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Abstract

This study aimed to examine the false memories in individuals with stabilized schizophrenia. Using the Deese, Roediger, and McDermott (DRM) task, schizophrenia patients and matched healthy controls had to recall words from each DRM list. Following the presentation of the DRM lists, the participants performed a recognition task. Neuropsychological tests were also administered. Results demonstrated that patients with schizophrenia recalled and recognized significantly fewer studied words than the healthy participants. This failure in retrieval is likely to result from a lack of encoding strategies. Results also showed that a stabilized schizophrenic pathology neither increased nor reduced false memories. Patients and controls showed high levels of false memories. Signal detection analyses revealed that patients discarded the critical word as not having been studied, relying on a lax decision criterion (based on familiarity, best guess or chance). Although false memories fell within the normal range for both groups, in individuals with schizophrenia they probably result from deficient encoding processes. Nevertheless, correlational analyses did not show which cognitive deficits contribute to false memories in schizophrenia.

Keywords

cognitive impairments, Deese, Roediger, and McDermott paradigm, false memory, schizophrenia

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False Memories in Individuals With Stabilized Schizophrenia

Cognitive deficits in patients with schizophrenia are well-documented and considered as critical factors in diagnostics (APA, 2013; Fioravanti et al., 2012; Green, 1998; Keefe & Harvey, 2012; Mesholam-Gately et al., 2009). Recent studies have focused on memory illusions in schizophrenia based on the Deese, Roediger, and McDermott (DRM) paradigm, a well-known procedure for inducing false memories (Roediger & McDermott, 1995). This paradigm typically consists of visual or verbal presentation to a participant of lists of semantically associated words (snow, mountain, slalom, chalet, etc.), followed by a recall and/or recognition task of the words presented. Usually, 70% of healthy participants claimed to recognize what is known as a critical word or critical lure (in this case, ski) event, even though this was not presented in the list. There was an average of 55% of false recalls. According to the Activation-Monitoring Theory (Roediger et al., 2001), the false lure memories result from the activation of words highly associated to the lists (where the critical lure is the most strongly associated word) plus a failure in monitoring at retrieval. Monitoring breakdown impedes distinction between the words on the list and those generated during encoding.

Research has examined the degree of involvement of clinical symptoms such as delusions or hallucinations in false memories (Bhatt et al., 2010; Peters et al., 2007; Peters et al., 2012; Paz-AlonsoGhetti et al., 2013). Notably, Bhatt et al. (2010) found an increase in false memories in patients with schizophrenia and delusions. These patients were also more confident in their errors compared to patients with schizophrenia and no delusions, or healthy participants. Peters et al. (2012) found a positive correlation between false memories of lures, distractors and Positive and Negative Syndrome Scale (PANSS) scores. Peters et al. (2007) and Paz-Alonso et al. (2013) also highlighted a relationship between the degree of disorganization (according to the Brief Psychiatric Rating Scale) and false memories of distractors. In contrast, Eifler et al. (2015; Moritz et al., 2004) found no relationship between clinical symptoms and DRM performance.

To obtain a clearer picture of the question of false memories, as induced by the DRM, in schizophrenia, and to establish a kind of baseline, it is crucial to exclude patients with specific symptoms such as hallucinations or delusions from studies and to focus solely on clinically stabilized patients. This baseline may also provide a better understanding of the effects of more specific symptoms in patients with schizophrenia. Few studies have examined DRM false memories in patients with stabilized schizophrenia. Moreover, the findings are unstable. For instance, Elvevåg et al. (2004) showed that the lower rate of false recognitions in schizophrenia patients compared to healthy participants resulted from a deficiency of the activation mechanism in semantic memory. An alternative hypothesis was that a reduction of correct and false recognitions was due to encoding deficits associated with decreased attention. Because the items to be learned were weakly encoded, they did not provoke sufficient activation of critical items (Eifler et al., 2015).

However, Moritz et al. (2004; Huron & Danion, 2002) reported a similar rate of false critical word recognitions in schizophrenia patients and healthy controls. These authors

suggested that schizophrenia patients adopted a recognition strategy that was based on familiarity (e.g., “similar words have been presented so I think that such-and-such a word has been presented”). This hypothesis was confirmed by [Balota et al. \(1999; Weiss et al., 2002\)](#), who reported a significant positive correlation between correct and false recognitions for both the healthy older adults and the patients with moderate dementia in their study. These false memories were considered to be due to the automatic process of semantic activation. In individuals with schizophrenia, the activation process is thought to be reduced or absent due, on the one hand, to the interval between encoding and retrieval ([Barch et al., 1996](#)) and, on the other hand, to attentional deficits at the encoding stage ([Heinrichs & Zakzanis, 1998](#)). The creation of false memories is believed to be based on a global memory of the event, namely a feeling of familiarity induced by global representations. The critical word is recalled or recognized because its content is compatible with the theme associated with the items studied.

[Moritz et al. \(2006; Zhu et al., 2018\)](#) showed that when presented with a pictorial variant of the DRM procedure, schizophrenia patients had a higher degree of certainty regarding their errors (omissions and false recognitions) than healthy controls, but a lower degree of certainty regarding their correct answers (see also [Bhatt et al., 2010; Moritz et al., 2004](#)). According to [Moritz et al. \(2006\)](#), this was because they relied on a more lenient decision criterion and less information than the healthy participants (see also [Eifler et al., 2015; Peters et al., 2012](#)).

According to [Lee et al. \(2007\)](#), poor performance in correct recognition in schizophrenia patients compared to controls is due to a lack of item-specific processing. This process, which is associated with relational (theme) processing, is thought to increase correct recognitions and decrease false memories. Based on the fuzzy trace theory, these authors argued that global traces account for a high rate of false recognition of critical words in participants with schizophrenia and controls. However, they noted that schizophrenia patients falsely recognized the unstudied and unassociated words (i.e., distractors) more often than healthy controls. A dysfunction of semantic memory, in other words atypical semantic activation, in schizophrenia patients is believed to have given rise to these unexpected associations. The authors suggested that false memories in individuals with schizophrenia result from a deficit of semantic memory and episodic memory.

More recently, [Paz-Alonso et al. \(2013\)](#) assessed a condition of the DRM in which participants were explicitly instructed to focus on the semantic relationships between the items at the encoding phase. Their results showed that the schizophrenia patients did not improve the recall performance of studied words and that there was no difference in the propensity for false memories between the patients and controls. This finding is surprising because it has been shown that reinforcing the semantic processing of studied words increases both correct and false recalls in children ([Brainerd et al., 2008](#)). [Paz-Alonso et al. \(2013\)](#) suggested that relational and conceptual processing during encoding is not fully functional in schizophrenia patients.

Overall, the few studies that have evaluated DRM false memories in persons with schizophrenia have shown that patients did not produce more false memories of critical

items than the healthy controls (Bhatt et al., 2010; Huron & Danion, 2002; Elvevåg et al., 2004; Lee et al., 2007; Paz-Alonso et al., 2013; Peters et al., 2007). However, some have found that schizophrenia patients falsely recognized unstudied and unassociated words (i.e., distractors, see Peters et al., 2007; Elvevåg et al., 2004; Lee et al., 2007) more often than the controls. This phenomenon has also been observed in patients suffering from amnesia or Alzheimer's disease and is generally interpreted as caused by deficiencies in activation processes and source monitoring (Balota et al., 1999; Schacter et al., 1996). However, it is important to note that the production of false memories of distractors by schizophrenia patients has varied across the studies.

