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Specificity deficit in the recollection of emotional memories in schizophrenia ☆,☆☆

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Abstract

The influence of emotion on episodic and autobiographical memory in schizophrenia was investigated. Using an experiential approach, the states of awareness accompanying recollection of pictures from the IAPS and of associated autobiographical memories was recorded. Results show that schizophrenia impairs episodic and autobiographical memories in their critical feature: autonoetic awareness, i.e., the type of awareness experienced when mentally reliving events from one's past. Schizophrenia was also associated with a reduction of specific autobiographical memories. The impact of stimulus valence on memory performance was moderated by clinical status. Patients with schizophrenia recognized more positive than negative pictures, and recalled more positive than negative autobiographical memories while controls displayed the opposite pattern. A hypothesis in terms of a fundamental executive deficit underlying these impairments is proposed.

Keywords: Schizophrenia; Episodic memory; Autobiographical memory; Emotion; Conscious recollection

1. Introduction

Among the large but selective memory deficits encountered in schizophrenia, the impairment of episodic memory is now well established (e.g., Bilder et al., 2000; Danion, Rizzo, & Bruant, 1999; Gold, Randolph, Carpenter, Goldberg, & Weinberger, 1992; Heinrichs & Zakzanis, 1998; Huron et al., 1995; Palmer et al., 1997; Saykin et al., 1994). Patients with schizophrenia typically fail in tasks that require explicit and conscious retrieval of information from memory. According to Tulving (1985), the main characteristic of episodic memory is its dependence on autonoetic awareness, i.e., the kind of awareness where people consciously recollect

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events by reliving them mentally. Noetic awareness, on the other hand, is the knowledge that an event has occurred but in the absence of any conscious recollection. It conveys a more abstract sense of the past, based on feelings of familiarity. The distinction between the different states of awareness can be assessed using an experiential approach in which autonoetic and noetic awareness are operationally defined in terms of the Remember/Know procedure (Gardiner, Java, & Richardson-Klavehn, 1996; Tulving, 1985). In a recognition task, participants are asked to report their subjective state of awareness at the time they recognize each item. They are instructed to give a Remember response if they consciously recollect something they experienced when they learned the item, i.e., if they mentally relive the learning episode. For example, they can remember a thought they had, or an event that occurred, when they learned the item. Participants are instructed to give a Know response if recognition is accompanied by feelings of familiarity in the absence of any specific memories of the learning episode.

Using this procedure, a series of studies have demonstrated that, compared to control participants, the recognition performance of patients with schizophrenia is associated with lower levels of Remember, but not of Know responses (e.g., Danion et al., 1999; Huron et al., 1995; Huron & Danion, 2002; Sonntag et al., 2003). This indicates that schizophrenia selectively impairs autonoetic awareness, but not noetic awareness.

More recently, several studies have reported that autobiographical memory (i.e., memory for personal events and facts) is also disturbed in schizophrenia (e.g., Baddeley, Thornton, Chua, & McKenna, 1995; Feinstein, Goldberg, Nowlin, & Weinberger, 1998; Riutort, Cuervo, Danion, Peretti, & Salamé, 2003; Tamlyn et al., 1992). Patients with schizophrenia generate fewer autobiographical memories than normal individuals. This deficit seems to be particularly marked for events that occurred after the onset of the disease (Elvevag, Kerbs, Malley, Seeley, & Goldberg, 2003a; Feinstein et al., 1998; Riutort et al., 2003). Further, patients with schizophrenia report overgeneral memories rather than unique episodes that happened at a specific time and place (Harrison & Fowler, 2004; Iqbal, Birchwood, Hemsley, Jackson, & Morris, 2004; Riutort et al., 2003). Indeed, when asked to retrieve specific memories (e.g., '*When my husband and I went to a Chinese restaurant last week*'), patients with schizophrenia tend to recall overgeneral events such as events that refer to repeated occasions (e.g., '*Every time I go shopping*'), or events that lasted longer than a day (e.g. '*A weekend with my husband in Paris*').

Schizophrenic patients' lack of specificity in the retrieval of their own personal past may be related to their difficulties in consciously recollecting past events. According to Conway and Pleydell-Pearce (2000), autobiographical memories are generated from the individuals' autobiographical knowledge base at different levels of specificity. The ability to specify personal events is linked to autonoetic awareness. Indeed, the recollection of highly specific details, such as the sensory-perceptual details of a particular situation, is necessary for mentally reliving these events. The experience of conscious recollection emerges when specific details are accessed in the autobiographical knowledge base (Conway & Pleydell-Pearce, 2000). In contrast, the subjective feeling of simply knowing that an event has occurred should be sufficient for the recall of more general, abstract memories (Conway & Pleydell-Pearce, 2000).

Taking these arguments into account, the difficulties for schizophrenic patients to recollect specific events could be intrinsically related to their autonoetic awareness deficit. This hypothesis has been recently tested in a study (Danion et al., 2005) comparing the performance of 22 patients with schizophrenia and 22 normal controls on an adaptation of the autobiographical memory inquiry (Piolino, Desgranges, Benali, & Eustache, 2002). Participants were asked to recall specific autobiographical memories and to indicate the subjective states of awareness associated with the recall of what happened, when and where. Danion and collaborators (2005) found that patients with schizophrenia retrieved fewer specific memories and provided lower levels of Remember responses than controls, and this was the case across all lifetime periods. More directly relevant to the present study, the proportion of Remember responses was significantly correlated with the level of specificity for both the patients and the control group.

When considering the relationship between consciousness and memory in schizophrenia, emotion may play a significant role. Because emotional disturbances are a major aspect of schizophrenia, it is crucial to establish whether patients with schizophrenia exhibit a different pattern of memory performance than control participants when emotional material is used. Many studies conducted on normal participants have shown that memory is strongly influenced by emotion (e.g., Blaney, 1986; Bower, 1981; Conway & Pleydell-Pearce, 2000). Memory for emotional events is better than memory for neutral events, a phenomenon known as the emotionality effect (e.g., Dutta & Kanungo, 1975; Rubin & Friendly, 1986; Rusting, 1998).

