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Impairment not only in remembering but also in knowing previously seen faces and words in schizophrenia

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ABSTRACT

Patients with schizophrenia have pronounced deficits in face recognition memory that severely hamper their social skills. The functional mechanisms of these impairments remain unknown. According to the dual-process theory, recognition memory comprises two distinct components: recollection and familiarity. Studies using the Remember/Know procedure in patients with schizophrenia showed impairments in conscious recollection as measured by *remember* responses, but not in familiarity as measured by *know* responses. Unfortunately, none of these studies used face material. We investigated both recognition memory components using words and faces and the 'Remember/Know' procedure in 25 patients with schizophrenia and 24 control participants. In the same task, size congruency of stimuli was manipulated between the study and test phases to have a selective impact on *know* responses for faces. Patients reported fewer *remember* responses than controls. Size changes between the study and the test affected *know* responses in controls but not in patients. These results reveal that patients with schizophrenia are impaired in terms of their ability to recollect details about previously seen faces as they are for words.

1. Introduction

The experience of seeing a face and recollecting information and knowledge about that person (e.g. name, age, profession and the spatio-temporal context of previous meetings) plays a central role in interpersonal interactions. This subjective experience of remembering is different from the feeling of knowing that a face is familiar. Indeed, recognizing a person as familiar, yet being unable to recollect any qualitative or contextual information about the person such as her name or where we met the person before is a particularly uncomfortable experience and is inefficient for guiding and controlling behaviour during social interactions.

Numerous studies have shown that patients with schizophrenia are impaired when it comes to processing facial information. Patients with schizophrenia perform abnormally as regards identifying, categorizing and recognizing faces, and matching, discriminating and recognizing facial emotional content (Baudouin et al., 2002; Chambon et al., 2006; reviews in Mandal and Pandey, 1998; Edwards et al., 2002). Several studies have found that patients with schizophrenia are impaired in episodic memory for faces (Conklin et al., 2002; Martin et al., 2004; Guillaume et al., 2007; Kayser et al., 2010), but the precise nature of the functional mechanisms causing this deficit remains unclear.

According to the dual-process theory of recognition, there are two distinct states of conscious awareness of information about previously experienced events: *recollection* and *familiarity* (Tulving, 1985). Recollection represents the standard experiential mode of the episodic memory system (Tulving, 1985; Wheeler et al., 1997). This awareness characterizes subjective experience of mentally reliving past events. This mental experience of traveling back in time includes perceptual, spatial, temporal, semantic, and emotional states attributed to a past event (Johnson and Raye, 1981; Johnson and Hashtroudi, 1993). By contrast, familiarity reflects the feeling of knowing that an event has taken place but without recollecting the context of its previous occurrence or any semantic information about it. It reflects subjective experience on what happened in the past

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(Tulving, 1985; Gardiner, 1988; Wheeler et al., 1997). Based on the dual-process theory, recollection refers to the conscious and relatively controlled reactivation of the encoding conditions, such as the encoding context. Familiarity reflects an automatic and graded decision based on the familiarity of the memory trace (Atkinson and Juola, 1974; Mandler, 1980, 1991; Jacoby, 1994; Yonelinas, 1994, 1997; Hockley and Consoli, 1999; Yonelinas, 2002). These two components of recognition memory do not have equivalent consequences on social adaptation: Recollection enables behavior flexibility with many details recuperation whereas no behavior adaptation is possible on the basis of familiarity. Understanding recognition memory deficits in schizophrenia requires specific knowledge of both memory components.

Recollection and familiarity can be directly accessed by the 'Remember/Know' procedure (Tulving, 1985; Gardiner, 1988). During a recognition memory task, participants are asked to give a *Remember* response if recognition is accompanied by conscious recollection of specific features of the item's presentation in the previous study phase (where it was, what they thought, etc.) and a *Know* response if recognition is combined with a feeling of familiarity without any conscious recollection. The feeling of knowing that we have already seen a person without remembering anything else prevents us from adjusting our social behaviour as a function of what we remember about that person. An impaired ability to remember details about a previous meeting could explain why patients cannot behave adequately in terms of interpersonal relations. Therefore, it is critical to study whether the reported memory recognition deficit for faces in schizophrenia is due to an impaired ability to consciously recollect information when patients are presented with faces or to an impaired feeling of familiarity for faces.