Ultimately, the mixed results in the literature reveal that the mechanisms underlying false memories in schizophrenia are not yet fully understood and thus underline the importance of extending prior research. A better understanding of the factors involved in the production of false memories in individuals with a stabilized schizophrenia pathology in turn, will allow us to better discern the specific deficiencies associated with each clinical symptom.

From this perspective, the present study aims to examine the creation of false memories in individuals with stabilized schizophrenia and to determine which cognitive deficits contribute to increasing false memories in schizophrenia. The literature was inconclusive in determining whether false memories stem from a deficit of semantic memory (i.e., an atypical diffusion of activation) or episodic memory (i.e., an inability to encode contextual details or to keep track of them in memory), or both. In addition, this study aims to evaluate the DRM as a tool in the exploration and understanding of memory illusions with respect to the conventional narrative tasks used to explore memory illusions in the schizophrenia population (Dalla Barba, 1993; Larøi et al., 2004; Lorente-Rovira et al., 2007; Nahum et al., 2012; Nathaniel-James & Frith, 1996).

We expected that participants with stabilized schizophrenia would produce higher rates of false memories compared to healthy participants. Based on the Activation-Monitoring Theory, such a finding would reveal normal functioning of the semantic activation process in individuals with stabilized schizophrenia. We expected this semantic memory efficiency to be corroborated by scores obtained from the usual neuropsychological tests used to estimate semantic memory in schizophrenia (Henry & Crawford, 2005; Neill et al., 2014). The scores from these tests were expected to be in the normal range for both the experimental and control groups. It was anticipated that a normal functioning of semantic memory would result in a low rate of intrusions in recalls (i.e., words non-studied and unrelated to the DRM lists) for both groups.

In addition, because encoding and attention are thought to be deficient in individuals with schizophrenia, we expected that the patients would produce lower rates of veridical memories compared to healthy participants. This result was expected to correlate positively with low scores on the attention and working memory tests (Stroop, digit symbol coding, and digit span test). In contrast to the recall test results, we expected that on the recognition test, source monitoring impairment would result in a higher rate of distractor identification (i.e., false memories of words that were not studied and not

Table 1. Demographic Characteristics of the Schizophrenia Patients and Healthy Groups, Mean (Standard Deviation).

	Patients (<i>n</i> = 25)	Controls (<i>n</i> = 28)	Statistical Tests
	M (<i>SD</i>)	M (<i>SD</i>)	
Age	34.76 (11.12)	36.68 (11.16)	<i>t</i> (48) = 0.61, <i>p</i> = .54
Education (yr)	11.00 (2.04)	11.92 (1.60)	<i>U</i> (48) = 400, <i>p</i> = .08, <i>r</i> _{br} = .28
Duration of illness (yr)	10.13 (8.26)		
PANSS			
Positive	15.48 (6.82)		
Negative	17.32 (7.27)		

Abbreviation: PANSS: Positive And Negative Syndrome Scale.

Effect size = Cohen's *d* for Student's test; in case of test of normality was significant (Shapiro-Wilk), effect size = the rank biserial correlation for the Mann-Whitney test.

associated with the DRM lists) in the patients compared with the participants. We also expected that low performances on the Stroop, digit symbol coding, and digit span tests would be negatively correlated with an increase in high false alarm rates in patients.

Method

Participants

The sample size was determined using G*Power analysis (Faul et al., 2007) that yielded a total sample size equal to 44 for statistical analyses (for alpha = .05, power = .95, a medium size effect = .25 for the Anova repeated measures within-between interaction). Therefore, the sample (*N* = 50) comprised 25 adults with schizophrenia (*M* = 34.76, *SD* = 11.13, 80% men, range 18–55 years) and 25 healthy adults (*M* = 36.68, *SD* = 11.16, 60% men, range 22–56 years). The two groups were matched for gender ($\chi^2 = 2.38$, *p* = .12), age, and education. The demographic data are presented in Table 1.

The experimental group's participants were under the care of adult psychiatry at the Hôpital Saint-Jacques in France (CHU Nantes). All were considered to be clinically stable, meaning that the patient was not at risk of an acute psychotic crisis and that they were in a period of symptom stabilization. We considered as clinically stable those patients who were no longer hospitalized for relapses, who no longer had disabling symptoms and who regularly took minimal pharmacological treatment (confirmed by a regular follow-up in day hospital). The schizophrenia or schizoaffective disorder diagnosis and the patients' state of stability were assessed according to the DSM-IV criteria (APA, 2000) by experienced psychiatrists.¹ Positive and negative symptoms were evaluated with the PANSS (Kay et al., 1987). The clinical stability of the participants with schizophrenia ensured a certain homogeneity in our experimental group. In addition, according to the DSM-IV criteria (APA, 2000), these patients presented no neurological disabling, no psychomotor, visual, or auditory disorders, no major

depressive episodes, and no dependence on alcohol or other psychoactive substances during the course of the study.

The matched control group complied with the same inclusion criteria as the schizophrenia group and consisted of healthy adults, that is, they were free from mental disorders according to the DSM-IV criteria (APA, 2000). Most of them were recruited on a voluntary basis from associations in the city of Nantes.

The inclusion criteria for all participants were that they had to be aged between 18 and 60 and have had between nine and 15 years of education (with 12 years corresponding to bachelor degree level). An additional inclusion criterion for the schizophrenia group was a duration of illness of between three and 36 years. All participants were native French speakers and took part in the study willingly. Written informed consent was obtained from each participant prior to participation. Patients have read and understand the consent (read and written) that informed them to be free to participate to this experience. This phase was crucial to ensure that they were able to understand the instructions for all the tests (clinical, cognitive and experimental tasks). The patients were autonomous.

We also obtained the agreement of the head of the psychiatric center and the medical staff who helped us select the patients. Finally, we met patients in an outpatient clinic, in the day hospital. At the time of the study, we did not have an ethics committee at the Nantes University.

The study was conducted in accordance with the Declaration of Helsinki. My co-authors and I do not have any interests that might be interpreted as influencing the research. Participants were fully informed of the current research, freely consented to participate and were able to withdraw whenever they wished.

Materials

Neuropsychological Evaluation

We used the Wechsler Intelligence Scale subtests for adults (Wechsler Adult Intelligence Scale-Revised: WAIS-R, Wechsler, 1989) and the Stroop task. This battery of tests is commonly used clinically and has been rigorously validated for both the general and the schizophrenia populations.

Subtests of the WAIS-R. We assessed forward and backward digit span, digit symbol coding, vocabulary (semantic knowledge), and verbal fluency. The span assessment consisted of repeating a series of single digits in the same order (forward span) and reverse order (backward span). Performances corresponded to the number of correctly repeated digits. The digit symbol coding test consisted of pairing a series of random digits from one to nine with the geometric symbols assigned to them in a key printed on the header of a sheet of paper. The participants had 120 seconds to apply the correct code to as many symbols as possible. The vocabulary test assessed the participants' verbal intelligence. It was composed of 35 words, which the participants had to define.

The response for each word was scored between 0 and two points. In the two categorical fluency tasks proposed (“Animals” and “Fruits”; Cardebat et al., 1990), the participants were given 120 seconds to provide as many words as possible belonging to the category in question without repeating themselves and without giving proper nouns or words from the same family. This test assesses mental flexibility and can also provide information on semantic memory functioning (e.g., on search and clustering strategies).