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There have been relatively few studies that have addressed the impact of emotion on memory in schizophrenia, and their findings are not consistent. Most of these studies have used emotional words to compare the impact of the emotional valence of to-be-learned words on recall performance in patients with schizophrenia and normal controls. Kayton and Koh (1975) have found that, contrary to normal controls, patients recalled unpleasant words and pleasant words equally well, indicating an emotionally undifferentiated recall. Another experiment has observed a more rapid forgetting of positive than negative words in patients as compared to controls (Calev & Edelist, 1993). Using free recall and recognition tasks, Mathews and Barch (2004) have observed that patients with schizophrenia demonstrate patterns of memory for emotional words similar to normal participants, with better performance for negative than positive words. Other studies have showed an intact emotionality effect and a preservation of the Pollyanna tendency for patients (Danion, Kazès, Huron, & Karchouni, 2003; Neumann, Philippot, & Danion, 2006), which is a better recall of positive than negative events often observed in normal individuals (Boucher and Osgood, 1969; Bradley and Mathews, 1983, 1988). However, other research did not find this Pollyanna tendency in the patient group (Koh, Grinker, Marusarz, & Forman, 1981). Obviously, no conclusions can be drawn from this discrepant pattern of results.

One reason for these inconsistencies might be that nearly all of the studies described above have investigated patients' abilities to recollect emotional events without considering the subjective experience associated with these memories. Because consciousness plays an important role in memory deficits for patients with schizophrenia (Danion et al., 1999), it is crucial to investigate the different states of awareness accompanying the recollection of emotional memories in schizophrenia. Moreover, the series of studies conducted by Ochsner (2000) on normal individuals suggests that the use of the Remember/Know procedure could cast a new light on the relationship between emotion and memory. Indeed, in three consecutive studies, Ochsner has demonstrated that Remember, but not Know responses were more frequent for emotional than for neutral events, underlining the importance of consciously re-experiencing an emotional event during its recall.

Relevant to this perspective, two recent experiments yielded preliminary evidence that the influence of emotion on autonoetic awareness is preserved in schizophrenia (Danion et al., 2003; Neumann et al., 2006). Using a Remember/Know procedure (Gardiner et al., 1996; Tulving, 1985), those studies have investigated the influence of the emotional valence of words (Danion et al., 2003) and sentences (Neumann et al., 2006) on the subjective states of awareness accompanying recognition performance in schizophrenia. Both of these studies have shown that despite poorer recollection and a global reduction of Remember responses in the patient group compared to normal controls, patients' autonoetic awareness was moderated by the emotionality of the material in the same way as in controls. Indeed, in both groups, the proportion of Remember responses was higher for positive than for negative material. Danion and collaborators (2003) also observed that the proportion of Remember responses was higher for emotional words than for neutral words.

However, the type of material used in these previous studies (i.e., emotional words or sentences) probably induced weak emotional responses, if any. It is thus possible that the influence of emotional words on autonoetic awareness was preserved because the evaluation of the emotional valence of the words was closely related to their semantic processing and did not really require the actual activation of their emotionally arousing features. This raises the question of the impact on episodic memory in schizophrenia for stimuli that elicit stronger emotional responses than words. To investigate this issue in the present study, we used photographs selected from the International Affective Picture System (IAPS, Lang, Greenwald, Bradley, & Hamm, 1993) as stimuli. Indeed these photos have been shown to elicit not only subjective and expressive changes, but also physiological changes involved in emotion, such as increases in heart rate, skin conductance, and muscle activity (Lang et al., 1993).

In sum, there is now converging evidence that patients with schizophrenia suffer from impaired episodic and autobiographical memories. However, little is known about their abilities to consciously recollect emotional personal episodes from their lives. Indeed, schizophrenia research concerning the impact of emotion on memory and states of awareness has focused on impersonal episodic memory tasks based on the ability to recall or recognize stimuli previously encoded in an experimental room. Further, the only study (Danion et al., 2005) that has addressed the possible link between conscious recollection and autobiographical memory in schizophrenia did not control for the valence of the memories reported. Thus, despite evidence in healthy individuals that the emotion felt during a situation strongly influences the richness of its retrieval and the associated subjective experience (Conway, Collins, Gathercole, & Anderson, 1996), this phenomenon is still unexplored in

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schizophrenia. This question, however, seems crucial as emotional autobiographical memories are central for the construction of a sense of self, the deficit of which constitutes the core symptom of schizophrenia.

The present study investigated the subjective states of awareness that accompany recognition of emotional episodic and autobiographical memories using the Remember/Know procedure (Gardiner et al., 1996; Tulving, 1985). In a learning session, pictures from the IAPS (Lang et al., 1993) were presented to patients with schizophrenia and normal controls. Participants were asked to assess the emotional valence of the picture. Twenty-four hours later, in a recognition session, participants had to recognize the target pictures among distractors and to indicate the subjective state of awareness associated with their recognition. On the basis of previous evidence, we predicted that patients with schizophrenia should exhibit poorer recognition performance and should provide fewer Remember responses in picture and valence recognition than control participants.

The second aim was to compare the recollection of autobiographical memories, and the associated subjective states of awareness, in patients with schizophrenia and in normal individuals. To achieve this goal, in the first session participants were asked to recall specific personal memories induced by each picture item. During the recognition session, participants were asked to retrieve the autobiographical memories provided during the first session when the picture was shown. In fact, the retrieval of the autobiographical memory generated during the first session was considered as recognition of the picture associated with autonoetic awareness. Indeed, it constitutes direct evidence that participants remembered something that happened during the first session when they saw the pictures.

