paranoid and non-paranoid) in Table 2.

The performance of the schizophrenic group was inferior to that of the other two groups, with the non-paranoid group being the poorest. The difference between the error scores for the three groups was not significant ($F = 0.40$, df (3,36) $P > 0.05$) – the only significant difference being between the error scores of the non-paranoid schizophrenics and the normal control group ($t = 3.4$, $df = 19$, $P < 0.02$). Not only was the performance of the non-paranoid group worse, but the pattern of errors was also different (Fig. 1). The non-paranoid group made most errors on the right-right task, whereas the other groups made least errors under this condition.

However, the main purpose of the research was to ascertain whether or not the three groups differed on the two variables in question, namely the transfer/no transfer comparison and the time interval.

Table 1. Mean number of errors per trial × three groups

Condition	Schizophrenic ($n = 20$)		Psychiatric in-patient ($n = 10$)		Normal controls ($n = 10$)	
	Mean	SD	Mean	SD	Mean	SD
A. *Hand*						
Right/right	2.35	1.35	1.40	1.28	1.35	1.32
Left/left	2.27	1.36	1.80	1.57	1.55	0.86
Right/left	2.15	1.16	2.15	1.59	1.90	1.24
Left/right	2.27	1.36	1.75	1.61	1.40	1.11
B. *Retention interval*						
Immediate	2.37	1.37	1.80	1.44	1.50	1.24
Delayed	2.15	1.23	1.80	1.63	1.59	1.07

Table 2. Mean number of errors per trial – schizophrenic subgroups

Condition	Paranoid ($n = 9$)		Non-paranoid ($n = 11$)	
	Mean	SD	Mean	SD
A. *Hand*				
Right/right	1.80	1.25	2.7	1.27
Left/left	2.11	1.19	2.4	1.46
Right/left	1.80	1.28	2.3	0.98
Left/right	2.10	1.28	2.4	1.40
B. *Retention interval*				
Immediate	2.00	1.22	2.6	1.4
Delayed	1.90	1.30	2.2	1.15

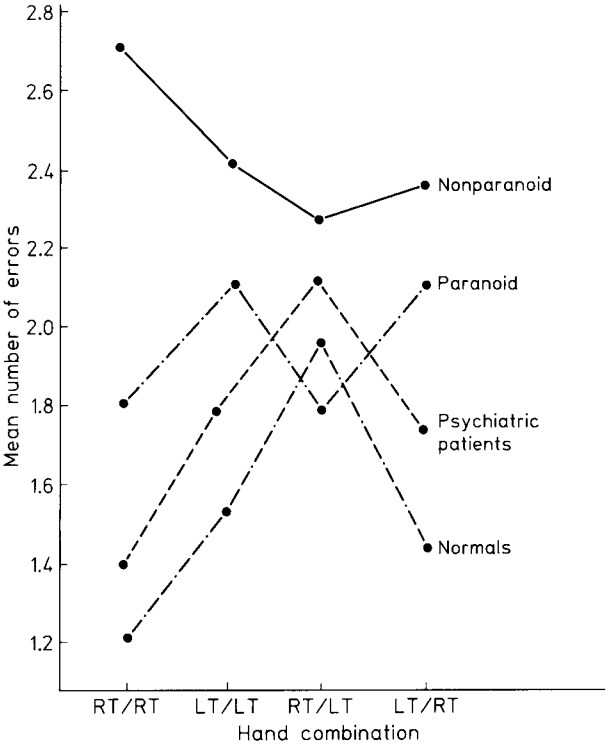

Fig. 1. Mean number of errors for the different hand combinations by group

Independent analyses of variance using an SAS programme were carried out to investigate the effects of:

A. Transfer (Total no. of errors same hand combinations) – (Total no. of errors opposite hand combinations)
B. Time interval
C. Transfer x time interaction
D. Right/right compared with left/left hand combination
E. Right/left compared with left/right hand combination

There was no significant difference between the three groups on the transfer variable ($F = 1.04$, df (2,39) $P = 0.364$) or for the time interval ($F = 0.53$, df (2,39) $P = 0.593$).