Stroop. The executive processes of inhibition and mental flexibility were measured by the Stroop test (standardized version; Albaret & Migliore, 1999). The participants had 45 seconds to complete a task of reading or naming the ink color used to print 100 words of colors. In the reading conditions, the participants had to read the names of colors. In the first condition, they had to read the names of colors (blue, green, red, or yellow) printed in the same color of ink (congruent condition). In the second condition, they had to read the names of colors printed in a different color of ink (incongruent condition, e.g., the word “yellow” was printed in blue ink). In the naming conditions, the participants had to name the color of the ink. In the first condition, the written color names matched their ink color (congruent condition). In the second condition, they did not match (incongruent condition, e.g., the word “red” was printed in blue). The Stroop Interference score was calculated according to Albaret and Migliore’s (1999). The cognitive functions most affected in schizophrenia are attentional and executive functions. The Stroop test explores the abilities to inhibit both automatic response and interference and to focus attention on the target. These processes might be related to the production of false memories (Lövdén, 2003; Sommers & Huff, 2003).

DRM. Eight DRM lists of 15 words (Corson et al., 2009) were selected. The critical lures were: shoe (*chaussure*), wool (*laine*), door (*porte*), ski (*ski*), train (*train*), car (*voiture*), duck (*canard*), and tiger (*tigre*). The recognition test consisted of 52 words: 24 studied words, 8 critical lures, and 20 non-studied and unrelated distractor words. The participants were asked to indicate on a 4-point graduated scale their degree of certitude that the word had been studied. The points of the scale were as follows: 1 for “I am sure this word was not presented”; 2 for “I am almost sure this word was not presented”; 3 for “I am almost sure this word was presented”; and 4 for “I am sure this word was presented.”

Procedure

Participants were informed of the experimental procedure, and socio-demographic data were collected. They then performed the DRM task. Each of the eight lists of 15 words was visually and orally presented to each participant on a computer screen at a rate of 1500 milliseconds per word. After each word list, the participant had to recall as many words from the list as possible. The time allotted for the recall was 75 seconds. At the end of the presentation of the eight DRM lists, the participant performed a recognition task. The participant had to determine whether or not the 52 words shown had been

studied during the encoding phase and to evaluate their level of certainty on the 4-point scale.

One week later, the participant performed neuropsychological tests (Stroop, vocabulary, forward and backward digit span, digit symbol coding, and verbal fluency). The aim was to target the areas commonly identified as deficient in the literature on schizophrenia, namely verbal memory, working memory, inhibition, and speed of processing.

Results

Data from the retrieval tasks were analyzed separately (the recall task before the recognition task), and between-group and within-group analyses were conducted for both groups of participants (schizophrenia patients and healthy controls). For all tests, the level of significance was set at $p \leq .05$, with $p < .10$ considered as trends. For the Student's *t*, effect size is given by Cohen's *d*. The Bonferroni test was used to make the multiple comparisons; significance level was corrected according to the Bonferroni method (Dunn, 1961).

Recall analyses

The dependent variable used for the recall test was the mean percentage of words correctly recalled (total number of words recalled/15 studied words \times 8 lists \times 100), the mean percentage of critical lures produced (total number of critical lures produced/8 critical words \times 100), and the mean percentage of semantic intrusions produced (total number of semantic intrusions produced/total number of words recalled \times 100). Mean percentages of recall for both groups are presented in Table 2.

A 2 \times 3 Anova with Group (patients vs. controls) as a between-subject variable and Item type (studied words, critical lures, and intrusions) as a within-subject variable indicated no significant Group effect, $F(1, 48) = 2.80, p = .101, n^2 = .007$; a significant Item type effect, $F(2, 96) = 103.53, p < .001, n^2 = .586$; and a trend for a Group \times Item interaction, $F(2, 96) = 2.91, p = .059, n^2 = .016$. The Bonferroni tests indicated that correct recalls of studied words were higher than false recalls of lures, $p < .001$. False recalls of lures were higher than recall intrusions, $p < .001$. These results confirm the production of false memories for all participants in the recall task (see Table 2).

The Bonferroni tests confirmed a deficit in episodic memory in the patients' group compared to the control group, $p = .002$. The schizophrenia patients recalled a lower rate of studied words than the controls. Nevertheless, both groups produced almost the same rates of false memories. Both the schizophrenia patients and the healthy controls made few semantic intrusions. The Bonferroni tests revealed no significant difference between the groups for lures and recall intrusions, respectively ($p = 1.000$).

The within-group comparisons revealed that, in the control group, correct recalls of studied words were higher than false recalls of critical words, $t(24) = 3.69, p < .001$, Cohen's $d = .739$, which were in turn higher than intrusions, $t(24) = 7.41, p < .001$,

Table 2. Mean Rates (Standard Deviation) of Correct Recalls/Recognitions (Studied Words), False Recalls/Recognitions (Lures) and Semantic Intrusions/False Alarms (New Words) for Controls and Patients.

	Controls (<i>n</i> = 28)	Patients (<i>n</i> = 25)
	<i>M</i> (<i>SD</i>)	<i>M</i> (<i>SD</i>)
Correct recalls	.53 (.09)	.42 (.09)
False recalls	.34 (.21)	.30 (.17)
Intrusions	.05 (.09)	.08 (.14)
Correct recognitions	.82 (.10)	.60 (.22)
False recognitions	.57 (.29)	.63 (.22)
False alarms	.03 (.05)	.21 (.34)

Cohen's $d = 1.483$. For the group of schizophrenia patients, the pattern of results was similar. Correct recalls were higher than false recalls, $t(24) = 2.64$, $p = .014$, Cohen's $d = .529$, which were higher than intrusions, $t(24) = 5.95$, $p < .001$, Cohen's $d = 1.192$. These results indicated the presence of false memories in both groups.

The current results corroborate the susceptibility of participants to produce false memories in the DRM paradigm. The majority of participants displayed false recalls for the critical lure in the same proportion as in prior research (e.g., Lee et al., 2007, Exp. 1; Moritz et al., 2004; 2006; Roediger & McDermott, 1995; Robin, 2011).

Recognition Analyses

The dependent variable used for the recognition task was the mean percentage of studied words correctly recognized as having been studied (i.e., responses 3 “almost sure” and 4 “sure”) (total number of responses 3 + 4/3 studied words \times 8 lists \times 100), the mean percentage of critical lures falsely recognized as having been studied (responses 3–4) (total number of responses 3 + 4/8 lures \times 100), and the mean percentage of false alarms (non-studied and unrelated words) falsely recognized as having been studied (responses 3–4) (total number of responses 3 + 4/20 distractors \times 100). The mean percentages of recognition for both groups (patients and controls) are presented in Table 2.

A 2 \times 3 Anova with Group (patients vs. controls) as a between-subject variable and Item type (studied words, critical lures, and distractors) as a within-subject variable indicated no significant Group effect, $F(1, 48) = 0.020$, $p = .886$; a significant Item type effect, $F(2, 96) = 101.70$, $p < .001$, $n^2 = .542$ and a significant Group \times Item interaction, $F(2, 96) = 10.80$, $p < .001$, $n^2 = .058$. The Bonferroni tests indicated that correct recognitions of studied words were higher than false recognitions of lures, $p = .022$. False recognitions of lures were higher than false alarms, $p < .001$.

The Bonferroni tests confirmed a deficit of episodic memory in the patients' group compared to the control group, $p < .001$. The schizophrenia patients recognized a lower rate of studied words than the controls. Nevertheless, the Bonferroni tests revealed no significant difference between the groups for false recognitions ($p = 1.000$) and false alarms ($p = .189$). Despite the results being non-significant, patients are more likely than the controls to incorrectly identify the false alarms as having been studied.