The demonstration of a reduced proportion of specific memories, associated with a low level of Remember responses, would be consistent with the notion of a positive relationship between autonoetic awareness and autobiographical memory specificity in patients with schizophrenia (Danion et al., 2005). In other words, we predicted that, considering their lack of conscious recollection, patients with schizophrenia should recall fewer specific personal memories than controls.

With regard to the influence of valence on memory, we predicted that for normal participants, as in the studies of Ochsner (2000), Remember responses would be more frequent for negative than for positive stimuli. In view of the inconsistent findings concerning the impact of emotion on memory in schizophrenia, no prediction was made for the patients group on that specific topic.

2. Method

2.1. Participants

Twenty patients with schizophrenia (11 men, 9 women) participated in the study. The patients were recruited from the Psychiatric Department of the Brugmann University Hospital, Belgium. They fulfilled the DSM-IV (American Psychiatric Association, 1994) criteria for chronic schizophrenia (paranoid, $N = 8$; residual, $N = 9$; undifferentiated, $N = 3$) as determined by consensus of the current treating psychiatrist and psychologist. All patients were clinically stabilized. The mean duration of illness was 16.4 years ($SD = 2.3$). Patients with histories of traumatic brain injury, epilepsy, alcohol or substance abuse, or other neurologic conditions were excluded from the study, as were patients treated with benzodiazepines or lithium. Four patients were receiving typical long-term neuroleptics administered at standard dose (mean dose: 168 ± 23 mg of Chlorpromazine or equivalent) and 14 were receiving atypical neuroleptics (mean dose: 9 mg of Clozapine, Risperidone or equivalent). Two patients were not receiving any treatment. Five were also receiving antiparkinsonian treatment. Global psychiatric symptoms were assessed in patients by means of the Brief Psychiatric Rating Scale (BPRS). Positive and negative symptoms were assessed with the Scale for the assessment of Positive Symptoms (SAPS) and the Scale for the Assessment of Negative Symptoms (SANS).

The comparison group comprised twenty normal participants (11 men, 9 women) recruited through local advertisements. They had no history of alcoholism, drug abuse, or neurological or psychiatric illness and did not take any medication. The two groups were paired according to age, gender and level of education. The Beck Depression Inventory (BDI, Beck & Steer, 1987) was administrated to assess the intensity of depression in the clinical and normal control groups. No significant differences in depression ratings were found between groups. IQ, as assessed by a short form of the Wechsler Adult Intelligence Scale-Revised (WAIS-R) (Silverstein, 1992),

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Table 1
Clinical and neuropsychological characteristics of patients with schizophrenia and control participants

Descriptive variables	Patients with schizophrenia ($n = 20$)		Control participants ($n = 20$)		t-tests	p
	M	SD	M	SD		
Age	40.5	±5.4	39.3	±6.2	−0.47	*ns*
Educational level (years)	11.5	±2.4	12.8	±2.1	−0.78	*ns*
Mean duration of illness	16.4	±3.1				
BDI	9.75	±6.7	7.35	±5.5	−1.24	*ns*
BPRS	44.4	±6.6				
SAPS	34.9	±8.9				
SANS	51.1	±10.3				
WAIS-R (performance)	91.5		110.2		−3.89	.001
WAIS-R (verbal)	89.01		107.9		−4.35	.001

Note. Values are means ± SD.
BDI, Beck Depression Inventory. BPRS, Brief Psychiatric Rating Scale. SAPS, Scale for the Assessment of Positive Symptoms. SANS, Scale for the Assessment of Negative Symptoms. WAIS-R, Wechsler Adult Intelligence Scale-Revised.

was significantly lower in patients than in control participants. Demographic, clinical and neuropsychological characteristics of the participants are given in Table 1.

The protocol was approved by the ethical committee of the university hospital where patients were recruited. All participants provided written informed consent and were paid for their participation.

2.2. Materials

One hundred and twenty pictures were selected from the International Affective Picture System (IAPS; Lang et al., 1993) as stimuli. The pictures represented scenes involving people, animals, and objects. Pictures that might have had a connotation of psychiatric condition were avoided, as well as pictures with sexual connotation. Using normative ratings of valence and arousal provided by Lang et al. (1993), two sets of 50 pictures were constructed and counterbalanced across participants as studied or non-studied items. One half of the stimuli in each set were classified as negative, and the other half were positive.[1] Additional care was taken to ensure that each set of pictures comprised equal numbers of high, medium, and low arousal pictures.[2] During the learning session, 10 buffer stimuli were presented at the beginning and end of each list to reduce primacy and recency effects. The recognition test consisted of all 100 pictures. Thus the target pictures from the first session for half of the participants were new pictures for the others.

2.3. Procedure

The experiment consisted of two sessions separated by a delay of 24 h. The first "learning" session lasted approximately 1 h and the second "recognition" session lasted 1 h and a half. Pilot studies on normal controls had determined that an interval of 24 h was long enough to avoid the occurrence of floor and ceiling effects in the recognition task (approximately 70–90% correct recognition). Both sessions were run individually, in a quiet room of the hospital or university building, with no distractions.

[1] In a pre-test, neutral pictures were also presented to participants. After analyses, we realized that the neutral stimuli (mostly representing usual objects) evoked fewer personal memories than emotional stimuli, and led to floor effects in pre-test controls. For this reason, and because the emotionality effect and its impact on states of awareness is now well documented in normal subjects (Ochsner, 2000), and in patients with schizophrenia (Danion et al., 2003), we decided not to use the neutral pictures.

[2] Negative pictures were more arousing (mean = 5.11) than positive pictures (mean = 4.35), $t(24) = 2.98$, $p < .05$, according to arousal ratings provided by Lang et al. (1993). This difference is typically observed with emotional pictures and may reflect intrinsic features of positive versus negative emotions (for a discussion see Ochsner, 2000, pp. 257–258).