To the best of our knowledge, memory recognition for faces has never been explored using the Remember/Know procedure. However, series of studies using the Remember/Know procedure and words or pictures as stimuli were conducted in patients with schizophrenia (reviewed in Danion et al., 2007). Results revealed that conscious recollection is consistently impaired in schizophrenia, as indexed by *Remember* responses, for neutral and affective words (Huron et al., 1995; Huron and Danion, 2002; Sontag and Gokalsing, 2003; Grillon et al., 2005, 2010; see also Tendolkar et al., 2002; van Erp et al., 2008), pictures (Huron et al., 2003) and pairs of objects (Danion et al., 1999). In contrast, familiarity as measured by *Know* responses seems to be spared.

Using the process dissociation procedure (Jacoby, 1991; Jacoby et al., 1992), another method to explore the contribution of familiarity and recollection, both Martin et al. (2004) and Guillaume et al. (2007) reported a familiarity rather than a recollection deficit when patients with schizophrenia were presented with faces (rather than words) as stimuli. These results are not consistent with numerous previous reports that recollection, but not familiarity, is impaired in schizophrenia.

One reason for these discrepancies could rise from the different types of stimuli: words (or pictures) versus faces. It could be that schizophrenia impairs recognition memory for words and faces but affects conscious recollection for words and familiarity for faces. In order to understand these discrepancies about recollection and familiarity deficits in schizophrenia better, we investigated both memory components in a memory task using the 'Remember/Know' procedure with words and faces. If conscious recollection is impaired for faces as it is impaired for words in patients with schizophrenia, therefore we should also observe a decrease in Remember responses for faces in patients with schizophrenia when compared with controls. In contrast, we might observe that schizophrenia impairs conscious recollection for words but familiarity for faces.

Critically, none of the studies using the Remember/Know procedure in schizophrenia has manipulated experimental variables that specifically influence Know responses. Nega (2005) showed that modifying the size of faces between the study and test phases resulted in a selective reduction in Know responses of normal participants, with no effect on Remember responses, when faces were presented briefly (1000 ms) during the study phase. Therefore, as in the study by Nega (2005), stimuli were presented briefly at encoding and size congruency was manipulated between the study and test phases, so that modulations of the level of Know responses could be compared between patients with schizophrenia and controls.

2. Methods

2.1. Participants

Twenty-five patients (seven women) participated in the study. All of them were hospitalized or receiving treated at the Vinatier Psychiatric Hospital in Lyon, France. They were recruited if their current diagnosis according to the criteria defined in the *Diagnostic and Statistical Manual of Mental Disorders* (4th ed.; *DSM-IV*; American Psychiatric Association, 1997) was schizophrenia, with no other psychiatric comorbidity on *DSM-IV* Axis I. All of the patients were receiving antipsychotic medication (without benzodiazepines; Mean = 295 ± 183 chlorpromazine equivalent) and in a stable phase of illness. They were rated for psychopathology according to the Scale for the Assessment of Positive Symptoms (SAPS) and the Scale for the Assessment of Negative Symptoms (SANS) (Andreasen, 1984a,b): Mean scores were 42.0 ± 30.1 (range: 3–112) and 36.9 ± 21.1 (range: 0–71) respectively.

The normal comparison group comprised 24 subjects (7 women). There was no difference between patients and controls in terms of gender, age (37.3 ± 9.2 years versus 38.1 ± 9.8 years; $t = -0.30$, $p = 0.77$) or education (10.0 ± 2.5 years versus 10.9 ± 1.6 years; $t = -1.6$, $p = 0.12$). Their socio-educational and parental socio-educational levels (based on the occupation of the head of household, usually the father) were defined according to the National Occupational Classification (NOC, 1993), catalogue number: 12-565-XPE which assigns occupations to five categories based on the level of skills: I = management, II = professional, III = technical, paraprofessional and skilled occupations, IV = intermediate occupations, and V = laboring and unskilled. Control participants were matched to patients on the basis of their socio-educational status (categories I to III = 37% versus 27%; $t = -0.70$, $p = 0.49$) and parental socio-educational status (categories I to III = 42% versus 46%; $t = 0.44$, $p = 0.66$).

Participants in both groups reported normal or corrected-to-normal vision, no neurological illness, dyslexia or prosopagnosia symptoms. Patients and controls had no history of traumatic brain injury, epilepsy, alcohol, substance abuse, or other neurological problems. An additional exclusion criterion for control participants was a history of psychiatric illness reported during an interview. After receiving a full description of the study, patients and controls provided their written informed consent. They were paid to take part in the experiment. The protocol was approved by a local ethics committee.