The within-group comparisons revealed that, in the control group, correct recognitions were higher than false recognitions, $t(24) = 4.30, p < .001$, Cohen's $d = .861$, which were in turn higher than false alarms, $t(24) = 10.50, p < .001$, Cohen's $d = 1.984$. For the group of schizophrenia patients, the pattern of results was slightly different, revealing a stronger inclination to create false memories. Indeed, false recognition rates were as high as correct recognitions, $t(24) = -.655, p = .518$. In addition, false recognitions of critical lures were significantly higher than false alarms, $t(24) = 5.47, p < .001$, Cohen's $d = 1.09$. Overall, these results indicated the presence of false memories in both groups.

Comparisons between the two tests (recall vs. recognition) were conducted within each group. The results showed higher correct recognition rates than correct recall rates for both the controls and patients, $t(24) = 12.54, p < .001$, Cohen's $d = 2.59$; $t(24) = 3.81, p < .001$, Cohen's $d = .761$, respectively. Similarly, the false recognition rates were higher than false recall rates for both groups (controls: $t(24) = 5.01, p < .001$, Cohen's $d = 1.00$; patients: $t(24) = 7.33, p < .001$, Cohen's $d = 1.46$). The intrusion rates (recall task) and the false alarm rates (recognition task) were not significantly different for the control, $t(24) = 1.11, p = .280$, and were marginally significant in the patient group, $t(24) = 1.81, p = .083$.

Signal Detection Analyses

To determine whether the recognition scores could be attributed to changes in sensitivity or response bias, we performed a signal detection analysis with A' as an estimate of sensitivity, and B_D'' as an estimate of response bias (Donaldson, 1992; Favre et al., 2020; Ost et al., 2013; Robin & Mahé, 2015; Snodgrass & Corwin, 1988; Van Damme, 2013).

The A' index gave some indication of memory accuracy. A value near zero indicated that the participant's distinction between items was low, whereas a value near one indicated a clear discrimination between the studied items compared to those not studied. A probability of 0.50 therefore indicated that the response had occurred by chance. Although the d' measure has been more frequently used in recent DRM studies, we chose to use the A' index because it was more suited to the unrelated and unstudied words used in this study. In addition, it has been argued that the A' measure results in fewer errors than d' (see Koutstaal & Schacter, 1997).

Although some authors have stated that lambda is a better estimate of memory monitoring (see Gunter et al., 2007), we decided in line with Koutstaal and Schacter (1997; Favre et al., 2020; Ost et al., 2013; Schacter et al., 1999), that given the nature of

Table 3. Values of Sensitivity (A') and Response Bias (B_D'') for “Old” Responses (Ratings 3 and 4) for Each Group (Patients and Controls).

Group	Hits-FM		Hits-FA		FM-FA	
	A'	B_D''	A'	B_D''	A'	B_D''
Controls	.68 (.18)	-.59 (.45)	.94 (.03)	.56 (.42)	.85 (.11)	.78 (.23)
Patients	.49 (.19)	-.32 (.50)	.76 (.26)	.43 (.67)	.76 (.25)	.35 (.71)

Note. Hits-FM = hits as old responses (ratings 3 and 4) for studied words compared to false memory as old responses (ratings 3 and 4) for related critical words; Hits-FA = hits as old responses (ratings 3 and 4) for studied words compared to false alarms as old responses (ratings 3 and 4) for unrelated distractors; FM-FA = false memory as old responses (ratings 3 and 4) for critical words compared to false alarms as old responses (ratings 3 and 4) for unrelated distractors. Standard deviations are given in parentheses.

our distractors (unstudied and unrelated words), the traditional B_D'' was a more suitable measure of bias. The B_D'' index reflects a bias response, which is the tendency to respond “old” to test items. More precisely, B_D'' corresponds to the decision criterion adopted by the participant. This decision criterion can be described as flexible and risky when the participants answer that they are “almost sure” or “sure” that a word (studied vs. non-studied; related or unrelated to studied words) has been presented previously (B_D'' value is near -1) or as strict and cautious when they answer “almost sure” or “sure” that a word has not been presented previously (value near 1). In other words, this measure “reflects the tendency to accept (reject) doubtful information as (in)correct” (Van Damme, 2013, p. 1067). The value zero corresponds to the lack of response bias. Because these measures were modified with responses three or 4 (on our scale), the data were first transformed, as recommended by Snodgrass and Corwin (1988), by computing $p(x)$ as $(x+.5)/n+1$ rather than x/n .

The A' and B_D'' measures were performed by treating the “old” responses (ratings 3 and 4 for “almost sure” and “sure” that the word had been presented) for the studied words, critical words and distractors as false alarms (see Table 3). Memory accuracy was assessed by comparing: (1) hits as old responses (scores 3 and 4) to studied items and false memories as old responses to related critical words; (2) hits and false alarms as old responses to unstudied and unrelated distractors; (3) hits and false alarms (Favre et al., 2020; Koutstaal & Schacter, 1997; Ost et al., 2013; Van Damme, 2013).

Comparisons were conducted using the Mann–Whitney U test, Shapiro–Wilk tests being significant, indicating an abnormal distribution of data. The results for A' showed a significant difference between the two groups (control vs. patient), $U(48) = 135.50$, $p < .001$, $r_{rb} = .566$, revealing that the healthy participants were more able to distinguish the critical words from the studied words (.68) than the schizophrenia patients (.49), whose A' value showed that they had performed by chance. The significant difference between the groups, $U(48) = 59.50$, $p < .001$, $r_{rb} = .810$, showed that distinguishing between the studied words and the distractors was easier for the healthy controls (.93) than for the patients (.76). Finally, the ability to differentiate the critical words from the

Table 4. Neuropsychological Characteristics of Schizophrenia Patient and Healthy Control Groups.

	Controls	Patients	Statistical Tests	Effect Size
Stroop IS	33.88 (12.49)	16.08 (12.06)	U (48) = 93.50, $p < .001$	$r_b = .70$
Digit span forward	06.12 (1.24)	05.08 (1.04)	U (48) = 168, $p = .004$	$r_{rb} = .46$
Digit span backward	04.84 (1.03)	03.80 (1.32)	U (48) = 161.50, $p = .003$	$r_{rb} = .48$
Verbal fluency	26.72 (6.26)	16.58 (4.40)	U (48) = 41.50, $p < .001$	$r_{rb} = .87$
Digit symbol	64.68 (11.74)	45.48 (10.93)	U (48) = 75, $p < .001$	$r_{rb} = .76$
Vocabulary	44.08 (4.55)	29.80 (11.99)	U (48) = 96.50, $p < .001$	$r_{rb} = .69$

Note. Standard deviations are given in parentheses. Effect size = the rank biserial correlation for the Mann-Whitney test. Stroop IS = the Interference Score calculated according to [Albaret & Miglione's formula \(1999\)](#). Digit span forward and backward = the number of correctly repeated digits. Verbal fluency = the number of correctly generated words in both semantic categories (animal and fruits). Digit symbol = the amount of correctly applied code in 120 seconds. Vocabulary = the number of words correctly defined.

distractors was high for control and patient groups (respectively, .85 vs. .76, see [Table 3](#)), with no significant difference between the two, $U(48) = 257.50, p = .288$.

The U -test for B_D'' revealed a marginal difference between the two groups, $U(48) = 217, p = .065, r_{rb} = .305$. Compared to the control ($-.59$) group, the patients ($-.32$) tended to use a more lenient response criterion during the recognition task in order to distinguish studied words from critical items. In contrast, both groups used a more stringent criterion to distinguish between studied words and unrelated distractors (.56; .43 for the control and the patients' groups, respectively). The difference between the two groups was not significant, $U(48) = 294, p = .719$. Nevertheless, the conservative bias that appeared in both groups, when differentiating critical words from distractors, was more pronounced in the controls (.78) than in the patients (.35), $U(48) = 201, p = .031, r_{rb} = .357$.

