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Patients with Schizophrenia Remember that an Event has Occurred, but not When

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Background. The context memory deficit hypothesis of schizophrenia postulates that the long-term deficit associated with this disorder is related to a memory impairment for contextual information.
Method. To test this hypothesis, memory for temporal context was assessed in 33 patients with schizophrenia and 33 normal subjects, using a recency discrimination task.
Results. Whereas patients were able to recall and recognise target items, they were unable to recognise from among the target items those which had been most recently learned.
Conclusions. Schizophrenia is associated with a temporal context memory deficit.

The context memory deficit hypothesis of schizophrenia postulates that the long-term memory deficit associated with this disorder is related to a memory impairment for contextual information (Schwartz *et al*, 1991). Contextual information refers to information about when and where a specific event took place, thus enabling this event to be distinguished from other events. This hypothesis is supported by direct, albeit contradictory, evidence. Some studies have reported that patients with schizophrenia exhibit an impairment of temporal order information (Schwartz *et al*, 1991) and of reality monitoring, i.e. an inability to discriminate read from previously self-generated items (Bentall *et al*, 1991). However, Shoqeirat & Mayes (1988) have reported that, relative to recall and recognition, spatio-temporal context memory is not disproportionately impaired in acute schizophrenic patients.

The first aim of this study was to investigate temporal context memory in patients with chronic schizophrenia using a slightly modified version of the recency judgement task developed by Parkin and colleagues (Parkin *et al*, 1990; Becker *et al*, 1993). To show that certain patients have special problems remembering contextual information it is necessary to demonstrate that they have poorer context memory than controls, even when the target information recall and recognition of the two groups has been equated by appropriate experimental manipulations (Schacter, 1987; Shoqeirat & Mayes, 1991). In other words, it is necessary to demonstrate that the context memory deficit is disproportionate. In this study, the use of a learning criterion during the learning phase ensured that recall of target information was the same in patients and controls. The second aim of the study was to examine whether the performance of patients with schizophrenia in the recency judgement task was correlated with the severity of the memory deficit. Indeed, in order to establish that context memory impairment is not the consequence, but one of the causes, of a more general memory deficit, it is necessary to show that context memory deficit is significantly correlated with a broader memory impairment (Shoqeirat & Mayes, 1991).

Method

Thirty-three patients (21 men, 12 women; mean age (s.d.): 32.8 (8.2) years; mean educational level: 10.2 (3.3) years) participated in the study which was part of a broader investigation of memory for different forms of contextual information. An investigation of spatial context memory carried out in these patients is reported elsewhere (Rizzo *et al*, 1996). There were five in-patients and 28 out-patients. All subjects (mean duration of illness: 8.5 (5.3) years) fulfilled DSM–III–R criteria for schizophrenia (American Psychiatric Association, 1987) and were clinically stabilised. Patients treated with antidepressants, benzodiazepines or lithium were excluded. Thirty-one patients were receiving a long-term neuroleptic treatment, administered in a standard dose (296 (246) mg of chlorpromazine or equivalent). Sixteen received also anti-Parkinsonian treatment (trihexyphenidyle, mean dose: 5.9 (3.8)

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mg, or tropatepine, mean dose 11.4 (6.3) mg). Two patients were free of any treatment. The normal group comprised 33 subjects previously matched with the 33 patients for gender, age (mean 31.3 (8.7) years) and educational level (mean: 11.2 (3.5) years). The two groups did not significantly differ in age ($t = 0.75$, NS) or education ($t = -1.12$, NS).

Psychiatric symptomatology was assessed by the Brief Psychiatric Rating Scale (mean 48.5 (14.7)), the Scale for the Assessment of Positive Symptoms (mean 34.7 (28.1)) and the Scale for the Assessment of Negative Symptoms (mean 54.3 (25.7)). Extrapyramidal symptoms and tardive dyskinesias were assessed by the Simpson–Angus Scale and by the Abnormal Involuntary Movement Scale, respectively. IQ was assessed using a short version of the WAIS–R, global memory competence using the revised Wechsler Memory Scale (WMS–R) and frontal lobe dysfunction using Nelson's version of the Wisconsin Card Sorting Test. In all these tasks, performance was significantly lower in schizophrenic patients than in control subjects ($t \geqslant 2.66$, $P < 0.005$, Table 1).

Recency judgement task

Temporal context memory was assessed using a modified version of the recency judgement task developed by Parkin *et al* (1990). The stimuli were 30 Snodgrass's pictures. The task comprised five trials. In trial 1, six of the pictures were presented to the subjects for 20 seconds, with instructions to look at the pictures and try to remember them. Following presentation of the pictures, subjects were given a free-recall test. If a subject could not recall all six pictures, they were presented for a further five seconds. This was continued until six pictures were recalled. After the subjects had satisfied this learning criterion, there was a retention period of five minutes, during which they were engaged in filler (cancellation) tasks. This was followed by a recognition test. Subjects were presented with an array of 30 pictures, consisting of 6 target stimuli and 24 distractors. They were required to pick up the six pictures they had just been asked to remember. In trial 2, subjects were presented with six more pictures to memorise, selected from the set of pictures which had served as distractors during the previous recognition test. Thus, in the next recognition test six distractors became targets while the six targets in trial 1 became distractors. When all six pictures had been learned and recalled correctly subjects were given the distractor tasks for 5 minutes and then presented with the same 30 pictures array. They were instructed to point to the six pictures most recently memorised. This process was continued until trial 5 when the six remaining distractors became targets while the trial 4 targets reverted to being distractors.

