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Implicit and explicit associative memory in patients with schizophrenia

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Abstract

Control and Schizophrenic subjects performed memory tests under conditions in which performance is influenced by newly acquired information about associations between pairs of normatively unrelated words (a 'context' word and a target word). In Experiment 1, the associative memory test was implicit. Control and schizophrenic subjects reached the same level of performance and, more importantly, both groups used contextual information to the same extent. In Experiment 2, subjects were submitted to an explicit and an implicit memory test in succession. Overall performance of schizophrenic patients was impaired in the explicit memory test. But, as in Experiment 1, the two groups did not differ in the overall level of implicit memory, and context improved performance to the same extent in both tests. These results run counter to the widespread idea that schizophrenic patients exhibit a deficit in processing all types of contexts, and suggest that the deficit may be limited to the processing of what Baddeley (1982) calls 'interactive' context.

Keywords: Schizophrenic patients; Associative priming; Explicit memory; Implicit memory; Context

1. Introduction

Despite being the focus of many experimental investigations, the cognitive deficits involved in schizophrenia remain poorly understood. Among the main theoretical constructs that have been invoked to account for these deficits is the idea that only the controlled processes are impaired in schizophrenia, while more automatic processes are spared (e.g., Hardy-Bayle, 1994). Research conducted in the memory field has provided support for this hypothesis by showing that performance

on recall and recognition tests is frequently impaired (Danion et al., 1992; Goldberg et al., 1993b; Heinrichs and Awad, 1993; Saykin et al., 1991; Tamlyn et al., 1992), whereas performance in implicit memory tasks is the same as in normals (Schmand et al., 1992; Clare et al., 1993; Goldberg et al., 1993a; Schwartz et al., 1993; but see Randolph et al., 1993; Heinrichs and Bury, 1991). Implicit memory tests tap the automatic effects of a previously studied stimulus on subsequent identification or production tasks, the term 'automatic' here being intended to mean that the effects are not mediated by the explicit retrieval of these stimuli.

Another explanation for the cognitive deficits in

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schizophrenia has been propounded by Cohen and Servan-Schreiber (1992). These authors posit that many of the cognitive deficits in schizophrenia can be accounted for by the idea that schizophrenics have a degraded ability to construct and maintain internal representations of context. These authors designate as context all elements of an experimental situation (including, for instance, the instructions given to subjects) that influence the behavioral response, with the exception of the target stimulus itself.

This view is partially rooted in the study by Chapman et al. (1964). In this study, subjects were asked to choose from among three possible meanings of an homonym the one that was appropriate in a given sentence. Schizophrenics tended to choose the dominant meaning of the homonyms, even when the context provided by the sentence probed another (weaker) meaning. Cohen and Servan-Schreiber (1992) recently replicated and extended these results. The joint consideration of these two accounts raises the question about the generality of the spared ability of schizophrenic patients to process implicit information. Whenever implicit memory performance requires the processing of contextual information, is the performance of schizophrenic patients preserved? In order to document this question, the following study involves an implicit memory task in which the use of context may improve performance.

Our paradigm was adapted from that of Graf and Schacter (1985) who investigated implicit memory for newly acquired associations (referred to as implicit associative memory in the following). Subjects were first presented with a set of pairs of normatively unrelated words. Within each pair, the first word played the role of context for the second, target word. Then the subjects were given a word-stem completion test involving the target word of each pair. Some stems appeared in the same context as they had during the study phase, whereas other stems appeared in a different context. The result was that subjects completed stems more often when they appeared in the same context than when they appeared in a different context. Because this effect appears only, or at least more clearly (Schacter and Graf, 1986), when a meaningful relation between the two words is

formed during the encoding phase, subjects either had to read a sentence including the two words or to generate such a sentence themselves. We hypothesised that in this situation, in which the context effect is presumably automatic, the schizophrenic patients would be sensitive to the congruence of the context-target relationship between the study phase and the test phase.