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During the learning session, pictures were presented on a computer screen, and were randomly assigned by the software program SuperLab 1.7. At the beginning of the session, participants were told that they would be presented with a set of pictures that might have some emotional content. They were instructed to first briefly describe the picture aloud, then to rate it on a 10-point scale according to their subjective feelings of pleasantness or unpleasantness. Finally, participants were asked to recall a specific personal memory evoked by the picture. They were told that a specific memory refers to an event that has happened only once, at a particular place and time and that has not lasted longer than a day (Williams & Broadbent, 1986). An example of a specific memory was provided. Participants were not informed that the second session would be a memory test. On each trial, a picture appeared on the screen for 3 s. Next, the picture disappeared and a rating scale for valence appeared. Once participants had rated the picture, the scale disappeared. Then participants were invited to recollect a specific memory evoked by the picture.

During the second session, the participants were presented with two mixed lists of pictures. Half of them were old (i.e., they had been seen the previous day), and half were new. In each trial, participants had to say whether they recognized the picture. If they did not recognize the picture, another picture appeared on the screen. If they recognized the picture, the participants were asked to indicate their subjective state of awareness associated with their recognition. They were instructed to give a Remember, Know or Guess response according to whether the recognition of the picture was associated with conscious recollection, feelings of familiarity or guessing, respectively.

The instructions regarding Remember, Know and Guess responses closely followed those specified by Gardiner (1988). Participants were told to give a Remember response if recognition was accompanied by conscious recollection, i.e., if they were consciously aware of some aspect of their experience when the picture was initially presented. It was specified that the recall of the personal memory reported during the learning session was considered a Remember response. Indeed, it constitutes direct evidence that they mentally relived what happened during the learning session. If they could not retrieve the memory evoked 24 h ago, or if they simply did not recall a personal event during the first session, the recollection of other aspects of their experience during the learning session was also considered as a Remember response. Some examples were provided to participants: an association with another item of the list, an image that came to mind, something about the physical appearance of the picture or something that had happened in the experiment room. The participants were asked to give details aloud to ensure that the item was really remembered.

Participants were told to give a Know response if recognition was accompanied by feelings of familiarity but no conscious recollection. This consists of the knowledge of an item's inclusion in the study list but with no memories of what happened when they saw the picture. Finally, participants had to give a Guess response if they neither consciously recollected nor simply knew, but just guessed the picture was on the study list.

After reporting their state of awareness associated with picture recognition, participants were asked to indicate whether, during the learning session, they had found the item pleasant or unpleasant. Then, they had to indicate their subjective state of awareness associated with this valence recognition. They were told to give a Remember response if they recollected specific details associated with the emotional valence of the picture (e.g., the valence of the personal event provided, an association that occurred at encoding, or an image they formed related to the emotional valence of the picture). Participants were told to give a Know response if they knew that they judged the picture as pleasant or unpleasant during the learning session but did not consciously recollect the reason for their rating. Finally, participants provided a Guess response if they neither consciously recollected specific details related to valence nor simply knew the valence, but just supposed that the item was pleasant or unpleasant. Once again, when participants provided a Remember response, they were asked to substantiate it.

On each trial, the picture remained on the screen until participants had answered all of the questions. Then they pressed the spacebar to go on to the next trial. Before the task, participants received written instructions and completed a short practice trial to ensure they correctly understood the instructions.

2.4. Statistical analyses

Negative pictures judged positively during the learning session and positive pictures judged negatively were excluded from the analyses. The proportion of such items was very small (mean = .005) and similar for both

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groups, $t(38) = 0.18$, *ns*. The proportion of false recognition was very small (.01 on the whole sample) and similar for the two groups, $t(38) = 0.31$, *ns*. Only analyses conducted on correct responses are reported, analyses conducted on corrected scores (correct recognition scores minus false recognition scores) led to similar results.

The proportion of Remember, Know and Guess responses associated with correct recognition of the pictures and of the valence was computed by dividing the number of correct responses of each type by the total number of possible responses. Most statistical analyses consisted of mixed designed analyses of variance (ANOVA). Student's *t*-tests were computed to localize the differences for significant results. In all comparisons, the alpha level was set at $p < .05$.

The Pearson product-moment correlation coefficient between the total number of Remember responses and the total number of specific memories was computed for each group to investigate plausible links between autonoetic awareness and memory specificity.

3. Results

3.1. Encoding ratings of the pictures for emotional valence

The subjective ratings of pleasantness and unpleasantness evoked by the pictures during encoding were analyzed using a 2 (group) × 2 (positive vs. negative picture) ANOVA. Both groups discriminated between positive and negative pictures, $F(1,38) = 82.3$, $p < .001$, and did so to the same extent, as indicated by a non significant group effect, $F(1,38) = 0.34$, *ns*., and a non significant interaction effect between group and word type, $F(1,38) = 0.16$, *ns*. (Table 2).

3.2. Recognition of pictures

The proportion of Remember, Know and Guess responses associated with correct recognition of the pictures are shown in Table 3. A 2 (group) × 3 (Remember vs. Know vs. Guess) × 2 (positive vs. negative picture) ANOVA computed on the proportion of correct recognition showed a significant main effect of group, $F(1,38) = 18.14$, $p < .001$, with patients recognizing fewer target pictures than controls. There was a significant

Table 2
Mean values and standard deviations for encoding ratings of positive and negative stimuli for emotional valence

Valence	Patients with schizophrenia ($n = 20$)		Control participants ($n = 20$)	
	M	*SD*	*M*	*SD*
Positive	7.14	0.19	7.62	0.31
Negative	1.87	0.28	2.19	0.15

Note. Subjects rated emotional valence of the pictures on a 10-point scale, ranging from 0 (extremely negative) to 9 (extremely positive).

Table 3
Mean proportion of correctly recognized pictures as a function of group, valence, and response type

Response type	Patients with schizophrenia ($n = 20$)		Control participants ($n = 20$)	
	Positive	Negative	Positive	Negative
Remember	.33	.28	.64	.71
Know	.53	.48	.20	.23
Guess	.01	.01	.01	.01

Note. Remember positive, proportions of Remember responses when the picture was positively connoted. Know positive, proportions of Know responses when the picture was positively connoted. Guess positive, proportions of Guess responses when the picture was positively connoted. Remember negative, proportions of Remember responses when the picture was negatively connoted. Know negative, proportions of Know responses when the picture was negatively connoted. Guess negative, proportions of Guess responses when the picture was negatively connoted.