2.2. Stimuli

Stimuli were 256 color front views of unfamiliar faces and 256 French words. The photographs were of Caucasian adults (128 females and 128 males) without distinctive features (e.g., bear, spectacles, scars) and with neutral expression, and they were carefully edited to maintain standard brightness and contrast of the grey background. The words were 128 feminine and 128 masculine common nouns (log[lexical frequency] = 331.8 ± 48.7, range = 200–400; imagery = 4.0 ± 1.0, range = 1–5; number of graphemes = 6.0 ± .9, range = 4–8; number of phonemes = 4.5 ± .9, range = 2–7; neutral affective valence). Faces and words were transposed onto a medium grey (50% black) background. The size of the pictures was 450 × 500 pixels ("large") or 225 × 250 pixels ("small"). For faces, each study list consisted of 64 faces, 32 small ones and 32 large ones, presented randomly. Test lists consisted of 128 faces, 64 items from the study list intermixed with 64 unstudied faces. In the test list, half of the studied faces were presented in the same size at study and test (large at study and test or small at study and test) and the other half were different in size across study and test (large at study and small at test, or small at study and large at test). Thus, two versions of the test lists and four versions of the study lists were created in order to achieve complete counterbalancing. The same procedure was used for words.

In the study phase, each stimulus was displayed for 2000 ms in the middle of a computer screen, after a fixation cross displayed for 1000 ms, and before a blank screen while the response was recorded. In the test phase, a fixation cross was displayed for 1000 ms, followed by the stimulus which remained in the middle of the screen until the participant responded.

2.3. Experimental procedure

During the study phase, participants were asked to make a gender decision in reaction to each presented stimulus by pressing either the "M" (for male) or "F" (for female) button of a response pad (see Fig. 1).

In an almost immediate recognition task (10 min after the study phase), participants were asked to respond 'yes' (by pressing "Y" button on a response pad) to old stimuli and to reject new stimuli by responding 'no' (by pressing the "N" button

