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False Memories in Schizophrenia

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In prior studies, it was observed that patients with schizophrenia show abnormally high knowledge corruption (i.e., high-confident errors expressed as a percentage of all high-confident responses were increased for schizophrenic patients relative to controls). The authors examined the conditions under which excessive knowledge corruption occurred using the Deese–Roediger–McDermott paradigm. Whereas knowledge corruption in schizophrenia was significantly greater for false-negative errors relative to controls, no group difference occurred for false-positive errors. The groups showed a comparable high degree of confidence for false-positive recognition of critical lure items. Similar to findings collected in elderly participants, patients, but not controls, showed a strong positive correlation between the number of recognized studied items and false-positive recognition of the critical lure.

Memory dysfunctions have been ascribed a key role in many pathogenetic models of schizophrenia (e.g., Hemsley, 1994). The literature suggests that both memory recall and recognition are severely compromised in schizophrenic patients relative to healthy participants (see Aleman, Hijman, de Haan, & Kahn, 1999, for a meta-analysis; see also Heinrichs & Zakzanis, 1998). However, as of yet, no schizophrenia-specific mnestic aberration has been identified. In contrast to an extensive body of research on forgetting in schizophrenia (i.e., false-negative errors), until recently the investigation of false-positive errors has attracted little attention. Depending on the paradigm used, some studies have provided evidence for enhanced false-positive memory errors in schizophrenia (Stirling, Hellewell, & Hewitt, 1997), whereas others have been unable to detect any group differences (e.g., Brébion, Amador, Smith, & Gorman, 1997; Moritz, Heeren, Andresen, & Krausz, 2001). Weiss, Dodson, Goff, Schacter, and Heckers (2002) have suggested that task demands and material may represent moderators for these inconsistent findings. In this study, increased false recognition in schizophrenia was evident for word, but not picture, material and only occurred in an experimental condition in which correct task performance necessitated retrieval of item-specific information (i.e., recollection of an item's spatial and temporal context).

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Another neglected area of memory research in schizophrenia is the investigation of memory confidence. In two source-monitoring studies (Moritz & Woodward, 2002; Moritz, Woodward, & Ruff, 2003), evidence for a dissociation between objective and subjective memory performance in schizophrenia was found (i.e., measured performance accuracy vs. subjective evaluation of one's performance). Results from both investigations support the claim that patients with schizophrenia, irrespective of psychopathological status, display an enhanced confidence for false memory responses relative to healthy controls, whereas no group differences occurred for confidence in correct decisions. In the second study (Moritz & Woodward, 2002), 12% of responses made by schizophrenic patients with high confidence were errors (hereafter referred to as the *knowledge corruption index*), whereas the corresponding percentage for controls was lower than 5%. It was proposed that healthy participants attach "non trustworthy tags" to mental episodes that are not supported by sufficient evidence. Impairment in this cognitive process may lead to a deficit in differentiating between imagined and real mental episodes and thus may represent a risk factor for the emergence of delusional ideation. It is important to note that memory problems per se are considered a necessary but not sufficient condition for the emergence of delusions. The focus of our account is on the conviction with which false memories are held. In fact, decreased accuracy in memory tasks is even more pronounced in patients with Korsakoff's syndrome (e.g., Duffy & O'Carroll, 1994) and dementia (e.g., Heaton et al., 1994), who frequently do not display delusional behavior.

A shortcoming of our previous experimental approach was that very few false-positive recognition errors occurred (i.e., words judged as old although not previously presented, or false alarms in terms of signal-detection theory). Because the knowledge corruption index did not distinguish between different error types, source-attribution errors (i.e., words correctly classified as old but attributed to the wrong source) and false-negative errors (i.e., previously studied words incorrectly judged as new, or misses in terms of signal-detection theory) contained more weight in the index than false-positive errors. For the current study, memory corruption was examined with a recognition memory task that is known to elicit a high number of false-positive errors, even in healthy participants: the Deese–Roediger–McDermott (DRM) paradigm (Deese, 1959; Roediger & McDermott, 1995). Thus, the new design allowed computation of the corruption index for false-positive and false-negative errors separately, thereby providing insight into whether knowledge corruption spans both false-positive and false-negative errors.