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effect of response type, $F(2,76) = 180.01$, $p < .001$, with participants providing more Remember and Know responses than Guess responses. Central to our hypothesis, the type of response reported was moderated by group, $F(2,76) = 69.90$, $p < .001$. Follow-up analyses indicated that patients provided fewer Remember responses, $t(38) = -9.87$, $p < .001$, and more Know responses, $t(38) = 10.16$, $p < .001$, than control participants. The proportion of Guess responses was similar in the two groups, $t(38) = -1.17$, *ns*.

There was no significant main effect of valence, $F(1,38) = 0.001$, *ns*, but there was a significant interaction between group and valence, $F(1,38) = 16.02$, $p < .001$. Patients performed worse than controls when pictures were negatively connoted, $t(38) = -4.58$, $p < .001$. The difference between groups was not significant for the positively connoted pictures, $t(38) = -1.01$, *ns*. The interaction between response type and valence was not significant, $F(2,76) = 0.92$, *ns*. Finally, the interaction between response type, valence, and group was significant, $F(2,76) = 4.36$, $p < .05$, with patients providing more Remember and Know responses when pictures were positive than negative. In contrast, controls provided more Remember responses when pictures were negative than positive. No differences were found for Know and Guess responses.

3.3. Recognition of valence

A 2 (group) × 3 (Remember vs. Know vs. Guess) × 2 (positive vs. negative picture) ANOVA carried out on the proportion of correct recognition of valence (Table 4) showed a significant effect of group, $F(1,38) = 16.47$, $p < .001$, with patients performing worse than controls. There was a significant effect of response type, $F(2,76) = 112$, $p < .001$, with participants providing more Remember than Know responses, and more Know than Guess responses. Finally, there was a significant interaction between group and response type, $F(2,76) = 79.94$, $p < .001$. As for picture recognition, follow-up analyses indicated that the patients provided fewer Remember responses, $t(38) = -8.84$, $p < .001$, and more Know responses, $t(38) = 9.33$, $p < .001$, than the control participants. The proportion of Guess responses was similar in the two groups $t(38) = -0.67$, *ns*.

There was no significant effect of valence, $F(1,38) = 0.02$, *ns.*, but there was a significant interaction between group and valence, $F(1,38) = 18.90$, $p < .001$. Indeed, patients performed worse than controls when the pictures were negatively connoted, $t(38) = -5.57$, $p < .001$. The difference between the groups was not significant for the positive pictures, $t(38) = 1.43$, *ns*. The interaction between response type and valence was not significant, $F(2,76) = 0.22$, *ns*. Finally, the interaction between response type, valence, and group was significant, $F(2,76) = 5.61$, $p < .01$, with patients providing more Remember and Know responses when pictures were positive than negative. No differences were found for Guess responses. In contrast, controls provided more Remember responses when pictures were negative than positive. No differences were found for Know and Guess responses.

3.4. Autobiographical memory recall

Analyses concerning autobiographical memories were divided into two main analyses. First, an analysis was carried out on the proportion and type of memories provided during the learning session. Second, an

Table 4
Mean proportion of correctly recognized valence as a function of group, valence, and response type

Response type	Patients with schizophrenia ($n = 20$)		Control participants ($n = 20$)	
	Positive	Negative	Positive	Negative
Remember	.28	.18	.52	.64
Know	.52	.44	.18	.22
Guess	.06	.06	.07	.05

Note. Remember positive, proportions of Remember responses when the picture was positively connoted. Know positive, proportions of Know responses when the picture was positively connoted. Guess positive, proportions of Guess responses when the picture was positively connoted. Remember negative, proportions of Remember responses when the picture was negatively connoted. Know negative, proportions of Know responses when the picture was negatively connoted. Guess negative, proportions of Guess responses when the picture was negatively connoted.

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analysis examined the recall of these memories during the recognition phase. This last analysis sought to explore whether recall during the second session was better for memories reported as specific (vs. general) at the first session.

3.5. Proportion and type of memory recalled

The level of specificity of each memory was rated by the first investigator according to the definition of Williams and Broadbent (1986). A memory was considered specific if it referred to an event that happened at a particular place and time and did not last for longer than a day. If the event recalled was not a unique episode (categoric memory), or was lasting more than 24 h (extended memory), it was rated as a general memory. To assess interrater agreement, a random selection of 30% of the memories provided was scored by a second independent rater who was blind to both hypotheses and participants' clinical status. High agreements was found for memories coded as specific responses ($r = .97$) and general responses ($r = .95$).

The proportions of specific and general memories recalled during the learning session are shown in Table 5. A 2 (group) × 2 (specific memory vs. general memory) × 2 (positive vs. negative picture) ANOVA performed on the proportion of memories recalled displayed a significant group effect, $F(1,38) = 11.38$, $p < .005$. Patients were found to provide fewer memories than the normal participants. However, there were no significant differences between the types of memory reported, $F(1,38) = 1.04$, *ns*. Finally, the interaction between type of memory and group was highly significant, $F(1,38) = 48.34$, $p < .001$: patients provided fewer specific memories, $t(38) = -9.85$, $p < .001$, but more general memories, $t(38) = 7.08$, $p < .001$ than control participants.