2. Experiment 1

2.1. Method

2.1.1. Subjects

Forty-eight subjects, half of them patients and half control subjects, participated in the study. The patient group consisted of 24 schizophrenic in- and out-patients (seven females and 17 males) fulfilling the Diagnostic and Statistical Manual of Mental Disorders-III-Revised (DSM-III-R) criteria for schizophrenia, of mean age 27.9 ± 7.9 years. They all received neuroleptic drugs, but were clinically stable (mean on BPRS, 63.7 ± 14.7 ; mean on Montgomery and Asberg Depression Rating Scale 21-item version (MADRS), 11.2 ± 5.6). The control group comprised 24 subjects (15 females and nine males) with no history of illness, somatic or psychiatric symptoms (mean age, 30.9 ± 8 years). All subjects were native speakers of French; their vocabulary level was assessed using a specially designed test (Binoit-Pichot). Control subjects scored higher (28.4 ± 3.5) than did schizophrenic subjects (23.9 ± 5.5) and the difference was significant ($F(1,39) = 9.63$, $p < 0.005$).

2.1.2. Material

The material was composed of three lists of 20 pairs of context/target words. All the words were concrete nouns of more than five letters in length. In order to fulfill the requirements for the word-stem completion task, the stems (i.e., the initial three letters) of each target word were unique to the whole set of words, had no diacritical marks, and could be completed to generate at least 10 common words. In no case was the selected word the most frequent of the possible words (according

to the Tresor de la Langue Francaise du CNRS, Nancy, 1977).

2.1.3. Procedure

Each subject was tested individually during two sessions. All subjects were unaware of the purpose of the study. During the study session, the subjects were shown pairs of words under one of the following two conditions. Either the two words were presented in isolation and the subjects had to generate a sentence integrating these two words (Generate condition); or the two words were displayed within a sentence, and the subjects had to read the sentence and rate the value of the semantic link (Read condition). In this latter case, the words were always displayed in upper-case letters while the rest of the sentences were written in lower-case letters. The Generate and Read conditions were intermixed for each subject. Within a group, the order of presentation of the context-target words differed for each subject, but schizophrenic and control subjects were yoked.

The test phase immediately followed the study phase, and was introduced as a 'filler' task in order to minimise the potential influence of any retrieval strategy on implicit memory performance. Subjects were shown a context word, followed by a three-letter stem. They had to read the context word and then provide the first word that came to mind to complete the stem.

There were three main test conditions. In the first condition, the stem associated with any given context word allowed the target word that was associated with this context to be generated during the study phase (Same Context). In the second condition, the context/target pairs displayed in the study pairs were mixed, so that all the context words were associated with a stem corresponding to a different target word (Different Context). In the third (Control) condition, both context and target words were new (distractors). There were three lists of words. Each list was used in each condition with different groups of subjects. This resulted in three groups of subjects, each group working with a different condition/list pairing. The results were averaged across the counterbalanced conditions.

2.2. Results and discussion

There was a sizeable overall effect of the earlier presentation of the target words. Indeed, all the subjects correctly completed the stems corresponding to old words far more often than those corresponding to new words (respectively: 8.56 vs. 0.98; $F(1,46)=191.3$, $p<0.0001$). This effect was comparable for control and schizophrenic subjects, as evidenced by the non-significant interaction between the Status of the words (old versus new) and the Groups (control vs. schizophrenic) ($F<1$).

The data concerning the effect of context were submitted to an analysis of variance (ANOVA) with one between-subject factor (control vs. schizophrenic) and two within-subject factors (Same Context vs. Different Context, Read Sentence vs. Generated Sentence). There was a reliable effect of context, with better performance being observed when stems were presented in association with the old context ($M=4.87$) than when stems were presented in a different context ($M=3.68$) ($F(1,46)=10.61$, $p=0.002$). However, as shown in Fig. 1, the effect was the same in control and schizophrenic subjects, as confirmed by the non-significant interaction between the subject's group and the type of context ($F<1$).