Analyses of Correlations

Using the Spearman's test, we examined the correlations between the performances of the schizophrenia patients and the healthy controls in the recall and recognition tasks and their scores on the psychometric tests. The results showed lower neuropsychological scores for the patients' group than for the control group in all cognitive tests (see [Table 4](#)).

For the healthy control group, backward span and verbal fluency scores were significantly positively correlated with correct recall, indicating that executive working memory and efficient semantic activation were associated with a higher probability of accurate recalls, $r = .449, p = .024$; $r = .562, p = .003$, respectively. The significant negative correlations between verbal fluency scores and false recognitions ($r = -.486, p = .014$), and marginal correlations between vocabulary scores and false recognitions ($r = -.378, p = .062$), for the control group, suggest that semantic fluency relying on

executive, verbal and memory functions may be predictable indicators leading to lower probability of false recognitions. In the patients' group, vocabulary and forward span scores were significantly correlated with correct recall ($r = .482, p = .015$; $r = .528, p = .007$) and recall intrusions ($r = -.420, p = .036$; $r = -.455, p = .022$). There were no significant correlations between the other cognitive test scores and DRM performances in the control and patient groups.

Like Moritz et al. (2004; Balota et al., 1999; Weiss et al., 2002), we compared true memories to false ones. No significant correlation was obtained for the performances in the recall and recognition tests in the control group. The control participants' veridical memories were not related to intrusions or false memories. On the other hand, patients' correct recalls tended to negatively correlate with intrusions, suggesting that the higher the probability of recalling studied items, the lower the probability of semantic intrusions, $r = -.579, p = .002$. This result suggests that errors in recall in schizophrenia patients depend on the quality of their veridical memory. These results are most interesting because they suggest that the DRM task, in these patients, enables deficiency in episodic memory to be evidenced (probably due to encoding deficits), giving rise to a higher level of memory errors (intrusions). In contrast, a high level of false memories that is not correlated with veridical memories or intrusions might reveal an efficient semantic memory.

Lastly, it appeared that age was positively correlated with false recall of critical words in the control group ($r = .534, p = .006$), confirming the increase of false memories over the adult life span. On the other hand, educational level was negatively correlated with recall intrusions in the patients' group ($r = -.403, p = .046$). This latter result is in line with studies suggesting that educational level and/or verbal IQ might affect memory illusions in schizophrenia patients (Zhu et al., 2018).

Discussion

The aim of this research was to identify mechanisms involved in the creation of false memories in individuals with a stabilized schizophrenic pathology, using the DRM paradigm (Roediger & McDermott, 1995). Regarding the cognitive mechanisms involved in the creation of false memories, we referred to the Activation-Monitoring Theory, which shares some similarities with the Fuzzy Trace Theory and which, from our point of view, allowed us to better identify the mechanisms involved in the inflation or reduction of false memories in the standard DRM.

In line with previous studies, our results showed that the schizophrenia patients recalled and recognized significantly fewer studied words compared to the healthy participants (Bhatt et al., 2010; Lee et al., 2007; Moritz et al., 2004; Paz-Alonso et al., 2013). This reduced performance can be attributed to encoding deficits in schizophrenia (Aleman, et al., 1999; Brébion et al., 1999). According to Brébion et al. (2005), encoding deficits in schizophrenia patients reflect the lack of learning strategies preventing patients from consolidating items in their memory for later retrieval (Brébion et al., 1998; Danion et al., 2007; Gershberg & Shimamura, 1995; Paz-Alonso

et al., 2013). In addition to the encoding deficits, attentional deficits may also be involved (Moritz et al., 2004; Peretti et al., 2004; Schwartz Place & Gilmore, 1980). However, our results did not reveal any significant correlation between the attention-assessing tests and veridical memories in schizophrenia patients. Only the correct recalls were positively correlated with vocabulary and verbal working memory. In contrast, the healthy participants' correct recall rates were positively correlated with verbal fluency and central executive function.

Corroborating the hypothesis of encoding impairment in schizophrenia patients, our results revealed that stabilized schizophrenic deficits did not affect creation of false memories. The schizophrenia patients' group produced as high a rate of false memories of lures as the control group in both the recall and the recognition tests. Our findings thus call into question the hypothesis of the alteration of semantic memory functioning and more specifically of implicit activation mechanism (Paz-Alonso et al., 2013; Pomarol-Clotet et al., 2008). Regarding inhibition, our findings did not demonstrate significant correlations between the Stroop Interference score and DRM performances. Nonetheless, it is likely that both positive and negative syndromes (i.e., PANSS scores) could affect false memory rates. Therefore, this confused variable should be explored in a subsequent experiment (see Peters et al., 2012; Paz-Alonso et al., 2013).

Regarding variations in performance between recall and recognition, our results indicated that both participant groups performed better in recognition than in recall (see Bhatt et al., 2010). One potential explanation is that free recall involves the conscious recollection of information (i.e., recalling target information with its encoding context). Therefore, administering the recall task directly after the presentation of each list may have benefitted the online monitoring of retrieval, which led participants to recall fewer correct and false memories than in the recognition task (administered after the presentation of all eight lists). In the recognition task, there might be very little information available for successful recognition monitoring (see Gallo, 2006). According to Tulving (see Tulving & Craik, 2000), recognition processes depend on the general meaning or gist conveyed by a collection of items and, if necessary, on the specific details of a prior encounter with a particular item (item-specific recollection). It is likely that a recognition task primes the activation of the words and is sufficient to induce doubt and create more correct and false recognitions based essentially on familiarity (see Robin, 2011). Thus, the feeling of familiarity could be preserved in individuals with schizophrenia (Bhatt et al., 2010; Bonner-Jackson et al., 2008; Elvevåg et al., 2004; Huron & Danion, 2002; Huron, et al., 1995; Lee et al., 2007). Nevertheless, in the absence of distinctive cues in the recognition task, schizophrenia patients are likely to make their decisions at random, as shown by the liberal bias response (B_D '').

Regarding healthy participants, veridical recognitions were systematically higher than false memories, which in turn were more frequent than false alarms. For the schizophrenia patients, the veridical and false recognition rates were of the same magnitude. This finding can be attributed to poor consolidation during encoding and to omissions due to interferences between the study and recognition phases. The sensitivity estimation (A') associated with a liberal response bias have revealed that the

patients distinguished between the critical and studied items by chance. Thus, the patients might rely on a feeling of familiarity or a lax decision criterion (resulting from best guess or chance) when deciding whether the word presented had previously been studied (Favrod et al., 2008; Mammarella et al., 2010; Moritz et al., 2003). This lax decision criterion can explain the similar rates of correct and false recognitions as well as the relatively high rate of false alarms. Caution is advised, however, as we observed high false alarm rates in five patients only. In any case, the patients' low rates of false alarm, the high sensitivity value (A'), and conservative response bias call into question the hypothesis of atypical activation in the semantic network of individuals with schizophrenia (see Lee et al., 2007). Indeed, the hypothesis of atypical activation of their semantic network seems to depend more on experimental variations of the DRM task in previous studies than on patients' characteristics.