Results

Recency judgements

To satisfy the criterion of 100% recall, patients needed more presentations than controls, the difference increasing with successive trials (except trial 5, see Fig. 1). This result was confirmed by a MANOVA carried out on the number of presentations. There was a significant trial (F (4, 61) = 7.53, $P < 0.0001$) and group (F (1, 64) = 53.5, $P < 0.0001$) effect and a significant interaction between trials and groups (F (4, 61) = 3.90, $P < 0.001$).

Correct responses as a function of groups and trials are shown in Fig. 2. Whereas performance in trial 1 was 100% correct in both groups, in subsequent trials patients' performance was lower than that of controls and steadily declined. A MANOVA revealed a significant trial (F (4, 61) = 15.3, $P < 0.0001$) and group (F (1, 64) = 7.0, $P < 0.01$) effect and a significant interaction between

Table 1
Neuropsychological assessment

	Schizophrenic patients n=33	Control subjects n=33	t	P
WAIS–R: IQ	85 (18)	110 (18)	−5.59	<0.0001
Wechsler Memory Scale				
Revised global memory index	78 (22)	109 (15)	−6.39	<0.0001
WCST				
number of categories	5.1 (1.8)	5.9 (0.4)	−2.66	<0.005
number of errors	4.8 (6.4)	0.2 (0.8)	3.97	<0.0001
number of perseverative errors	2.8 (3.4)	0.03 (0.2)	4.53	<0.0001

Values are mean (s.d.). Statistical comparisons are by Student's t-tests.

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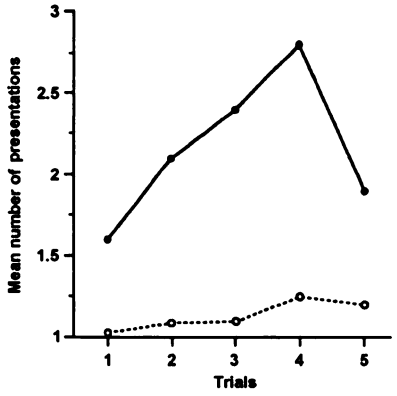


Fig. 1 Recency judgement task. Number of picture presentations required to satisfy the learning criterion. —●—, patients; ---○---, controls.

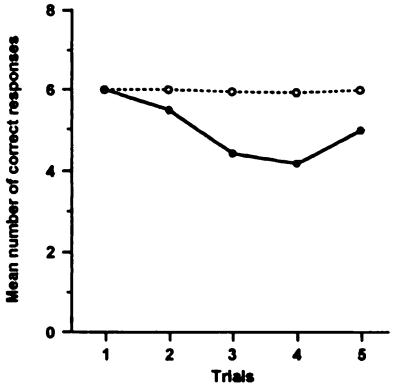


Fig. 2 Recency judgement task. Number of responses. —●—, patients; ---○---, controls.

trials and groups (F (4, 61) = 12.7, $P<0.0001$). Performance was significantly lower in patients than in controls from trial 2 to trial 5 (F (1, 64) $\geqslant$ 5.5, $P<0.05$). This remained the case when the analysis was carried out on subgroups of schizophrenic and control subjects matched for IQ (the 11 patients and 30 control subjects whose IQ was within one standard deviation of that of control subjects). A further analysis of errors was carried out to assess the performance of the two groups. In trials 2 to 4, subjects could make two types of errors: they could choose a picture which had served as a target in a previous trial or one which had never been a target. Patients made significantly more errors than controls on pictures which had previously served as targets (F (1, 64) $\geqslant$ 13.5, $P<0.001$), with the proportion of errors, i.e. the number of errors divided by the number of pictures which had previously served as targets (12, 18 and 24 for trials 2, 3 and 4, respectively) remaining constant across trials (trial 2: (7) *v.* (0)%; trial 3: (8.8) *v.* (0.5)%; trial 4: (7.2) *v.* (0.5)%, in the schizophrenic *v.* control groups, respectively). Patients and controls made so few errors on pictures that had never been a target that no meaningful statistical analysis was possible.

Influence of anticholinergic medication

To evaluate the contribution of anticholinergic medication to recency judgement impairment, patients were subdivided into those who were receiving anticholinergic medication ($n=16$) and those who were not ($n=17$). Recency judgement performance as measured by the total number of correct responses was not significantly different in the two subgroups (25.6 (3.6) *v.* 26.4 (2.6), respectively, $t=-0.72$, NS).