In the DRM paradigm, participants are presented with a series of lists, each converging on one word that is not contained in the study list: the critical lure. Lists are arranged in descending semantic relatedness to the critical lure as determined by association studies with large samples (e.g., critical lure: *mountain*; study list: *hill, climb, valley, summit, top, molehill, peak, plain, glacier, goat, bike, climber, range, steep*). Deese (1959), Roediger and McDermott (1995), and others (e.g., Miller & Gazzaniga, 1998, who demonstrated the DRM effect with pictures) have shown that healthy controls often falsely recall or recognize the critical lure. Further, such errors are typically made with high confidence, and participants usually claim to remember that the critical lure was part of the list. Although some experimental manipulations attenuate the rate of false-positive errors (e.g., modality shifts; Gallo, McDermott, Percer, & Roediger, 2001), the effect is usually not abolished unless the study list is unrelated to the critical lure. For the current study, we explored whether the confidence of patients for both false-negative and false-positive errors would exceed the confidence of controls for their errors. It was expected that patients would display overconfidence for false-negative responses. In view of the sizeable literature showing that the false memory effect in healthy individuals is usually accompanied by high-confident ratings (e.g., Roediger & McDermott, 1995), no predictions were made regarding false-positive errors.

Method

Participants

Twenty inpatients with an established diagnosis of schizophrenia were recruited from a psychiatric long-term institution (Riverview Hospital, Port Coquitlam, British Columbia, Canada). Diagnoses relied on *Diagnostic and Statistical Manual of Mental Disorders* (fourth edition; American Psychiatric Association, 1994) criteria and were made by ward physicians. Patients were excluded if they fulfilled criteria for an Axis I diagnosis other than schizophrenia. Further exclusion criteria were an IQ score below 85, severe physical illness, or any form of documented or suspected brain or liver damage. Except for 2 patients, all schizophrenic patients were medicated with atypical neuroleptic agents. Twenty control participants were drawn from hospital staff and the community through word of mouth. Control participants were carefully screened for absence of brain damage and mental illness by means of a semistructured self-developed short interview. All participants gave written informed consent to participate. Participants were paid $5 Canadian per hour.

Psychopathological symptoms were assessed using the Signs and Symptoms of Psychotic Illness (SSPI) rating scale (Liddle, Ngan, Duffield, Kho, & Warren, 2002). The SSPI is a 20-item, 5-point (0–4) rating scale with the following anchor points: 0 = *not present,* 1 = *questionable abnormality,* 2 = *definite but mild abnormality,* 3 = *pathology of moderate severity that has a substantial impact on mental functioning*, and 4 = *severe psychopathology.* The SSPI can be completed after a 25- to 30-min semistructured interview with 15 direct questions about symptoms. The SSPI is criterion referenced, providing specific examples of behavior that correspond to severity levels for each item. The psychomotor poverty syndrome was composed of the sum of the scores for items tapping underactivity, flattened affect, and poverty of speech. Disorganization included the sum of the scores for items rating inappropriate affect and formal thought disorder. The reality-distortion syndrome incorporated the sum of the scores for items for delusions and hallucinations.

Material

We drew from the six lists used by Roediger and McDermott (1995) in their Experiment 1. Stimuli for the learning and recognition trials were derived from the first 15 associations to the critical lure words. The study lists were associated with the following lures: *chair, mountain, needle, rough, sleep,* and *sweet.* The words in each list were ordered by descending semantic relation to the lure word (determined using the Kent-Rosanoff association norms with modifications introduced by Roediger & McDermott, 1995). For the recognition trial, four different types of nonstudied items were presented:

1. Unrelated items (nonstudied): 12 items from other false-memory lists that were not part of the current study and were not related to any of the words in the study lists.
2. Weakly associated items (nonstudied): 1 weakly associated word taken from each list (words from Positions 13–15 from the first 15 associations of the critical lure; i.e., 6 words).
3. Strongly associated recognition items (nonstudied): 1 strongly associated word taken from each list (Positions 1–3; i.e., 6 words).
4. Critical lure items (nonstudied): 6 items were the critical lure words for each list.