It has been suggested that a feeling of fluency may be a criterion in the rejection or acceptance of the critical word in the DRM task (Whittlesea & Williams, 2001; Whittlesea et al., 2005). However, fluency is not a stringent enough criterion for a substantial rejection of the critical words. In fact, fluency could well be the criterion that leads healthy participants to accept lures or studied words as having been encountered before (see Robin et al., 2018). Nevertheless, in line with Whittlesea and Williams's discrepancy-attribution hypothesis (2001), we can assume that the fluency with which the critical lure was activated in the memory during the recognition test increased its credibility and thus the participant's certainty that it had been presented. Therefore, if encoding processes are deficient in individuals with schizophrenia, then the higher correct and false recognition rates (compared to recall) could be based on the fluency with which each item was activated during the recognition task, as the signal detection analyses tend to confirm. Recent neuropsychological measures support the idea that schizophrenia patients relied on familiarity during the DRM task compared to healthy controls (Favre et al., 2020).

Conclusion

The current study demonstrates a rate of false memories as well as deficits in episodic memory in individuals with stabilized schizophrenia. Our results suggest that a deficit of encoding strategies in these patients may lead to failure in information retrieval. This deficit may prevent patients with schizophrenia from storing and remembering previously studied words, leading them to recall or recognize words on the basis of a lax decision criterion. Compared to Korsakoff's amnesic syndrome, the DRM false memories in individuals with stabilized schizophrenia seem to depend on different mechanisms (McKenna et al., 1990). Indeed, the DRM performances of these two pathologic populations both reveal a lower rate of accurate memories than the healthy controls. However, the Korsakoff patients produce fewer false memories than the controls (Van Damme & d'Ydewalle, 2009). This result has been linked to deficits in episodic memory leading to an alteration in the recollection occurring at the time of retrieval rather than to deficits specifically related to encoding (Van Damme &

d'Ydewalle, 2010). In contrast, high rates of false recognitions in patients with schizophrenia compared to controls seem to result from fluency or familiarity. In the recognition test, signal detection analyses, especially the sensitivity measure, showed that the schizophrenia patients were not able to distinguish between the words they had studied and related critical words.

From a critical point of view, this work has several limitations and raises new questions. The link between different forms of memory distortion is still poorly understood and, to our knowledge, no study has simultaneously evaluated false DRM memories and confabulations in schizophrenia. Our future research will aim to fill this gap. In addition to improving our understanding of the cognitive mechanisms that underlie episodic memory in schizophrenia, our aim is to propose improved techniques for addressing these cognitive deficits. Lastly, the potential effect of gender should be examined, as recent research has revealed differences between male and female patients (Brébion et al., 2018).

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Notes

1. The French version of the DSM was released in 2015: DSM-5, French version. APA, French translation coordinated by M-A Crocq and J-D Guelfi. Elsevier-Masson, June 2015. Most patients were diagnosed for an average of 10 years, that is in 2010 (see Table 1), that is 5 years before the French version of DSM-5.

References

- Albaret, J.-M., & Migliore, L. (1999). *Test de Stroop*. Éditions du Centre de Psychologie Appliquée.
- Aleman, A., Hijman, R., De Haan, E. H., & Kahn, R. S. (1999). Memory impairment in schizophrenia: A meta-analysis. *The American Journal of Psychiatry*, *156*(9), 1358–1366. <https://doi.org/10.1176/ajp.156.9.1358>
- APA. (2000). *DSM-IV. Diagnostic and statistical manual of mental disorders*. American Psychiatric Association.

- APA. (2013). *DSM-V. Diagnostic and statistical manual of mental disorders*. American Psychiatric Association.
- Balota, D. A., Cortese, M. J., Duchek, J. M., Adams, D., Roediger, H. L., McDermott, K. B., & Yerys, B. E. (1999). Veridical and false memories in healthy older adults and in dementia of the Alzheimer's type. *Cognitive Neuropsychology*, *16*(3–5), 361–384. <https://doi.org/10.1080/026432999380834>
- Barch, D. M., Cohen, J. D., Servan-Schreiber, D., Steingard, S., Steinhauer, S. S., & Van Kammen, D. P. (1996). Semantic priming in schizophrenia: An examination of spreading activation using word pronunciation and multiple SOAs. *Journal of Abnormal Psychology*, *105*(4), 592–601. <https://doi.org/10.1037/0021-843X.105.4.592>
- Bhatt, R., Laws, K. R., & McKenna, P. J. (2010). False memory in schizophrenia patients with and without delusions. *Psychiatry Research*, *178*(2), 260–265. <https://doi.org/10.1016/j.psychres.2009.02.006>
- Bonner-Jackson, A., Yodkovik, N., Csernansky, J. G., & Barch, D. M. (2008). Episodic memory in schizophrenia: The influence of strategy use on behavior and brain activation. *Psychiatry Research: Neuroimaging*, *164*(1), 1–15. <https://doi.org/10.1016/j.psychres.2007.12.012>
- Brainerd, C. J., Reyna, V. F., & Ceci, S. J. (2008). Developmental reversals in false memory: A review of data and theory. *Psychological Bulletin*, *134*(3), 343–382. <https://doi.org/10.1037/0033-2909.134.3.343>
- Brébion, G., Amador, X., Smith, M. J., & Gorman, J. M. (1998). Memory impairment and schizophrenia: The role of processing speed. *Schizophrenia Research*, *30*(1), 31–39. [https://doi.org/10.1016/S0920-9964\(97\)00123-0](https://doi.org/10.1016/S0920-9964(97)00123-0)
- Brébion, G., Amador, X., Smith, M. J., Malaspina, D., Sharif, Z., & Gorman, J. M. (1999). Opposite links of positive and negative symptomatology with memory errors in schizophrenia. *Psychiatry Research*, *88*(1), 15–24. [https://doi.org/10.1016/S0165-1781\(99\)00076-1](https://doi.org/10.1016/S0165-1781(99)00076-1)
- Brébion, G., Gorman, J. M., Malaspina, D., & Amador, X. (2005). A model of verbal memory impairments in schizophrenia: Two systems and their associations with underlying cognitive processes and clinical symptoms. *Psychological Medicine*, *35*(1), 133–142. <https://doi.org/10.1017/S0033291704002879>
- Brébion, G., Stephan-Otto, C., Ochoa, S., Nieto, L., Contel, M., & Usall, J. (2018). Verbal fluency in male and female schizophrenia patients: Different patterns of association with processing speed, working memory span, and clinical symptoms. *Neuropsychology*, *32*(1), 65–76. <https://doi.org/10.1037/neu0000394>
- Cardebat, D., Doyon, B., Puel, M., Goulet, P., & Joanette, Y. (1990). Evocation lexicale formelle et sémantique chez des sujets normaux. Performances et dynamiques de production en fonction du sexe, de l'âge et du niveau d'étude [Formal and semantic lexical evocation in normal subjects. Performance and dynamics of production as a function of sex, age and educational level]. *Acta Neurologica Belgica*, *90*(4), 207–217.
- Corson, Y., Verrier, N., & Bucic, A. (2009). False memories and individual variations: The role of field dependence-independence. *Personality and Individual Differences*, *47*(1), 8–11. <https://doi.org/10.1016/j.paid.2009.01.036>
- Dalla Barba, G. (1993). Different patterns of confabulation. *Cortex*, *29*(4), 567–581. [https://doi.org/10.1016/S0010-9452\(13\)80281-X](https://doi.org/10.1016/S0010-9452(13)80281-X)