There was a reliable effect of the mode of presentation of the pair of words, with better performance in the Generated condition ($M=2.85$) than in the Read condition ($M=2.02$; $F(1,46)=5.07$, $p=0.029$). As expected, this effect was obtained for the Same Context condition ($F(1,46)=11.9$, $p=0.001$) but did not occur for Different Context ($F<1$). As shown in Fig. 2, the effect of the mode of presentation in the Same Context condition was the same for controls and schizophrenics, as evidenced by the non-significant interaction between the two factors ($F<1$). All analyses contrasting control and schizophrenic subjects were replicated for different groups of schizophrenic patients, formed on the basis of their performance in BPRS (Positive vs. Negative schizophrenic patients) on the one hand, and the criteria of DSM-III-R (Paranoid, Undifferentiated, Disorganized Schizophrenic patients) on the other, in order to examine whether the results were the same for different subtypes of

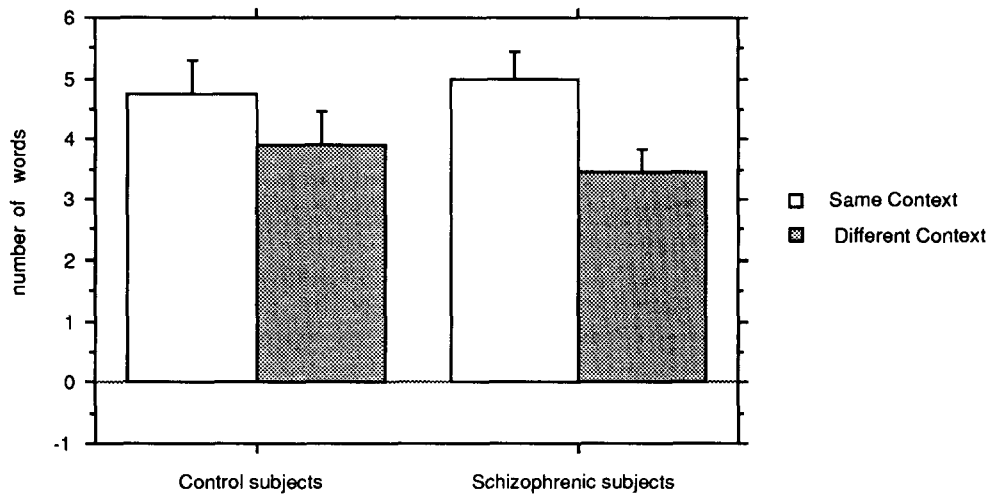


Fig. 1. Performances of schizophrenic patients and control subjects in the associative implicit memory task, in the Same Context and in Different Context, in Experiment 1.

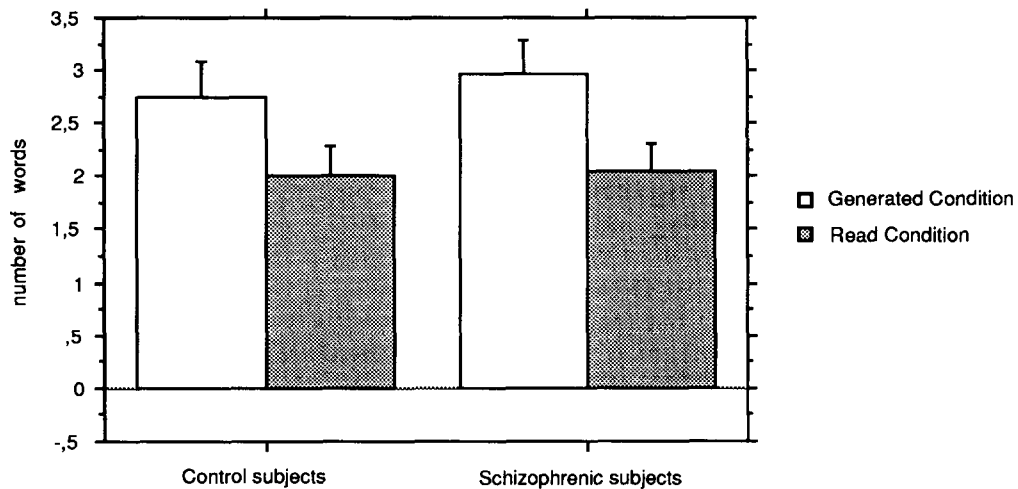


Fig. 2. Performances of schizophrenic patients and control subjects in the associative implicit memory task, in the Generate condition and in the Read condition, in Experiment 1.

schizophrenic patients. None of these exploratory analyses revealed reliable differences.