Concerning the proportions of positive and negative memories recalled during the learning session, there was no significant effect of valence, $F(1,38) = 0.001$, *ns*. However, there was a significant interaction between group and valence, $F(1,38) = 26.45$, $p < .001$. Patients provided fewer negative memories than controls, $t(38) = -5.65$, $p < .001$. The difference between the groups was not significant for positive memories, $t(38) = 1.67$, *ns*. A significant interaction between response type and valence, $F(1,38) = 15.68$, $p < .001$, indicated, on one hand, that there were more negative specific memories than positive, and on the other hand, that there were more positive general memories than negative ones. Finally, the interaction between response type, valence, and group was significant, $F(1,38) = 5.32$, $p < .05$, with patients recalling more positive general memories than negative, whereas controls provided more negative specific memories and more negative general memories than positive memories.

3.6. Recognition of pictures when a memory was provided at encoding

Table 6 shows the proportion of Remember, Know and Guess responses associated with correct recognition of the pictures as a function of the specificity of the autobiographical memory evoked. For the recognition of pictures that were associated with specific memories, a 2 (group) × 3 (response type) ANOVA performed on the proportion of correctly recognized pictures showed no effect of group, $F(1,38) = 1.18$, *ns*. There was a significant main effect of response type, $F(2,76) = 578.07$, $p < .001$, with participants providing much more Remember responses than Know responses, and more Know than Guess responses. However, the interaction between response type and group was not significant, $F(2,76) = 0.38$, *ns*, indicating that the two groups had similar picture recognition performance when they provided a specific memory at encoding.

Concerning the recognition of pictures associated with an evocation of general memories, a 2 (group) × 3 (response type) ANOVA performed on the proportion of correctly recognized pictures showed no significant

Table 5
Mean Proportion of Autobiographical Memories Recalled as a Function of Group, Valence, and Memory Specificity

Type of Autobiographical Memory	Patients with schizophrenia ($n = 20$)		Control participants ($n = 20$)	
	Positive	Negative	Positive	Negative
Specific	.10	.08	.26	.38
General	.36	.20	.11	.15

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Table 6
Mean proportion of correctly recognized pictures as a function of group, type of awareness at recall, and specificity of associated autobiographical memory

Response type	Patients with schizophrenia ($n = 20$)		Control participants ($n = 20$)	
	Specific	General	Specific	General
Overall	.95	.97	.98	.97
Remember	.85	.52	.88	.74
Know	.10	.45	.10	.24
Guess	.00	.003	.004	.001

difference between the groups, $F(1,38) = 1.01$, *ns*. There was a significant effect of response type, $F(2,76) = 101.93$, $p < .001$, with more Remember responses than Know responses, and more Know than Guess responses. Finally, the interaction between response type and group was significant, $F(2,76) = 13.26$, $p < .005$. Follow-up analyses indicated that patients provided fewer Remember responses, $t(38) = -3.52$, $p < .005$, and more Know responses, $t(38) = 3.80$, $p < .005$, than the control participants. The proportion of Guess responses was similar in both groups, $t(38) = -0.96$, *ns*.

3.7. Correlational analyses

The number of Remember responses provided during picture recognition was significantly correlated with the number of specific memories provided by the group of patients ($r = .66$, $n = 20$, $p < .002$) and the normal participants ($r = .72$, $n = 20$, $p < .001$). In the group of patients with schizophrenia, there were no statistically significant correlations between memory variables (picture and valence recognition, number of specific memories) and IQ, BDI, psychiatric symptoms (BPRS, SAPS and SANS scores and sub-scores), or daily dose of neuroleptic treatment ($n = 20$, $rs < -.39$, $p > .08$).

In addition, to ensure that medication was not responsible for the pattern observed in the patients group, data from the two un-medicated patients were compared to those of the medicated patients. A difference was considered as significant if the mean of the two medicated patients differed of more than two standard deviation from the medicated sample mean. For all the results, no differences were found between the two subgroups. The highest difference observed, which was for the proportion of Remember responses associated with correct recognition of the pictures when a specific memory was provided at encoding, was less than one standard deviation (for the un-medicated patients: $M = .90$; for the medicated patients: $M = .84$; $SD = 0.28$).

4. Discussion

The present study is, to our knowledge, the first to investigate simultaneously in a group of patients with schizophrenia (a) conscious recollection in recognition memory when an emotionally arousing material is used (b) the influence of the same material on the generation of autobiographical memories, and (c) possible associations between an overgenerality memory bias and an autonoetic awareness deficit. The aim of this study was to examine these different aspects, all central to the formation and the maintenance of identity, in a disease characterized by an abnormal personality.

The main results can be summarized as follows. Patients with schizophrenia and controls evaluated the emotional valence of the pictures similarly. However, as predicted, patients with schizophrenia exhibited impairment in the recognition of emotional pictures and in the recall of the emotional valence associated at encoding. Moreover, patients provided significantly fewer Remember but more Know responses than controls. The pattern of recognition as a function of the emotional valence of the pictures differed between patients and controls. Indeed, controls demonstrated better recognition for negative as compared to positive stimuli, whereas patients with schizophrenia displayed better performance for positive than for negative pictures.

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For the retrieval of autobiographical memories, patients recalled fewer memories than controls. Patients also provided significantly fewer specific memories and significantly more general memories than the control participants. The influence of emotional valence on memory was similar in the recall of personal events and in picture recognition: Patients recalled more positive than negative memories whereas normal individuals displayed the opposite pattern. Interestingly, when a specific autobiographical memory was provided during the learning session, its probability of recall during the recognition phase was similar in both groups. However when the memory provided in the first session was general, patients performed worse than controls.

Before examining the implications of these results, some critical issues should be discussed. First, the overall pattern of responses of the patient group cannot be fully explained by general, non-specific reduction in cognitive abilities or by drug treatment since memory performance of patients was not significantly correlated with IQ or the type and dose of neuroleptic treatment. In addition, the pattern of results of the two un-medicated patients was similar to the pattern observed for the medicated patients. Another critical issue concerns the truthfulness of the autobiographical memories retrieved by patients with schizophrenia. In the present study, we did not find evidence of memories that were obviously implausible or unrealistic. Further, the fact that most of these memories were recalled again during the recognition phase decreases the probability of false memories. Finally, previous studies that have investigated schizophrenic patients' susceptibility to false memories have surprisingly observed that they actually produce fewer false memories (Huron & Danion, 2002) and less false recognition than normal participants (Elvevag, Maylor, & Gilbert, 2003b). In sum, it is unlikely that, in the present study, patients with schizophrenia have produced more false memories than controls.