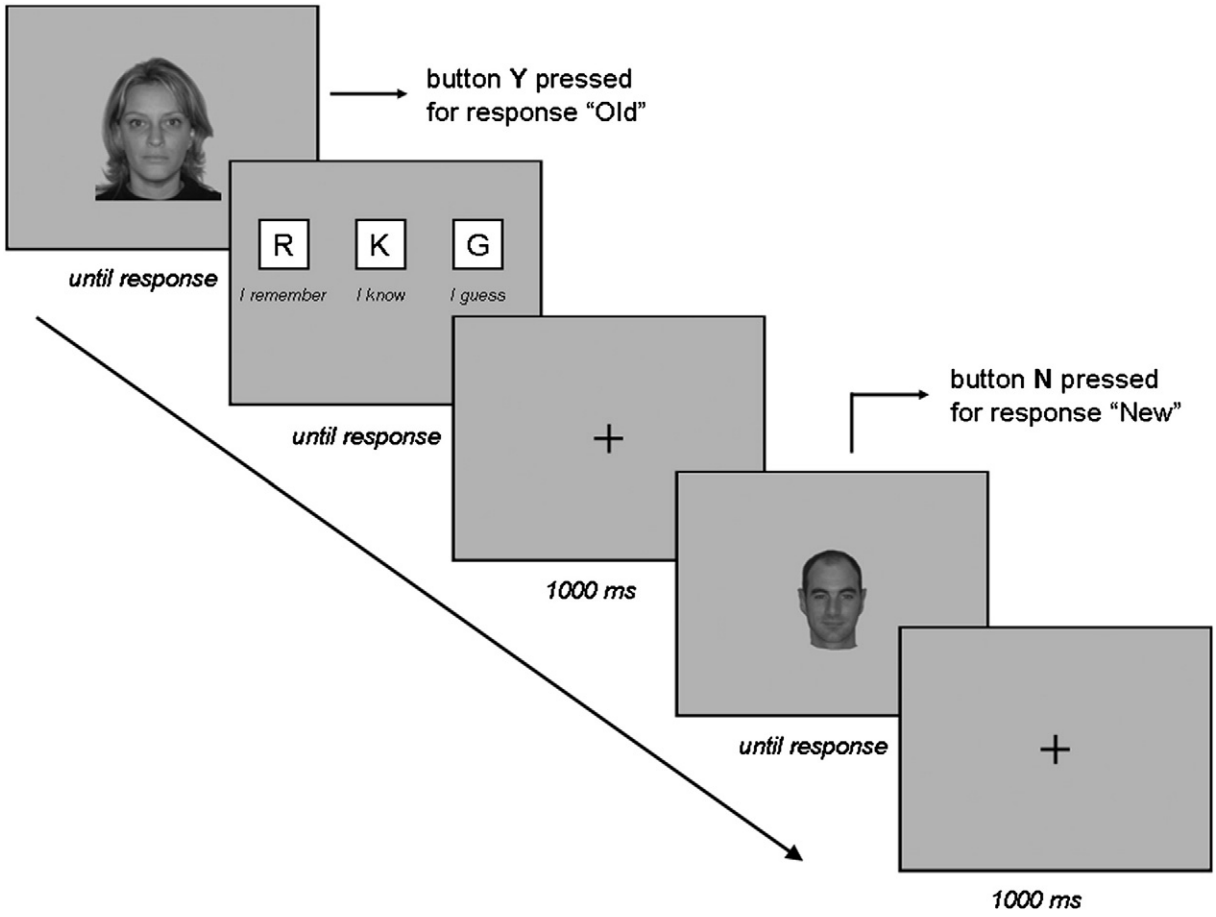

Fig. 1. Experimental design. Example of two consecutive trials.

on the same response pad). Participants were instructed to ignore the size of the faces while making their recognition judgments. The immediate recognition task was combined with the 'Remember/Know/Guess' procedure. Every time participants gave a 'yes' response, they were asked to indicate their subjective state of awareness at the time they recognized the item. A 'remember' response indicated that recognition was accompanied by conscious recollection of what had happened or had been experienced when the stimulus was presented in the study phase (e.g., an image, a word or a thought that came to mind, something about the physical appearance or size of the stimulus, something of personal significance in autobiographical memory, or something that had happened in the experiment room). A 'know' response indicated that recognition was associated with feelings of familiarity but without the ability to consciously recollect any specific details about its prior occurrence in the study list. A 'guess' response[2] indicated that stimuli elicited neither the experience of remembering nor that of knowing but might have appeared during the study phase (Gardiner and Java, 1996). Half of the participants performed the task on faces and the task on words 20 min later and the other half performed the tasks in the reverse order.

Before starting the task, participants were given oral and printed instructions for the general test procedure, and Remember, Know and Guess responses. They were told they could refer to the printed instructions during the test phase as often as necessary. Some examples from everyday life were described, and for each example participants were asked to choose a Remember, Know, or Guess response. Corrections were made by the investigator when the category of response did not match with the event description. In addition, all participants took part in a practice test involving 12 stimuli in the study phase, 12 old and 12 new items in the test phase. For each item, participants were asked whether or not they recognized it as having been presented previously. If they recognized an item, they were asked to select a Remember, Know, or Guess response. At the end of the practice test, they were asked to explain each response to check they had interpreted the instructions correctly. Before the real task they were all properly trained to ensure the validity of the R/K/G responses.

[2] Some studies using the Remember-Know procedure suggest that some Know responses are based not on feelings of familiarity but rather on guessing (Gardiner and Java, 1996): participants guess they previously studied an item but without experiencing familiarity (knowing) and without recollecting any details from the learning phase (remembering). To distinguish between knowing and guessing, a third category of responses – Guess responses – has been introduced.

2.4. Data analysis

The proportion of *Yes*, *Remember*, *Know* and *Guess* responses was calculated by dividing the number of responses given by the number of items presented during the learning phase. This was done separately for words and faces in each condition. Four scores were computed: *Corrected recognition scores* were obtained by subtracting the false recognition rate from the correct recognition rate. *Corrected Remember*, *Know* and *Guess scores* were obtained by subtracting the false recognition rate from the correct recognition rate for Remember, Know and Guess responses respectively. These four scores were subjected to separate analyses of variance (ANOVAs), with group (schizophrenic versus control), material (words versus faces) and size (same versus different) as factors. Analyses of variance were followed-up by Scheffe's tests to localize differences.