These findings run counter to our hypothesis and strongly suggest that the preservation of performance in schizophrenic subjects previously observed in the simple implicit memory task is maintained when the task involves context processing. This result was obtained when the semantic link between context and target words was pro-

vided to subjects, as well as when the link was generated by the subjects.

The fact that the selective deficit of context processing in schizophrenia reported by Chapman et al. and Cohen and Servan-Schreiber was no longer found in an implicit memory task suggests that this deficit in context processing could be limited to the task involving explicit processing of the context. The available literature is consonant

with this suggestion, but the arguments are admittedly unconvincing. Indeed, the studies of Chapman et al. and Cohen and Servan-Schreiber were not devised to deal with this issue, and the extent to which their tasks involve explicit and implicit processes consequently remains unclear.

If our line of reasoning is correct, the deficit in context processing in schizophrenic patients should be obtained in an associative memory task designed as in Experiment 1, except that subjects are explicitly asked to use the information conveyed by the context to complete the word stem. Experiment 2 was intended to test this hypothesis and to replicate the results from Experiment 1 regarding the lack of differences between schizophrenics and controls in an implicit associative memory task. Such an outcome would be indicative of a genuine implicit/explicit dissociation.

3. Experiment 2

3.1. Method

3.1.1. Subjects

Forty new subjects (half of them patients and half normal control subjects) participated in the study. The patient group included 20 schizophrenic in- or out-patients (four females and 16 males) fulfilling the DSM-III-R criteria for schizophrenia, of mean age 31.8 ± 11.9 years. All of them received neuroleptic drugs, and they were clinically stable (mean on BPRS, 63 ± 16.2 ; mean on Assessment of Thought Language and Communication disorders (TLC) (Andreasen, 1979), 12.1 ± 7.9 ; mean on Montgomery and Asberg Depression Rating Scale 21-item version (MADRS), 11.7 ± 7.2). The control group comprised 20 subjects (nine females and 11 males) with no history of illness, somatic or psychiatric symptoms (mean age, 37.4 ± 10.9 years).

All subjects were native speakers of French; their vocabulary level was assessed using a specially designed test (Binoit-Pichot). Control subjects scored higher (28.5 ± 5.6) than schizophrenic subjects (19.7 ± 5.8) and the difference was significant ($F(1,34) = 21.1$, $p = 0.0001$).

3.1.2. Material

The material was the same as in Experiment 1, but the 60 pairs of context/target words were divided into five lists of 12 pairs, instead of being divided into three lists of 20 pairs (the two additional lists were needed for the explicit memory tests).

3.1.3. Procedure

The procedure was the same as in Experiment 1 for the study session and the part of the test session assessing implicit associative memory.

The test of explicit memory immediately followed the test of implicit memory. Subjects were shown a context word, followed by a three-letter stem. They had to read the context word and then complete the stem in order to produce the target that was paired with this context word during the study phase. There were two main conditions. In the first condition, the stem associated with any given context word allowed the target word that was associated with this context during the study phase (Same Context) to be generated. In the second condition, the context/target pairs displayed in the study pairs were mixed, so that all the context words were associated with stems corresponding to different target words (Different Context).

There were five lists of words. Each list was used in each condition in different groups of subjects. This resulted in five groups of subjects, each group working with a different condition/list association. The results were averaged across the counterbalanced conditions.