For the study list, 13 words (15 minus the 2 taken from each list for the recognition trial) per list (78 words) remained. Of these, 30 words were selected for the recognition trial to equate the number of old and new items. Three types of old words were presented in the recognition trial:

1. Weakly associated items (studied): 2 words per list from Positions 13–15 not taken for the corresponding nonstudied words.
2. Medium associated items (studied): 1 word per list from Positions 7–9.
3. Strongly associated recognition items (studied): 2 words per list from Positions 1–3 not taken for the corresponding nonstudied words

Procedure

Participants were tested individually in a quiet room as part of a larger neurocognitive evaluation. Before testing, the following instructions were given: “In the following task, I will read some lists of words to you. Please listen carefully. Later, I will present words that were just read and new words. For each word, you will be asked if it was presented in the earlier lists or not. Do you have any questions?” Words from the study list were then presented at a rate of approximately one word/2 s. However, for motor-retarded participants, reading speed could be slightly reduced. Lists were announced as “list1,” “list2,” and so on. Between each list, a pause of approximately 5 s was made.

Subsequent to the presentation of the study list, the experimenter read the recognition list. Participants were required to state whether each word was in one of the previous lists (in this case, participants were instructed to respond with “old”) or had not been presented before (“new”). Participants were also asked to state whether they were positive, rather certain, rather uncertain, or guessing about their answer. Responses were recorded by the experimenter. Words from each item type were pseudorandomized within the recognition list.

Results

Background Variables

As can be seen in Table 1, groups did not differ on age, gender distribution, or IQ score (National Adult Reading Test). Patients had less school education, but parental education was comparable between groups.

Task Performance, Error Data

Initially, false-positive and false-negative errors were analyzed separately. Mixed analyses of variance were conducted, with percentage of errors as the dependent variable and relatedness (false-negative errors: weak, medium, strong; false-positive errors: unrelated, weak, strong, critical lure) as the within-subject factor. For false-positive errors, the main effect of relatedness, $F(3, 114) = 82.55$, $p < .001$, was highly significant; the greater the semantic relatedness of the distractors to the critical lure, the larger was the false memory effect. Both the effects of group, $F(1, 38) = 0.22$, $p > .60$, and the interaction of Group × Relatedness, $F(3, 114) = 1.67$, $p > .15$, failed to reach significance (Figure 1 and Table 2).

For the false-negative errors, the main effect of relatedness, $F(2, 76) = 9.85$, $p < .001$, achieved significance; fewer errors were made the stronger the relatedness of the presented words to the critical lure word. In addition, the group effect, $F(1, 38) = 9.68$, $p = .004$, was highly significant, whereas the Group × Relatedness interaction was not, $F(2, 76) = 0.33$, $p > .70$. As can be seen in Figure 2 and Table 2, schizophrenic participants made more false-negative errors for every word type.

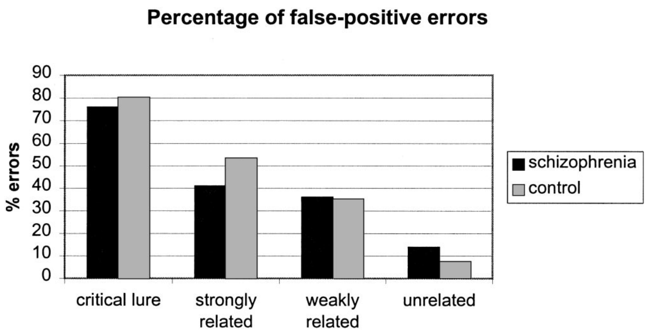

Figure 1. False-positive errors expressed as a percentage of the number of distractor items. Both groups displayed the highest error rate for critical lure words. For the remaining word types, the rate of errors was moderated by the relatedness of the distractors to the critical lure. Groups did not differ at any level of semantic relatedness.