3. Results

An ANOVA performed on corrected recognition scores revealed a significant group effect ($F[1,47]=26.73$, $P<0.001$): patients recognized fewer items than controls. There was a significant effect of material ($F[1,47]=18.94$, $P<0.001$) with no group × material interaction ($F[1,47]=0.03$, $P=0.86$): both groups recognized more words than faces. There was also a significant effect of size ($F[1,47]=13.57$, $P<0.001$) with a significant material × size interaction ($F[1,47]=7.20$, $P=0.01$) and no size × group interaction ($F[1,47]=3.29$, $P=0.08$). Participants recognized fewer faces when the size of the face changed between study and test than when the size did not change ($P<0.001$). In contrast, the change of size between study and test did not influence the recognition of words ($P=0.81$) in both groups. The triple interaction was not significant ($F[1,47]=2.13$, $P=0.15$; cf. Table 1).

Separate analyses were conducted for *Remember*, *Know* and *Guess* responses to investigate material and size effects on processing types (Table 2).

Table 1
Mean proportions and standard deviations of overall recognition, *Remember*, *Know* and *Guess* responses in respect of studied and new items, as a function of item type (words versus faces; same versus different) in patients with schizophrenia and control participants.

		Patients with schizophrenia ($n=25$)								Control participants ($n=24$)							
		Yes		Remember		Know		Guess		Yes		Remember		Know		Guess	
		Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.
Words	Same	0.55	0.21	0.30	0.27	0.21	0.23	0.04	0.06	0.79	0.15	0.43	0.17	0.28	0.15	0.08	0.05
	Different	0.54	0.21	0.29	0.27	0.21	0.22	0.05	0.07	0.76	0.17	0.43	0.20	0.25	0.14	0.09	0.07
	New	0.14	0.13	0.05	0.08	0.06	0.09	0.03	0.04	0.19	0.16	0.04	0.06	0.1	0.12	0.05	0.05
Faces	Same	0.48	0.20	0.26	0.23	0.17	0.18	0.05	0.07	0.75	0.11	0.38	0.20	0.27	0.15	0.10	0.09
	Different	0.44	0.21	0.22	0.20	0.18	0.17	0.04	0.08	0.62	0.16	0.29	0.17	0.22	0.10	0.12	0.12
	New	0.18	0.15	0.07	0.09	0.07	0.1	0.03	0.05	0.22	0.12	0.04	0.08	0.1	0.07	0.07	0.06

An ANOVA performed on *corrected Remember scores* showed a significant group effect ($F[1,47]=10.31$, $P=0.002$): patients reported fewer Remember responses than controls. Material effect ($F[1,47]=8.54$, $P=0.005$), size effect ($F[1,47]=10.56$, $P=0.002$) and material × size interaction ($F[1,47]=4.99$, $P=0.03$) were significant. No interaction with group effect was significant (all Ps>0.27). Post-hoc analysis on material × size interaction showed that both groups reported fewer Remember responses when the size of faces changed between study and test ($P=0.006$), whereas size had no effect on Remember responses for words ($P=0.94$).

An ANOVA performed on corrected proportions of *Know* responses revealed a significant material effect ($F[1,47]=7.97$, $P=0.007$) and no material × group interaction ($F[1,47]=0.53$, $P=0.47$): both groups reported more *Know* responses for words than for faces. There was no group effect ($F[1,47]=0.72$, $P=0.40$), no size effect ($F[1,47]=2.90$, $P=0.10$), no material × size interaction ($F[1,47]=0.16$, $P=0.69$) but a significant group × size interaction ($F[1,47]=4.26$, $P=0.04$): controls reported more *Know* responses when the size of stimuli was the same between study and test ($P=0.011$), but the size had no effect on patients' *Know* responses ($P=0.80$). The triple interaction was not significant ($F[1,47]=0.55$, $P=0.46$).

An ANOVA carried out on corrected *Guess* responses revealed no significant results (all Ps>0.09). No significant correlation was found between memory recognition scores and drug doses in patients.

4. Discussion

4.1. Impaired conscious recollection for faces in schizophrenia

As with previous studies, patients with schizophrenia exhibited lower levels of *conscious recollection* than controls (Huron et al., 1995; Danion et al., 2003; van Erp et al., 2008). Interestingly, no material × group interaction was observed, indicating that conscious recollection impairment in schizophrenia was observed for words and faces to the same extent. This result shows that the ability of patients with schizophrenia to remember faces is impaired to the same extent as their ability to remember words.

Table 2
Mean proportions and standard deviations of *conscious recollection* and *familiarity* in respect of studied items, as a function of item type (words versus faces; same versus different) in patients with schizophrenia and control participants.