Our results support the notion that schizophrenia is associated with an impairment of episodic memory in its critical feature, i.e., autonoetic awareness (Danion et al., 1999, 2003; Huron et al., 1995; Huron & Danion, 2002; Sonntag et al., 2003), and extends it to emotionally arousing material. One could argue that the Remember responses observed in the present study do not reflect recollective processes but rather a highest level of confidence than for Know responses. Indeed, a growing literature suggests that remembering is not qualitatively different from knowing but that both responses only differ in the degree of memory strength or confidence (Donaldson, 1996; Hirshman & Master, 1997; Rotello, Macmillan, & Reeder, 2004; Rotello, Macmillan, Reeder, & Wong, 2005). If this interpretation is true, we must admit that our results only provide evidence that patients' memories were weaker than those of normal controls. However, there are several reasons to believe that it is not the case, and that the Remember and Know responses as assessed in the present experiment do measure distinct memory processes.

Most of the authors disagreeing with the dual-process model posit that an introspective technique such as the Remember/Know paradigm fails to capture the distinction between recollective and non recollective memory (e.g., Donaldson, 1996; Rotello et al., 2005). Indeed, an argument often advanced is that responses in the Remember/Know procedure are profoundly affected by subjects' willingness to respond Remember. In two consecutive experiments, Rotello and colleagues (2005) have consistently demonstrated that when participants do not have to substantiate their responses (neutral condition), the proportion of Remember responses was higher than when they were instructed to respond Remember only if they could describe details of the learning experience (conservative condition). These results led the authors to conclude that the neutral condition of their experiments reflected more levels of confidence and demand effects than recollection versus familiarity. In the present study, as in their conservative condition, our participants were clearly informed to reserve their Remember responses for recollection they could explain to the experimenter. Then it is certain that the Remember responses provided by the participants really reflect the recollection of what happened during the learning session.

In addition, the fact that the proportion of Remember false alarms (a false recognition of a new item associated with a Remember response) was close to zero (mean = .001) confirmed the good understanding of the instructions by the participants. Finally, a large proportion of the Remember responses were substantiated by the recall of autobiographical memories that were first retrieved during the first session. The fact that in both groups the recollection of the pictures previously associated to past personal episodes was mainly accompanied by a Remember response strongly suggests that recollective memories involved episodic memory while non recollective memories reflect more semantic knowledge. In conclusion, if the possibility of some overlaps between the Remember and the Know responses can not be completely ruled out, we assume that the paradigm used in the present study indexes distinct bases of recognition memory.

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In agreement with previous research (Baddeley et al., 1995; Elvevag et al., 2003a; Feinstein et al., 1998; Tamlyn et al., 1992), our study confirms that patients with schizophrenia generate fewer personal memories and that patients' memories are less specific than those of control participants (Harrison & Fowler, 2004; Iqbal et al., 2004; Riutort et al., 2003). Overgeneral memories have been described in clinical groups other than psychosis, and are particularly marked in depression (for a review see Van Vreeswijk & de Wilde, 2004). So it could be objected that the overgeneral retrieval style found in the patient group was due to comorbid depression. But the fact that no group differences were found on the depression scale (BDI; Beck & Steer, 1987) does not support this argument. Moreover, our results suggest some particularities in the overgeneral memory bias observed in patients with schizophrenia. The proportion of specific memories provided by the patients was more than three times lower in patients than in controls, demonstrating a large deficit. This impairment was partly compensated by general memories that were approximately two times more frequent in the patient group. But, almost all of the specific memories provided by the patients with schizophrenia during the learning session were recalled again 24 h later during the recognition session. In fact, the two groups had a similar performance for the recall of specific memories. This was not true for general memories, with patients performing worse than controls. So, even if most of the time the patients with schizophrenia are unable to specify personal experiences, when they succeed in doing so, the mnesic trace seems stronger than for more general or abstract information, leading to better later retrieval.

In agreement with Danion and collaborators (2005), our results confirm that the proportion of specific memories provided in both groups is significantly correlated with the number of Remember responses. This observation suggests that the retrieval of specific experiences needs conscious recollection. From this perspective, the deficit of autonoetic awareness in patients with schizophrenia would explain their overgeneral retrieval bias. Indeed, patients with schizophrenia tend to report more frequently general experiences associated with a simple feeling of familiarity. However in some occasions, the process of specification can succeed when a sufficient level of consciousness emerges.

Before examining the influence of emotional valence on memory performance in patients with schizophrenia, we will discuss why healthy individuals displayed a better recognition for negative than for positive pictures. This tendency was particularly marked for Remember responses. Most of the research that has addressed the modulation of memory by emotional valence has used emotional words as stimuli, and has investigated emotional event recognition without considering the associated subjective experience. The only study that shared a common approach with the present study has found similar results: In a series of three experiments using the Remember/Know procedure to investigate the subjective states of awareness accompanying recognition of pictures from the IAPS, Ochsner (2000) found better recognition for negative than for positive pictures, especially for Remember responses. This is exactly what was observed in our control group.

Concerning the influence of emotional valence on the recall of autobiographical memories, controls again performed better for negative than for positive events. Why would positive memories be less likely to be recalled than negative ones? There is some preliminary evidence that in real life people experience negative situations more intensely and distinctly than positive events (Christianson, 1986). The superiority of the negative stimuli observed in the present study could result more from an intensity bias than from a valence effect. In favor of this view, a series of studies have found that the intensity of the material was a better predictor of the retention performance than valence (Holmes, 1970; Thompson, 1985; Walker, Vogl, & Thompson, 1997). And recently, Talarico, Labar, and Rubin (2004) have demonstrated in a series of three experiments that intense events were remembered longer, had greater vividness, and were more often consciously recollected. These results suggest that intensity influences the properties of autobiographical memories more than valence.