In a subsequent analysis, the interaction of Error Type (false negative vs. false positive) × Relatedness was analyzed. Because error type could only be compared with regard to strong and weak words, all other item types were removed from analysis. The dependent variable again was percentage of errors. No main effects emerged for group, $F(1, 38) = 1.81$, $p > .10$, error type, $F(1, 38) = 3.13$, $p > .05$, or relatedness, $F(1, 38) = 1.07$, $p > .30$. The Error Type × Group interaction achieved significance, $F(1, 38) = 4.40$, $p = .04$, which is attributable to an increased number of false-negative errors for the schizophrenic group relative to controls. Also, the Relatedness × Group interaction achieved

Table 1
Sociodemographic and Psychopathological Characteristics of the Samples

Variables	Schizophrenia ($n = 20$)	Controls ($n = 20$)	Statistics
Age (years)			$t(38) = 1.14$, $p > .20$
M	33.20	29.20	
SD	9.28	12.51	
Gender (male/female)	15/5	12/8	$\chi^2(1, N = 40) = 1.03$, $p > .30$
IQ (NART)			$t(34) = 1.04$, $p > .30$
M	100.10	103.06	
SD	6.54	10.38	
Education (years)			$t(38) = 3.17$, $p = .004$
M	12.06	14.20	
SD	1.71	2.11	
Parental education (years)			$t(38) = 1.65$, $p > .10$
M	13.10	11.88	
SD	2.52	2.16	
Age at illness onset			
M	19.88		
SD	5.25		
No. hospitalizations			
M	4.36		
SD	2.56		
Chlorpromazine equivalent dosage (mg)			
M	676.59		
SD	523.86		
SSPI total			
M	13.84		
SD	4.51		

Note. NART = National Adult Reading Test; SSPI = Signs and Symptoms of Psychotic Illness.

Table 2
Mean Number of Errors Broken Down by Error Type, Word Type, and Group

Variable	Schizophrenia (n = 20)		Controls (n = 20)		Statistics
	M	*SD*	*M*	*SD*	
Nonstudied words, no. false-positive errors					
Unrelated (max: 12)	1.65	2.39	0.90	1.33	$t(38) = 1.22, p > .20$
Weakly related (max: 6)	2.15	1.23	2.10	1.77	$t(38) = 0.10, p > .90$
Strongly related (max: 6)	2.45	1.43	3.20	1.44	$t(38) = 1.65, p > .10$
Critical lure (max: 6)	4.55	1.70	4.80	1.44	$t(38) = 0.50, p > .60$
Total errors (max: 30)	10.80	4.37	11.00	4.42	$t(38) = 0.14, p > .80$
Studied words, no. false-negative errors					
Weakly related (max: 12)	5.90	2.57	3.75	2.10	$t(38) = 2.90, p = .006$
Medium related (max: 6)	2.70	1.38	1.60	0.99	$t(38) = 2.89, p = .006$
Strongly related (max: 12)	3.70	3.01	2.15	2.81	$t(38) = 2.53, p = .02$
Total errors (max: 30)	12.30	5.81	7.50	4.25	$t(38) = 2.98, p = .005$

Note. Analysis of variance results are presented in text.

significance, $F(1, 38) = 5.17$, $p = .03$, which reflects a small decline in errors on stronger words relative to weaker words in the schizophrenic group. Also, the Error Type × Relatedness interaction achieved significance, $F(1, 38) = 15.32$, $p < .001$; more false-negative errors occurred on weakly related words relative to strongly related words, whereas the opposite pattern occurred for false-positive errors. The three-way interaction of Group × Error Type × Relatedness was not significant, $F(1, 38) = 0.35$, $p > .50$.

In a third analysis, both error types were examined simultaneously but without relatedness as a factor so that all errors could be incorporated in the model. Controls made significantly fewer errors than patients, $F(1, 38) = 7.03$, $p = .012$. No main effect emerged for error type (false-positive vs. false-negative), $F(1, 38) = 0.66$, $p > .40$. However, the interaction achieved significance: Controls made slightly more false-positive errors than false-negative errors, whereas patients showed the opposite pattern, $F(1, 38) = 4.13$, $p = .05$ (see also Table 2).