3.2. Results

3.2.1. Associative implicit memory

In the implicit memory test, the results for Experiment 2 exactly replicated those of Experiment 1. Subjects correctly completed the stems corresponding to old words far more often than those corresponding to new words (respectively: 5.78 versus 0.80; $F(1,38) = 105.6$, $p = 0.0001$). This effect was comparable for control and schizophrenic subjects, as evidenced by the non-significant interaction between the status of

the words (old versus new) and the groups (control vs. schizophrenic) ($F < 1$).

There was a reliable effect of context, with better performance when stems were presented in association with the old context ($M = 3.20$) than when stems were presented within a different context ($M = 2.58$) ($F(1,38) = 4.97$, $p = 0.03$). However, the effect was the same in the control and schizophrenic subjects, as confirmed by the non-significant interaction between the subject's group and the type of context ($F < 1$).

As in Experiment 1, there was an effect of the mode of presentation of the pairs of words, with better performance being observed in the Generated condition than in the Read condition ($M = 2.97$ vs. 2.70). However, this effect was not statistically reliable, even when the effect was considered only for the Same Context condition ($F < 1$ in both cases). These results occurred for controls as well as for schizophrenic patients, as evidenced by the non-significant interaction between the two factors ($F < 1$).

All analyses contrasting control and schizophrenic subjects were replicated for different subgroups of schizophrenic patients, formed according to (1) the criteria of DSM-III-R and (2) their performance in TLC, in order to examine whether the results were the same for different subtypes. None of these exploratory analyses revealed reliable differences.

3.2.2. Associative explicit memory

In contrast with the results for implicit memory, performance for the two groups of subjects differed reliably ($F(1,38) = 8.11$, $p = 0.007$). Control subjects completed more of the word stems on the basis of the previously displayed words than did schizophrenic subjects (7.9 vs. 5.15).

Other results were similar to those obtained in the implicit memory task. There was a strong effect of context, with better performance being observed when stems were presented in association with the old context ($M = 4.22$) than when they were presented in a different context ($M = 2.30$) ($F(1,38) = 33.62$, $p = 0.0001$). However, the effect was the same in control and schizophrenic subjects, as confirmed by the non-significant interaction

between the subject group and the type of context ($F < 1$).

There was also a reliable effect of the mode of presentation of the pair of words, with better performance observed in the Generated condition ($M = 3.82$) than in the Read condition ($M = 2.67$) ($F(1,38) = 9.69$, $p = 0.003$). As expected, this effect was obtained for the Same Context condition ($F(1,38) = 14.17$, $p = 0.0006$), but did not occur for Different Context ($F < 1$). As shown in Fig. 3, the effect of the mode of presentation in the Same Context condition was stronger for schizophrenic subjects than for controls, as evidenced by the significant interaction between the two factors ($F(1,38) = 4.56$, $p = 0.039$). In the Generated condition, the performances of the schizophrenic and control subjects did not differ but in the Read condition, controls performed significantly better than did schizophrenic patients.

Analyses contrasting control and schizophrenic subjects for implicit and explicit memory tests were replicated for different subtypes of schizophrenic patients, formed on the basis of (1) the criteria of DSM-III-R, and (2) their performance in TLC, in order to examine whether the results were the same for different subtypes. No consistent pattern of differences between schizophrenic groups emerged from these exploratory analyses.

4. Discussion and conclusion

One of the results of these studies was that, when overall performances were considered, control and schizophrenic subjects differed in the explicit memory task, whereas they were comparable in the implicit memory task. This is a new illustration of a dissociation that has been observed in a number of other pathological populations suffering from a relative explicit memory deficit (Bazin et al., 1994; Schacter et al., 1988). Note that, in the present case, the attribution of the dissociation to the schizophrenic disorder must be made with caution, given that our two populations also differed with regard to their vocabulary level.