Considering the fact that we have used pictures from the IAPS (Lang et al., 1993), it seems plausible that the negative pictures presented, such as scenes of violent injuries and crimes, induced more intense reactions than the positive pictures, such as sunshine or a piece of chocolate. This is corroborated by the arousal ratings provided by Lang et al. (1993). Unfortunately, we did not ask the participants to rate the intensity of the material. Future experiments might request participants to rate the pictures not only for valence, but also for arousal.

Concerning the influence of picture valence on memory performance, we observed that patients performed worse than controls when the pictures were negative. Contrary to controls, they provided more Remember and Know responses when the item was positive than negative. Finally, patients generated more positive mem-

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ories than negative. As discussed in the introduction, research on the interaction between memory and emotion in schizophrenia has been limited, and shows inconsistent findings. However, our results are consistent with the only two studies that have taken into account the states of awareness associated with the recognition of an emotional material in schizophrenia (Danion et al., 2003; Neumann et al., 2006). Why would patients with schizophrenia have a memory bias toward positive stimuli as compared to controls? One possibility is that, contrary to healthy individuals, patients with schizophrenia encoded more distinctively positive than negative experiences. Indeed, since the onset of the disease, patients with schizophrenia are probably less often engaged than normal individuals in situations that elicit positive emotions. Therefore, the positive events could be more easily retrieved because they are more salient than the many negative experiences that are daily encountered in the context of recurrent hospitalizations and relapses.

A second explanation is that the pleasantness bias displayed by the patients group could be the result of a voluntary protective strategy to escape the arousal of acute aversive emotions. This argument has been developed by Williams (1996) to explain the overgeneral retrieval style of autobiographical memory often observed in depression and Post Traumatic Stress Disorder (PTSD). According to the *affect-regulation* hypothesis (Williams, 1996), individuals who have experienced traumatic events during childhood develop an overgeneral memory in order to avoid the reactivation of painful feelings associated with these personal specific negative experiences. Over time, this general retrieval mode generalizes to all emotional situations becoming an adaptative cognitive avoidance strategy. However, if in the present study the patients with schizophrenia had voluntarily recalled fewer negative memories to avoid the reactivation of aversive emotions, this tendency should have been observed not only for general memories, but also, and even more, for specific memories, which was not the case. In addition, the *affect-regulation* model (Williams, 1996) does not make assumptions concerning the different states of consciousness accompanying recollection. Then, this theoretical rationale cannot account for the deficit of consciousness observed, which is a key feature of schizophrenia (Andreasen, 1999; Danion et al., 1999; Frith, 1992).

Another way to account for the pleasantness bias observed for the group of patients refers to recent multilevels models of emotion (for a review see Philippot, Baeyens, Douilliez, & Francart, 2004) and to Conway and Pleydell-Pearce's (2000) model of autobiographical memory. According to these authors, specifying personal emotional events, such as autobiographical memories, is an effortful, time consuming and strategic process involving executive processes. When the retrieval of emotional memories is intentional, as in the present study, such processes require an inhibition of the emotional features of the information to be specified (Conway & Pleydell-Pearce, 2000; Philippot et al., 2004). Indeed, in the absence of inhibition, the parallel activation of intense emotions would disrupt and might eventually abort the effortful process required to elaborate and specify memories. In favor of this view, several authors have hypothesized reciprocal inhibitory interactions between emotional and executive systems in the brain (Drevets & Raichle, 1998), a notion corroborated by neuroimaging studies (e.g., Gusnard, Akbudak, Shulman, & Raichle, 2001; Simpson, Drevets, Snyder, Gusnard, & Raichle, 2001).

There is now converging evidence for a deficit in executive processes in schizophrenia (for a review see Keefe, 2000). This executive impairment might be responsible for the lack of regulation of the emotions activated during memory search. As a consequence, the process of specification of emotional memories would be disrupted by the emotional arousal triggered by the memory. Patients with schizophrenia would thus tend to report overgeneral memories in the absence of conscious recollection. Patients with schizophrenia might be particularly sensitive to such emotional disruption when they attempt to recall highly emotional events. From this perspective, the greater emotional intensity of our negative stimuli compared to positive ones might have induced a better recognition for normal participants, and the reverse effect on the performance of patients with schizophrenia.

Several aspects of our data support this third hypothesis. First, patients showed a clear impairment in providing specific memories. Most of the memories reported by patients were overgeneral, which could be explained by executive deficits. Indeed, recent studies provide evidence that the retrieval of specific memories necessitates central executive resources (Dalgleish, 2004; Williams et al., in press). Second, the overgeneral memory bias displayed by patients with schizophrenia was strongly associated with autonoetic awareness impairment. If both deficits are related, it might be that common executive resources are required for the recollection of contextual details supporting autonoetic awareness in episodic memory tasks, and for the recol-

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lection of specific details of personal events during autobiographical memory tasks. In agreement with this perspective, a study of Ramponi, Barnard, and Nimmo-Smith (2004) suggests that the voluntary retrieval of specific autobiographical memories and the construction of consciously recollected memories involve executive resources. As a consequence, the impairment of executive functions in schizophrenia may be responsible for low levels of specific memories and of Remember responses.

The memory deficits exhibited by patients with schizophrenia are likely to have clinical implications. Consciously recollected specific emotional autobiographical memories are necessary for the construction and maintenance of identity (Conway & Pleydell-Pearce, 2000). It is also necessary for guiding behavior and is implicated in problem solving of everyday life (Goddard, Dritschel, & Burton, 1996). Autobiographical memory provides the knowledge base that defines and organizes current goals and is linked to the capacity to project oneself into the future (Williams et al., 1996). Taken together, the present data support the notion that the memory impairments exhibited by patients with schizophrenia contribute to abnormalities in the construction of their personal identity.

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