		Patients ($n=25$)				Controls ($n=24$)			
		Recollection		Familiarity		Recollection		Familiarity	
		Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.
Words	Same	0.25	0.23	0.22	0.20	0.39	0.16	0.38	0.18
	Different	0.23	0.23	0.19	0.17	0.39	0.20	0.33	0.17
Faces	Same	0.20	0.18	0.13	0.13	0.33	0.17	0.30	0.13
	Different	0.15	0.14	0.14	0.14	0.25	0.14	0.21	0.13

4.2. Size congruency effect for faces but not for words in both groups

Size changes had significant effects on *conscious recollection* for faces but not for words, to the same extent in both groups. This result is consistent with previous findings which showed that, despite schizophrenic patients' quantitative deficit of *conscious recollection*, their qualitative characteristics in respect of this type of processing might not be different to those of controls (Huron et al., 2003). Van Erp et al. (2008) showed that patients with schizophrenia were impaired as regards recognizing inter-item stimulus features (association between word pairs) whereas their performance in recognizing intra-item stimulus features (association between a color and a target) was spared. Our result confirms that patients with schizophrenia can process an intra-item stimulus feature, such as size, as well as control participants. This interpretation is consistent with the previous report according to which the impact of affective valence of words (also an intra-item stimulus feature) on *conscious recollection* was the same in patients and controls (Danion et al., 2003).

4.3. No significant difference in Know responses between groups

The proportions of *Know* responses did not differ between groups. These findings are consistent with results from several studies (Huron and Danion, 2002; Huron et al., 2003; Sontag et al., 2003; van Erp et al., 2008) according to which the proportions of *Know* responses for words did not differ between patients and controls. They are at variance with the results of Martin et al. (2004) which showed, using the 'ROC' procedure, that schizophrenia impairs both recollection and familiarity in respect of faces (see also Thoma et al. (2006) for similar results with words). Our study at least reveals that the discrepancy between previous studies does not depend on the type of material since the same decrease in familiarity in patients is observed for words and faces (no material × group interaction).

4.4. Size congruency effect on Remember and Know responses of controls

Our results showing a size congruency effect in normal controls for both remembering and knowing are also at variance with Nega (2005) who reported such an effect in knowing but not remembering. One explanation for this discrepancy could be that because patients are not able to make a gender decision quickly enough, we had to use 2-second presentation times in the study phase. Nega (2005) showed that size congruency effects emerged in knowing at a study time of 1000 ms but only occurred in remembering when the study time was increased to 5000 ms. This suggests that 2000 ms is an intermediate study time in respect of which size congruency effects occur for both remembering and knowing. Interestingly, Yonelinas and Jacoby (1995) observed a decrease in both familiarity and recollection when geometric shapes were presented at a 5 s rate in the study phase, and with a size manipulation between the study and test of 4:1. Therefore, a future study with an experimental manipulation that has a selective impact on *Know* responses (and not *Remember* responses)

might be useful in order to observe whether under such conditions a decrease in *Know* responses would occur in patients with schizophrenia.

4.5. No size congruency effect on Know responses of patients

Interestingly, the size congruency effect on Know responses of controls was not observed on patients' *Know* responses. The size congruency effect on Know responses has been explained by an increase in processing fluency when the stimuli are presented in the same size at study and at test (Rajaram, 1996; Gardiner et al., 2001; Nega, 2005). A previous study (Grillon et al., 2005) showed that there was no effect of repetition, another experimental manipulation that increases familiarity by increasing processing fluency, in *Know* responses in patients with schizophrenia despite an intact repetition priming effect at encoding. These findings suggest that recognition based on familiarity might rely less on processing fluency in patients with schizophrenia than in controls. However, an explanation in terms of differences occurring during the processing of faces at encoding cannot be ruled out given the amount of evidence supporting the hypothesis that the perception of faces is impaired in schizophrenia.

4.6. Study limitations

In contrast with Nega (2005), participants did not report more Know responses than Remember responses for faces. Therefore, our study does not provide any information about any deficit that might occur in schizophrenia only under conditions in which recognition memory relies more on familiarity than on conscious recollection.

Participants into our study were mainly men (17 out of 24). Because differences in face processing have been reported between men and women (e.g., Rehnman and Herlitz, 2007), it cannot be totally excluded that results would have been different if the number of men and women had been equal.

5. Conclusion

For the first time, our study shows that patients with schizophrenia are impaired in remembering faces. As a result, when they meet someone that they had already seen before, it might be more difficult for them to recollect details of the previous encounter with that person. This impairment could explain in part their impairment of social interactions.

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