The schizophrenics' deficit in the explicit memory task was observed when subjects had to read a sentence integrating the context and the

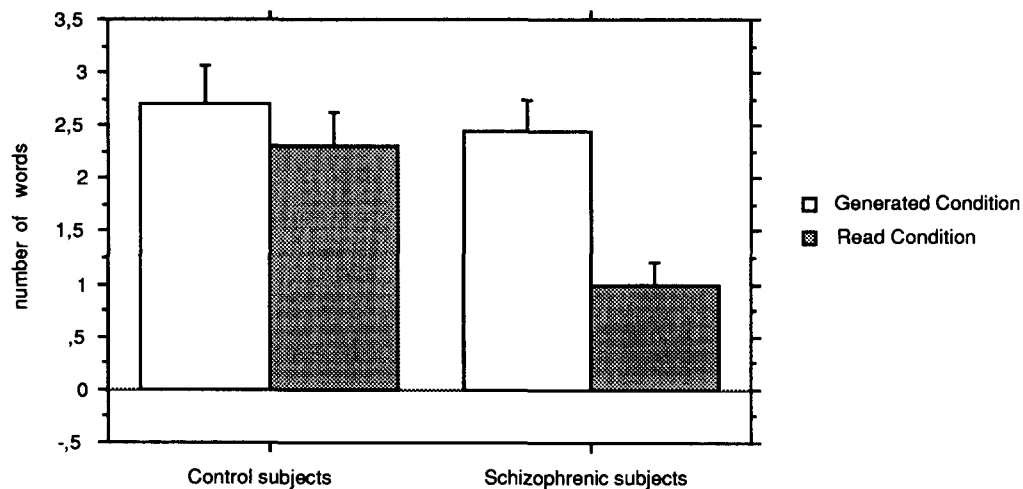


Fig. 3. Performances of schizophrenic patients and control subjects in the associative explicit memory task, in the Generate condition and in the Read condition, in Experiment 2.

target words, but no longer occurred when subjects were asked to generate an integrative sentence themselves. This result is consonant with studies showing that the deficit of schizophrenics in some tasks can be attenuated or suppressed if the subjects are oriented toward an efficient strategy (Goldman et al., 1992; Koh and Peterson, 1978). In associative implicit memory, there is evidence that the most efficient way to deal with the task consists of elaborating a semantic link between the context word and the target word during the study phase (Graf and Schacter, 1985), and it is possible that asking subjects to perform this elaborative work improves the performance of schizophrenics to a greater extent than it does the performance of control subjects.

We began with the studies showing that schizophrenic patients, when compared to controls, tended to ignore the contextual information (e.g., Cohen and Servan-Schreiber, 1992). Although these studies were not designed to contrast implicit and explicit processes, we argued that they mainly involved explicit processes. Our main question focused on the degree of this impairment in context processing under conditions primarily involving implicit forms of processing. The above two experiments showed that context processing was spared in this condition: schizophrenic subjects were able to construct context-target associations and to use

this new representation in a subsequent task just as well as control subjects. This result runs counter to the hypothesis according to which the main cognitive deficit of schizophrenia consists in a degraded ability to construct and maintain internal representations of context.

However, this preserved ability to use the contextual information was also observed in Experiment 2 in an associative memory task involving the explicit use of contextual information. This result prevents us from accounting for the discrepancy between earlier results and our own by invoking the contrast between explicit and implicit or automatic processing. This stresses the need to explore the possible influence of other differences between our paradigm and earlier ones. Although both situations differ with respect to several features, the role of the context in dealing with the target information may constitute a particularly pertinent difference. Baddeley (1982) distinguished between two categories of context. One of them, the interactive context, is defined by the fact that it affects the meaning, or the interpretation, of the target event. For instance, a semantic context allowing the meaning of an homophone to be disambiguated is undoubtedly interactive in nature. By contrast, independent context does not interfere with the meaning-based interpretation of the target event. The pairing of two unrelated

context/target words provides a typical instance of independent context.

Baddeley's distinction can help to account for the discrepancy between empirical data. Indeed, the context used by Cohen and Servan-Schreiber (1992) and Chapman et al. (1964) was interactive, insofar as it dispelled the ambiguity of the meaning of the target word, whereas the context in the reported experiments did not. Further research is needed to investigate whether the deficit in context processing in schizophrenic patients is limited to the tasks in which the context is interactive.

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