Task Performance, Confidence Data

Following the claim that a fixed false belief is based on a large number of high-confident intrusions (pseudofacts), the main dependent variable in the next set of analyses were responses made with highest confidence (i.e., confidence rating score *positive* [rating = 4]). Table 3 displays the means and standard deviations of the memory responses separated by confidence ratings. For old responses (both correct and incorrect), the groups performed similarly. For the new responses (both correct and incorrect), controls were more reluctant than patients to respond with the highest confidence. Whereas the sum of correct new responses made with the highest confidence was not different between groups ($p < .10$), patients committed significantly more high-confident false-negative errors (i.e., high confidence for old items that were misclassified as new) than healthy controls.

The knowledge corruption index (percentage of high-confident incorrect responses over all high-confident responses) was significantly different, $t(38) = 3.10$, $p = .004$. Among patients, 33.71% (12.16) of all high-confident responses were errors compared with 21.22% (13.31) for controls. When the corruption index was computed for false-negative and false-positive errors separately, it achieved significance for false-negative errors (schizophrenia: 29.83% [27.98]; controls: 7.47% [10.51]); $t(38) = 10.10$, $p = .003$, but not for false-positive errors (schizophrenia: 40.44% [29.58]; controls: 41.10% [25.21]), $t(37) = 0.94$, $p > .90$.

As in Moritz and Woodward (2002), the percentage of high-confident responses made per response type (correct, incorrect) was calculated. Patients showed a higher rate of high confidence for false-negative errors (patients: 45.47% [37.25]; controls: 17.45% [22.97]), $t(38) = 2.79$, $p = .008$. The rate of false-positive errors committed with high confidence in patients was also higher than for controls (patients: 56.27% [32.46]; controls: 50.62% [28.41]). However, this difference did not achieve significance, $t(38) = 0.58$, $p > .50$. Similarly, no group differences emerged for the rate of high-confidence correct responses: On old items, patients scored 70.05% (23.39) and controls, 72.02% (15.88), $t(38) = 0.28$, $p > .70$. On new items, patients scored 52.08% (32.53) and controls 36.77% (25.90), $t(38) = 1.65$, $p > .10$.

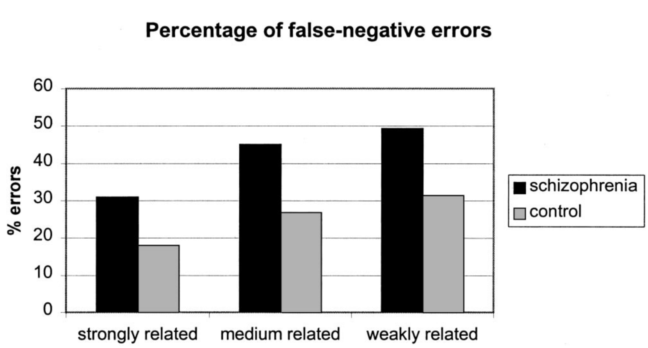

Figure 2. False-negative errors expressed as a percentage of the number of studied items. Overall, schizophrenic patients made significantly more errors than controls. As semantic relatedness to the critical lures increased, errors decreased.

Psychopathology

No significant correlation emerged between the SSPI total score, any psychopathological syndrome, formal thought disorder, psy-

Table 3
Mean Number of Responses to Studied and Nonstudied Items Separated by Response (Old vs. New) and Confidence (High vs. Low)