Correlation analysis

In the schizophrenia group, performance in the recency judgement task, as measured by the total number of correct responses, was significantly correlated with the WMS–R global memory index ($r=0.56$, $P<0.005$). It was also significantly and negatively correlated with the number of perseverative errors in the WCST ($r=-0.44$, $P<0.02$). Recency judgement task performance was neither significantly correlated with IQ, age, measures of psychiatric and neurological symptomatology, nor with the number of presentations required to satisfy the criterion of 100% recall.

Discussion

Recency judgement impairment

The main finding of this study was that the recency judgements of patients with schizophrenia were impaired. The analysis of the error pattern indicated that patients had a disproportionately defective memory for temporal context. Whereas they were able to recall and recognise pictures which had been presented as targets, they were unable to recognise from among the target pictures those which had been most recently presented. In other words, they remembered which items they had learned, but not when. Patients needed significantly more presentations of the items to achieve the 100% perfect learning criterion; as supported by correlation analyses, this finding is

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unlikely to account for the recency judgement impairment. The impairment can hardly be explained in terms of IQ performance since it was still found when subgroups of schizophrenia and control subjects matched for IQ were compared. The results confirmed a previous study (Schwartz *et al*, 1991) which investigated the temporal context memory of patients with chronic schizophrenia using another type of recency discrimination task in which subjects judged which of two previously presented items had been shown most recently. Despite this difference, both studies showed a similar pattern of memory impairment, indicating that defective performance was not linked to a particular task, but reflected a genuine temporal context memory impairment. They are at variance with that of Shoqeirat & Mayes (1988), who concluded that temporal context memory was not disproportionately impaired in schizophrenic patients. However, that study is hardly comparable since it investigated patients with acute, rather than chronic, schizophrenia. The disproportionate temporal context memory defect observed in the present study was significantly correlated with the severity of the patients' memory deficit, as measured by WMS–R performance, thus validating the prediction of the context memory deficit hypothesis. This suggests that the impairment of temporal context memory was not a non-specific consequence of a broader memory impairment, but rather one of its causes.

The role of treatment

Many of the patients were receiving neuroleptic drugs and 16 out of them anticholinergic agents. It is unlikely that the memory impairment was due to anticholinergic agents since recency judgements were not significantly different in patients who were or were not receiving these drugs. Unfortunately, inasmuch as all but two patients were treated by neuroleptic medication, it was not possible to examine the effect of these drugs on memory performance. In a recent review of the impact of medication on the memory functions of patients with schizophrenia, Goldberg & Gold (1995) came to the conclusion that this impact is small. Even though it cannot be totally excluded that neuroleptic agents may have contributed to the memory impairment observed in the present study, it is unlikely that they can account for the whole deficit.

Temporal context memory and frontal lobe dysfunction

The WCST performance of patients was significantly correlated with the recency judgement impairment but not with the ability to discriminate targets from distractors. A similar significative correlation has been previously reported in patients with schizophrenia by Schwartz *et al* (1991), indicating that the disproportionate temporal discrimination defect observed in schizophrenia is associated with frontal lobe dysfunction. These results are consistent with increasing evidence from human and animal studies that the impairment of temporal context memory could be related to frontal lobe dysfunction (Schacter, 1987).

Contextual memory deficit as part of a broader cognitive impairment

An important question is whether the defective temporal context memory of patients with schizophrenia reflects a specific deficit in temporal information processing or is part of a broader cognitive impairment. Bowers *et al* (1988) have

Clinical implications

- Schizophrenia is associated with a temporal context memory deficit: patients with schizophrenia are able to remember that an event has occurred, but not when.
- The demonstration of a disproportionate temporal context memory deficit suggests that the context memory impairment is not the consequence, but rather one of the causes, of a more general memory deficit.
- The impairment of temporal context memory could itself be part of a broader cognitive impairment. If, as has been previously shown, patients with schizophrenia have some difficulty in organising and elaborating ongoing experience, they would also have some difficulty in discriminating between experiences with respect to time.

Limitations

- Despite patients and control subjects being matched for educational level, IQ was lower in the schizophrenia group than in the control group. However, this difference can hardly explain the present findings since the temporal context memory deficit was still observed when subgroups of schizophrenic and control subjects matched for IQ were compared.
- It is not clear whether the present findings, obtained in patients with chronic schizophrenia, can be extended to patients with more acute forms of schizophrenia.
- Even though it is unlikely that neuroleptics can account for the whole context memory deficit, it cannot be totally excluded that they may have contributed to the memory deficit.

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suggested that normal subjects can use two strategies for processing temporal information: an organisational strategy that is dependent on frontal lobe functioning and a more automatic time-tagging mechanism which allows temporal marking of new information. According to this hypothesis, the context memory deficit observed in patients with frontal lobe dysfunction is part of a broader organisational strategy deficit. This could also be the case with schizophrenia, which is characterised by a failure to organise and elaborate ongoing experience (Koh *et al*, 1976): if the ability of patients with schizophrenia to organise experience into temporally distinctive units is impaired, it would be difficult for them to discriminate among experiences with respect to time.

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