- Damme, I. V., & d'Ydewalle, G. (2009). Memory loss versus memory distortion: The role of encoding and retrieval deficits in korsakoff patients' false memories. *Memory, 17*(4), 349–366. <https://doi.org/10.1080/09658210802680349>
- Danion, J.-M., Huron, C., Vidailhet, P., & Berna, F. (2007). Functional mechanisms of episodic memory impairment in schizophrenia. *The Canadian Journal of Psychiatry, 52*(11), 693–701. <https://doi.org/10.1177/070674370705201103>
- Donaldson, W. (1992). Measuring recognition memory. *Journal of Experimental Psychology: General, 121*(3), 275–277. <https://doi.org/10.1037/0096-3445.121.3.275>
- Dunn, O. J. (1961). Multiple comparisons among means. *Journal of the American Statistical Association, 56*(293), 52–64. <https://doi.org/10.1080/01621459.1961.10482090>
- Eiffer, S., Rausch, F., Schirmbeck, F., Veckenstedt, R., Mier, D., Esslinger, C., Englisch, S., Meyer-Lindenberg, A., Kirsch, P., & Zink, M. (2015). Metamemory in schizophrenia: Retrospective confidence ratings interact with neurocognitive deficits. *Psychiatry Research, 225*(3), 596–603. <https://doi.org/10.1016/j.psychres.2014.11.040>
- Elvevåg, B., Fisher, J. E., Weickert, T. W., Weinberger, D. R., & Goldberg, TE (2004). Lack of false recognition in schizophrenia: A consequence of poor memory? *Neuropsychologia, 42*(4), 546–554. <https://doi.org/10.1016/j.neuropsychologia.2003.08.013>
- Faul, F., Erdfelder, E., Lang, A.-G., & Buchner, A. (2007). G*Power 3: A flexible statistical power analysis program for the social, behavioral, and biomedical sciences. *Behavior Research Methods, 39*(2), 175–191. <https://doi.org/10.3758/BF03193146>
- Favre, G., Horat, S. K., Herrmann, F. R., Gothuey, I., Ventura, J., Merlo, M. C. G., & Missonnier, P. (2020). False memory production in schizophrenia: A neurophysiological investigation. *Schizophrenia Research: Cognition, 20*, 100174. <https://doi.org/10.1016/j.scog.2020.100174>
- Favrod, J., Vianin, P., & Pomini, V. (2008). Reconnaissance de la source et symptômes psychotiques: Implications pour la clinique. *Revue francophone de Clinique Comportementale et Cognitive, 13*(1), 8–17.
- Fioravanti, M., Bianchi, V., & Cinti, M. E. (2012). Cognitive deficits in schizophrenia: An updated meta-analysis of the scientific evidence. *BMC Psychiatry, 12*, 64. <https://doi.org/10.1186/1471-244X-12-64>
- Gallo, D. A. (2006). *Associative illusions of memory: False memory research in DRM and related tasks*. Psychology Press.
- Gershberg, F., & Shimamura, A. P. (1995). Impaired use of organizational strategies in free recall following frontal lobe damage. *Neuropsychologia, 33*(10), 1305–1333. [https://doi.org/10.1016/0028-3932\(95\)00103-A](https://doi.org/10.1016/0028-3932(95)00103-A)
- Green, M. F. (1998). *Schizophrenia from a neurocognitive perspective: Probing the impenetrable darkness*. Allyn & Bacon.
- Gunter, R. W., Bodner, G. E., & Azad, T. (2007). Generation and mnemonic encoding induce a mirror effect in the DRM paradigm. *Memory & Cognition, 35*(5), 1083–1092. <https://doi.org/10.3758/BF03193480>
- Heinrichs, R. W., & Zakzanis, K. K. (1998). Neurocognitive deficit in schizophrenia: A quantitative review of the evidence. *Neuropsychology, 12*(3), 426–445. <https://doi.org/10.1037/0894-4105.12.3.426>

- Henry, J., & Crawford, J. (2005). A meta-analytic review of verbal fluency deficits in schizophrenia relative to other neurocognitive deficits. *Cognitive Neuropsychiatry*, *10*(1), 1–33. <https://doi.org/10.1080/13546800344000309>
- Huron, C., & Danion, J.-M. (2002). Impairment of constructive memory in schizophrenia. *International Clinical Psychopharmacology*, *17*(3), 127–133. <https://doi.org/10.1097/00004850-200205000-00006>
- Huron, C., Danion, J. M., Giacomoni, F., Grangé, D., Robert, P., & Rizzo, L. (1995). Impairment of recognition memory with, but not without, conscious recollection in schizophrenia. *The American Journal of Psychiatry*, *152*(12), 1737–1742. <https://doi.org/10.1176/ajp.152.12.1737>
- Kay, S. R., Fiszbein, A., & Opler, L. A. (1987). The positive and negative syndrome scale (PANSS) for schizophrenia. *Schizophrenia Bulletin*, *13*(2), 261–276. <https://doi.org/10.1093/schbul/13.2.261>
- Keefe, R. S. E., & Harvey, P. D. (2012). Cognitive impairment in schizophrenia. *Novel Antischizophrenia Treatments*, (213), 11–37. https://doi.org/10.1007/978-3-642-25758-2_2
- Koutstaal, W., & Schacter, D. L. (1997). Gist-based false recognition of pictures in older and younger adults. *Journal of Memory and Language*, *37*(4), 555–583. <https://doi.org/10.1006/jmla.1997.2529>
- Larøi, F., Van der Linden, M., & Marczewski, P. (2004). The effects of emotional salience, cognitive effort and meta-cognitive beliefs on a reality monitoring task in hallucination-prone subjects. *The British Journal of Clinical Psychology/the British Psychological Society*, *43*(Pt 3), 221–233. <https://doi.org/10.1348/0144665031752970>
- Lee, Y.-S., Iao, L.-S., & Lin, C.-W. (2007). False memory and schizophrenia: Evidence for gist memory impairment. *Psychological Medicine*, *37*(4), 559–567. <https://doi.org/10.1017/S0033291706009044>
- Lorente-Rovira, E., Pomarol-Clotet, E., McCarthy, R. A., Berrios, G. E., & McKenna, P. J. (2007). Confabulation in schizophrenia and its relationship to clinical and neuropsychological features of the disorder. *Psychological Medicine*, *37*(10), 1403–1412. <https://doi.org/10.1017/S0033291707000566>
- Lövdén, M. (2003). The episodic memory and inhibition accounts of age-related increases in false memories: A consistency check. *Journal of Memory and Language*, *49*(2), 268–283. [http://dx.doi.org/10.1016/S0749-596X\(03\)00069-X](http://dx.doi.org/10.1016/S0749-596X(03)00069-X)
- Mammarella, N., Altamura, M., Padalino, F. A., Petito, A., Fairfield, B., & Bellomo, A. (2010). False memories in schizophrenia? An imagination inflation study. *Psychiatry Research*, *179*(3), 267–273. <https://doi.org/10.1016/j.psychres.2009.05.005>
- McKenna, P. J., Tamlyn, D., Mortimer, A. M., Lund, C. E., Hammond, S., & Baddeley, A. (1990). Memory dysfunction in schizophrenia. *Schizophrenia Research*, *3*(1), 67. [https://doi.org/10.1016/0920-9964\(90\)90160-9](https://doi.org/10.1016/0920-9964(90)90160-9)
- Mesholam-Gately, R. I., Giuliano, A. J., Goff, K. P., Faraone, S. V., & Seidman, L. J. (2009). Neurocognition in first-episode schizophrenia: A meta-analytic review. *Neuropsychology*, *23*(3), 315–336. <https://doi.org/10.1037/a0014708>
- Moritz, S., Woodward, T. S., Cuttler, C., Whitman, J. C., & Watson, J. M. (2004). False memories in schizophrenia. *Neuropsychology*, *18*(2), 276–283. <https://doi.org/10.1037/0894-4105.18.2.276>