	"Old" response				"New" response			
	High confidence		Low confidence		High confidence		Low confidence	
Item	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
Schizophrenia								
Nonstudied								
Unrelated	0.45	0.76	1.20	2.26	6.15	4.13	4.20	3.85
Weakly related	0.95	1.21	1.20	.95	1.75	1.68	2.10	1.62
Strongly related	1.45	1.32	1.00	1.12	1.95	2.01	1.60	1.27
Critical lure	3.20	1.99	1.35	1.42	0.70	1.08	0.75	1.16
Sum nonstudied	6.05	3.97	4.75	3.75	10.55	7.70	8.65	6.07
Studied								
Weakly related	4.55	2.54	1.55	1.61	2.80	2.55	3.10	3.14
Medium related	2.75	1.41	0.55	0.83	1.15	1.42	1.55	1.50
Strongly related	6.00	3.60	2.30	2.18	1.85	2.58	1.85	2.25
Sum studied	13.30	6.62	4.40	3.27	5.80	5.81	6.50	6.10
Healthy controls								
Nonstudied								
Unrelated	0.45	1.15	0.45	0.69	4.85	3.54	6.25†	3.58
Weakly related	0.85	1.42	1.25	1.16	0.75*	1.07	3.15†	1.81
Strongly related	1.40	1.64	1.80*	1.40	1.25	1.21	1.55	1.10
Critical lure	3.45	2.06	1.35	1.50	0.15*	0.37	1.05	1.23
Sum nonstudied	6.15	5.37	4.85	2.92	7.00†	5.17	12.00†	6.08
Studied								
Weakly related	5.55	2.74	2.70*	1.87	0.75**	1.25	3.00	1.81
Medium related	3.40	1.19	1.00	1.08	0.40*	0.60	1.20	0.89
Strongly related	7.45	3.19	2.40	1.60	0.30*	0.92	1.85	2.46
Sum studied	16.40	5.35	6.10	3.55	1.45**	2.04	6.05	3.95

Note. *t*-test differences: † $p < .10$. * $p < .05$. ** $p < .005$.

chomotor slowing, education, age, or neuroleptic dosage with knowledge corruption or confidence indexes.

Determinants of False Memory Errors

Roediger, Watson, McDermott, and Gallo (2001) have examined several possible predictors of enhanced false recall and recognition of the critical lure. Apart from the degree of semantic relation of list items toward the critical lure and the distinctiveness of the critical lure (the degree of false recall/recognition for long and distinctive critical lure words is usually decreased), correct recall/recognition of the studied items was negatively correlated with recall/recognition of the critical lure. It should be noted, however, that some studies have found insignificant or even positive relationships between list recall/recognition and false memory. For example, Balota et al. (1999) reported a strong positive correlation between veridical and false recognition in elderly participants and very mildly demented elderly participants. For younger controls, insignificant negative correlations were reported (rs $= -.06$ and $-.20$, respectively).

In the current study, when the correlations between the number of correctly recognized items and the number of false-positive recognitions of the critical lure were computed for each group separately, a dramatic discrepancy occurred. Correct list recognition was an extremely strong predictor for false recognitions of the critical lure in the schizophrenic group ($r = .76$, $p < .001$). For controls no systematic relationship was observed ($r = -.05$, $p > .80$).

In schizophrenic patients, the number of correctly recognized studied items was positively correlated as a function of the semantic relatedness to the critical lure. Whereas false-positive errors for unrelated and weakly related items were not associated with better recognition of the initial lists ($-.1$, *ns*; $r = .36$, *ns*), the probability that strong distractors and the critical lure were incorrectly recognized as old was strongly linked to correct recognition of studied items in patients ($r = .57$, $p = .008$, and $r = .76$, $p < .001$, respectively).

Patients had a higher tendency to give new responses, which is reflected by larger β values in schizophrenic participants compared with controls, but this difference was not significant (patients: $M = 1.02$; controls: $M = 0.86$; $p = .12$). However, because of a higher hit rate, healthy participants had higher d' scores (patients: $M = 0.65$; controls: $M = 1.12$; $p = .01$). For computing signal-detection parameters, items from all word types were collapsed for hit and false-alarm parameters (signal-detection parameters were computed according to Velden, 1982). Computation of the relative false-alarm rate according to Watson, Balota, and Sergent-Marshall (2001; false alarms–hits $\times$ 100) revealed a trend toward greater relative false alarms in the schizophrenic group (patients:

$M = 65.33\%$; controls: $M = 50.71\%$; $p = .10$). This indicates that patients made more false-alarm errors than would be expected from their overall decreased level of recognition.