The analyses of C, D + E (above) were also not significant.

The second analysis did not assume homogeneity of the schizophrenic group and therefore employed a four-group comparison: paranoid and non-paranoid schizophrenics, psychiatric in-patients and control subjects. The same variables were employed as for the previous analysis. The groups were not found to differ significantly on any of the variables in question. Thus

there was no evidence that paranoid and non-paranoid schizophrenics differ in their interhemispheric transfer of stereognostic information.

Discussion

The poorer performance of schizophrenic subjects when compared with normal subjects on tasks involving the interhemispheric transfer of information has been interpreted as an impairment in the functioning of the corpus callosum. However, the results obtained here fail to provide evidence of such an impairment and are thus at variance with those of Green (1978), Carr (1980) and others. This finding was true both when the schizophrenics were assumed to form a homogeneous group and also when heterogeneity was acknowledged and the total schizophrenic group subdivided into paranoid and non-paranoid groups.

The main finding of interest was the markedly inferior performance of the non-paranoid schizophrenics on the right hand/right hand no transfer condition, regardless of time interval. As this was a post hoc finding (the comparison not having been planned) this result must be treated with caution. However, it indicates a different pattern of performance across conditions rather than a simple deficit; the latter is always difficult to interpret. For all groups except the non-paranoid the right hand/right hand no transfer condition produced fewest errors (cf. Tables 1, 2).

Care had been taken to use only non-meaningful shapes as meaningful shapes are easily verbalised and thus their use leads to a marked left hemisphere superiority on such tasks, which confounds interpretation of results. Despite this, many of those in the two control groups commented afterwards that they had tried to use verbal labels for the shapes, whilst no such observation was made by the schizophrenic group. This may, in part, explain the tendency towards inferior performance by the schizophrenic group.

This, however, cannot explain the different pattern of the results and it may be that the performance of the non-paranoid group reflects a left hemisphere deficit in processing the type of stimuli used here. If this were so, then it would be support for Magaro (1980), who suggested that paranoid and non-paranoid schizophrenics have different information processing strategies and that a left hemisphere dysfunction is specific to non-paranoid schizophrenics. This warrants further investigation.

The major difference between this study and many others in this area is the mean age of the schizophrenics and the extent to which the patients would be seen as chronic. The mean age of the schizophrenic group was only 29.25 years compared with a mean age of 50 years in the work of Carr (1980). Further, none of the subjects was classified as chronically ill and the majority had been in hospital less than 6 months. Other studies do not necessarily give the age of their subjects but usually state that they are classified as suffering from chronic schizophrenia. Thus it is possible that any deficits in the interhemispheric transfer of information are associated with older, chronically ill patients and are not present in younger subjects in the more acute phase of their illness. These factors would bear further investigation.

However, it is far from certain that one can directly equate performance on such tasks (a psychological correlate of schizophrenia) with the functioning of the corpus callosum. As Butler (1979) observed: even if schizophrenic subjects do show impaired transfer of information, this does not necessarily mean that there is a deficit in the corpus callosum as the findings could be a result of a disturbance elsewhere in the central nervous system. He further notes that split-brain patients (with whom the performance of the schizophrenic patients has been compared) do not become schizophrenic, nor do they display any of the symptoms associated with schizophrenia.

In this context it should be reminded that evidence for a disorder of the corpus callosum is still highly speculative. A recent study (Bigelow et al. 1983) only partially confirmed the earlier findings of Rosenthal and Bigelow (1972) of a significant increase in the width of the callosum. This not only raises questions about the significance of such reported defects but leads to the wider question of whether or not it is valid to infer abnormality of physiological functioning from performance on psychological tasks. From evidence to date this would appear a premature step.

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