- Moritz, S., Woodward, T. S., & Rodriguez-Raecke, R. (2006). Patients with schizophrenia do not produce more false memories than controls but are more confident in them. *Psychological Medicine*, 36(5), 659–667. <https://doi.org/10.1017/S0033291706007252>
- Moritz, S., Woodward, T. S., & Ruff, C. C. (2003). Source monitoring and memory confidence in schizophrenia. *Psychological Medicine*, 33(1), 131–139. <https://doi.org/10.1017/S0033291702006852>
- Nahum, L., Bouzerda-Wahlen, A., Guggisberg, A., Ptak, R., & Schnider, A. (2012). Forms of Confabulation: Dissociations and associations. *Neuropsychologia*, 50(10), 2524–2534. <https://doi.org/10.1016/j.neuropsychologia.2012.06.026>
- Nathaniel-James, D. A., & Frith, C. D. (1996). Confabulation in schizophrenia: evidence of a new form?. *Psychological Medicine*, 26(2), 391–399. <https://doi.org/10.1017/S0033291700034784>
- Neill, E., Gurvich, C., & Rossell, S. L. (2014). Category fluency in schizophrenia research: Is it an executive or semantic measure? *Cognitive Neuropsychiatry*, 19(1), 81–95. <https://doi.org/10.1080/13546805.2013.807233>
- Ost, J., Blank, H., Davies, J., Jones, G., Lambert, K., & Salmon, K. (2013). False memory ≠ false memory: DRM errors are unrelated to the misinformation effect. *Plos One*, 8(4), Article e57939. <https://doi.org/10.1371/journal.pone.0057939>
- Paz-Alonso, P. M., Ghetti, S., Ramsay, I., Solomon, M., Yoon, J., Carter, C. S., & Ragland, J. D. (2013). Semantic processes leading to true and false memory formation in schizophrenia. *Schizophrenia Research*, 147(2–3), 320–325. <https://doi.org/10.1016/j.schres.2013.04.007>
- Peretti, C.S., Martin, P., & Ferreri, F. (2004). *Schizophrénie et cognition*. John Libbey Eurotext.
- Peters, M. J. V., Cima, M. J., Smeets, T., De Vos, M., Jelicic, M., & Merckelbach, H. (2007). Did I say that word or did you? Executive dysfunctions in schizophrenic patients affect memory efficiency, but not source attributions. *Cognitive Neuropsychiatry*, 12(5), 391–411. <https://doi.org/10.1080/13546800701470145>
- Peters, M. J. V., Engel, M., Hauschildt, M., Moritz, S., Jelinek, L., & Otgaar, H. (2012). Investigating the corrective effect of Forewarning on memory and meta-memory deficits in schizophrenia patients. *Journal of Experimental Psychopathology*, 3(4), 673–687. <https://doi.org/10.5127/jep.022011>
- Pomarol-Clotet, E., Oh, T. M. S. S., Laws, K. R., & McKenna, P. J. (2008). Semantic priming in schizophrenia: Systematic review and meta-analysis. *British Journal of Psychiatry*, 192(2), 92–97. <https://doi.org/10.1192/bjp.bp.106.032102>
- Robin, F. (2011). Imagination and false memories. *Imagination, Cognition and Personality*, 30(4), 407–424. <http://dx.doi.org/10.2190/IC.30.4.e>
- Robin, F., Bonamy, J., & Ménétrier, E. (2018). Hypnosis and false memories. *Psychology of Consciousness: Theory, Research, and Practice*, 5(4), 358–373. <https://doi.org/10.1037/cns0000150>
- Robin, F., & Mahé, A. (2015). Effects of image and verbal generation on false memory. *Imagination, Cognition and Personality*, 35(1), 26–46. <https://doi.org/10.1177/0276236615574488>
- Roediger, H.L., Balota, D. A., & Watson, J.M. (2001). Spreading activation and arousal of false memories. In H. L. Roediger, J. S. Nairne, I. Neath, & A. M. Surprenant (Eds.), *The nature of*

- remembering: Essays in honor of Robert G. Crowder* (pp. 95–115). American Psychological Association.
- Roediger, H. L., & McDermott, K. B. (1995). Creating false memories: Remembering words not presented in lists. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, 21(4), 803–814. <https://doi.org/10.1037/0278-7393.21.4.803>
- Schacter, D. L., Israel, L., & Racine, C. (1999). Suppressing false recognition in younger and older adults: The distinctiveness heuristic. *Journal of Memory and Language*, 40(1), 1–24. <https://doi.org/10.1006/jmla.1998.2611>
- Schacter, D. L., Reiman, E., Curran, T., Yun, L. S., Bandy, D., McDermott, K. B., & Iii, H. L. R. (1996). Neuroanatomical correlates of veridical and illusory recognition memory: Evidence from positron emission tomography. *Neuron*, 17(2), 267–274. [https://doi.org/10.1016/S0896-6273\(00\)80158-0](https://doi.org/10.1016/S0896-6273(00)80158-0)
- Schwartz Place, E. J., & Gilmore, G. C. (1980). Perceptual organization in schizophrenia. *Journal of Abnormal Psychology*, 89(3), 409–418. <https://doi.org/10.1037/0021-843X.89.3.409>
- Snodgrass, J. G., & Corwin, J. (1988). Pragmatics of measuring recognition memory: Applications to dementia and amnesia. *Journal of Experimental Psychology: General*, 117(1), 34–50. <https://doi.org/10.1037/0096-3445.117.1.34>
- Sommers, M. S., & Huff, L. M. (2003). The effects of age and dementia of the Alzheimer's type on phonological false memories. *Psychology and Aging*, 18(4), 791–806. <http://dx.doi.org/10.1037/0882-7974.18.4.791>
- Tulving, E., & Craik, F. I. M. (2000). *The oxford handbook of memory*. Oxford University Press.
- Van Damme, I. (2013). Mood and the DRM paradigm: An investigation of the effects of valence and arousal on false memory. *Quarterly Journal of Experimental Psychology*, 66(6), 1060–1081. <https://doi.org/10.1080/17470218.2012.727837>
- Van Damme, I., & d'Ydewalle, G. (2010). Incidental versus intentional encoding in the deese-roediger-McDermott paradigm: Does amnesic patients' implicit false memory depend on conscious activation of the lure? *Journal of Clinical and Experimental Neuropsychology*, 32(5), 536–554. <https://doi.org/10.1080/13803390903310990>
- Wechsler, D. (1989). *Manuel de l'échelle d'intelligence pour adulte, forme révisée*. Editions du Centre de Psychologie Appliquée
- Weiss, A. P., Dodson, C. S., Goff, D. C., Schacter, D. L., & Heckers, S. (2002). Intact suppression of increased false recognition in schizophrenia. *American Journal of Psychiatry*, 159(9), 1506–1513. <https://doi.org/10.1176/appi.ajp.159.9.1506>
- Whittlesea, B. W. A., Masson, M. E. J., & Hughes, A. D. (2005). False memory following rapidly presented lists: The element of surprise. *Psychological Research Psychologische Forschung*, 69(5-6), 420–430. <https://doi.org/10.1007/s00426-005-0213-1>
- Whittlesea, B. W. A., & Williams, L. D. (2001). The discrepancy-attribution hypothesis: I. The heuristic basis of feelings and familiarity. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, 27(1), 3–13. <https://doi.org/10.1037/0278-7393.27.1.3>
- Zhu, B., Chen, C., Loftus, E. F., Dong, Q., Lin, C., & Li, J. (2018). Intellectual factors in false memories of patients with schizophrenia. *Psychiatry Research*, 265, 256–262. <https://doi.org/10.1016/j.psychres.2018.05.007>

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