In a final analysis, the samples were matched on recognition performance for studied items (all word types) to determine whether equating on veridical recognition affected the number of false-positive recognitions of the critical lure. To meet this purpose, 4 participants in each group were removed from the analysis. Both groups were again comparable regarding false-positive recognition of the critical lure ($p > .80$; patients displayed somewhat more false-positive errors than controls). Similar results emerged when group status was regressed on false-positive recognition after covarying out correct recognition of the studied items (collapsed for all word types; $p > .60$).

Discussion

The current results corroborate the susceptibility of participants to commit errors in the DRM paradigm. The majority of participants displayed false memories for the critical lure. As expected from prior research (e.g., Roediger & McDermott, 1995), the rate of false memories decreased as a function of relatedness to the study list: Distractors representing weak and strong associates of the critical lure elicited more false-positive errors than unrelated distractor words but less in comparison to the critical lure word. False recognition of the critical lure in both groups was associated with more high-confident than low-confident ratings, again in accordance with previous findings.

Although false-positive memory errors occurred to a comparable degree in schizophrenic patients and healthy participants, there is strong evidence that false recognition has different causes in patients and controls. In the current investigation, a near-zero negative correlation emerged between the number of correctly recognized old items and false recognition of the critical lure for controls. In strong contrast, a very high positive correlation was found between correct recognition of list items and false recognition of the critical lure in schizophrenic patients. These results agree with the assumption that the main source for false recognition in healthy controls stems from spreading of activation during encoding, whereas veridical recognition had a negligible impact on performance. Similar to Balota et al. (1999), who reported a weak correlation between veridical recall and false recall, recognition of studied items apparently neither decreased (by means of an item-specific response strategy) nor increased (by means of a familiarity-based response strategy) false recognition in healthy participants. In contrast, the high correlation between veridical recognition and false memory in patients suggests that schizophrenic participants, unlike healthy individuals, adopt a familiarity- or gist-based response strategy at recognition (e.g., "*similar words [bed, cushion. . .] have been presented, so I guess sleep has been presented, too*"). This is in line with Huron et al. (1995) and Danion, Rizzo, and Bruant (1999), who have provided evidence that patients are less efficient in consciously retrieving item-specific information, making them prone to rely on semantic relatedness (see also Weiss et al., 2002).

At first sight, the postulation of an additional mechanism for evoking false recognition in schizophrenia does not seem intuitive because patients displayed no more false memories than controls. However, from the literature, there is some evidence that false memory caused by spreading of activation during encoding might have been less strong in patients relative to controls, resulting in decreased false recognition. First, encoding deficits in the study phase owing to attentional difficulties (see Heinrichs & Zakzanis, 1998) may lead to impoverished veridical recognition as well as decreased false recognition because memory episodes were not stably represented and thus would not powerfully converge onto the critical lure. Second, there are many findings confirming that schizophrenic patients produce stronger semantic priming for short intervals (e.g., Spitzer, Braun, Hermle, & Maier, 1993) but decreased priming for longer intervals (e.g., Barch et al., 1996). Therefore, summation of spreading activation (i.e., additive combination of multiple sources of activation; see Balota & Paul, 1996) during list presentation, which is discussed as an important contributor to the false-memory effect (see Roediger, Balota & Watson, 2001), was likely stronger for controls than for schizophrenic patients. To conclude, comparable rates of false recognition arise in schizophrenic patients and healthy participants because attentional difficulties and decreased long-lasting spreading of activation in schizophrenia resulting in lower rates of false recognition are "compensated for" by a familiarity-based strategy adopted by patients at recognition.

A number of testable predictions follow from the prior discussion. Under conditions in which item-specific recognition is strengthened (e.g., multiple repetitions of study lists), schizophrenic patients should display increased false recognition similar to Korsakoff patients (Schacter, Verfaellie, Anes, & Racine, 1998). From the claim that long-lasting spreading of activation during list learning is stronger in healthy participants than schizophrenic patients, it follows that, under conditions in which the impact of spreading activation is weaker (fewer items in the study list), healthy controls should show decreased rates of false recognition. Support for the latter claim comes from a study in which patients committed more false-recognition errors for new words related to only two target words (e.g., target words: *foot, hand*; lure word: *toe*) than healthy controls (Moritz et al., 2003). Whereas spreading of activation with two items was not powerful enough to "overrule" item-specific recognition in healthy controls, patients relying on a familiarity-based strategy may have recognized the lure word as old because it came from a familiar category.

As in a prior study conducted with a source memory task, knowledge corruption (high-confident errors expressed as a percentage of all high-confident responses) was significantly higher in patients than in controls. Whereas knowledge corruption in schizophrenia was present for approximately 30% of all high-confident new responses, controls showed knowledge corruption in only 7% of all high-confident new responses ($p = .003$). No substantial differences emerged between groups for false-positive errors, confirming that healthy participants are also prone to committing high-confident errors under special conditions (Roediger & McDermott, 1995).

We have previously claimed (Moritz & Woodward, 2002) that schizophrenic patients are overconfident regarding incorrect memory judgments. This very strong and general claim needs modification in view of the current findings. Our results demonstrate that confidence for false-positive memories, as generated by the DRM, is not different between groups. As already outlined, false-positive recognition errors, although occurring to a comparable extent in both samples, were probably evoked by different mechanisms in patients versus controls. Whereas the main source of false recognition in healthy participants is spreading of activation during encoding, the current results provide evidence that patients produce false-positive memory errors beyond this because of a familiarity-based strategy at recognition. Thus, both groups were equally incautious when judging new words as old but for different reasons.

In a more recent study (Moritz, Woodward, Whitman, & Cuttler, 2002), evidence for knowledge corruption was found in both false-negative and false-positive errors, suggesting that knowledge corruption is not confined to false-negative errors as might be inferred from the current results (we would like to emphasize that in the current study the false alarm rate in schizophrenic patients was increased compared with controls when baseline veridical recognition was taken into account). The task was very similar to that already described early in this article: Patients were required to provide associates for experimenter-read words and were later instructed to distinguish presented and self-generated items from new words and subsequently judge the degree of confidence for memory responses. The introduction of additional distractor words allowed separate computation of false-negative and false-positive corruption indexes. Patients were overconfident for both error types and displayed somewhat lower confidence for correct responses. As already outlined, lure words in the source memory task were probably less conducive for healthy participants than those in the DRM paradigm because related distractor words were less strongly contextually primed. Thus, when recognition is driven less by spreading of activation, healthy participants (a) commit fewer errors and (b) encounter less certainty when making errors compared with patients.

To date, the specificity and stability of knowledge corruption in schizophrenia are unknown. The current study has shown that knowledge corruption is not a ubiquitous phenomenon. At least, it does not emerge for false-positive errors evoked by the DRM paradigm. An important question for future research is the relationship between *remember–know* judgments and confidence in schizophrenia. Healthy participants typically base high-confidence judgments on conscious recollections of prior episodes (see Yonelinas, 2001, Experiment 1). There is reason to believe that patients have problems with item-specific recollection as reflected by more *know* than *remember* responses in recognition tasks (Huron et al., 1995; see also Weiss et al., 2002). At first glance, this contrasts with the overconfidence in errors reported in our studies (Moritz & Woodward, 2002; Moritz et al., 2003). However, it may be that patients with schizophrenia have a more lax criterion for high memory confidence, implicating that know judgments may be sufficient for schizophrenic patients to generate a high-confidence response. This would be in line with the "jumping to conclusions" account of schizophrenia put forward by Garety, Hemsley, and Wessely (1991), which suggests that patients reach decisions on the basis of less information than controls (see also Johnson, Hashtroudi, & Lindsay, 1993, pp. 14–15). Such a response bias could also account for the strong positive correlation found in schizophrenic patients between the rate of recognized studied items and false-positive recognition of the critical lure: Familiarity of nonstudied but list-related distractors is taken as sufficient evidence in favor of an old decision, whereas a healthy participant would rely more strongly on item-specific information.

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