PERGAMON

Neuropsychologia 40 (2002) 2360–2368

NEUROPSYCHOLOGIA

www.elsevier.com/locate/neuropsychologia

The effect of retrieval instructions on false recognition: exploring the nature of the gist memory impairment in amnesia

Mieke Verfaellie [a,*], Daniel L. Schacter [b], Shaun P. Cook [a]

[a] *Memory Disorders Research Center (151A), Boston VA Healthcare System, 150 S Huntington Avenue, Boston, MA 02130, USA*
[b] *Department of Psychology, Harvard University, Cambridge, MA 02138, USA*

Received 4 September 2001; received in revised form 10 June 2002; accepted 10 June 2002

Abstract

In previous studies, we found that amnesic patients show reduced levels of false recognition in a converging semantic associates paradigm. This finding was interpreted as reflecting an impairment in amnesia in the ability to form, retain and/or retrieve a well-organized representation of the semantic 'gist' of studied items. To further explore the nature of amnesics' impairment in gist memory, the current study compared performance in two retrieval conditions. In a standard retrieval condition, participants were asked to endorse on a recognition test only items that had appeared on the study list. In a meaning retrieval condition, participants were asked to endorse any item that shared the meaning of studied items. Meaning retrieval instructions failed to eliminate the reduction in false recognition in amnesia. These results suggest that amnesics' impairment in gist memory is not attributable to a failure to access well-formed gist representations when given item-specific retrieval cues. Rather, it suggests that amnesic patients are impaired in their ability to encode, store, or maintain strong gist information.
Published by Elsevier Science Ltd.

Keywords: Amnesia; Gist memory; False recognition

1. Introduction

Studies of patients with global amnesia have contributed greatly to our understanding of the brain structures and processes that mediate memory. These studies have focused primarily on quantitative aspects of patients' performance, emphasizing differences in the amount of information that can be recovered from memory as a function of retrieval instructions. Dissociations between patients' intact performance on implicit memory tasks and marked deficits in explicit memory for the same stimuli [24,35] were among the first findings to suggest the existence of distinct forms of memory that are functionally and neuroanatomically dissociable.

Recognizing that tasks are rarely process pure, later studies have examined the contribution of distinct processes within single tasks and have characterized amnesics' performance in terms of the contribution of underlying memory processes [47,49]. This approach has been enhanced by the analysis of qualitative aspects of patients' performance, including the memory errors, distortions and illusions that sometimes accompany remembering (e.g. [20,23,28,41]). These forms of errors are of particular interest because they shed light on the constructive nature of encoding and retrieval processes (e.g. [15,36]). The study of such errors in patients with amnesia provides an opportunity to gain further insight into the functional and neural correlates of illusory memory.

The memory illusion studied most extensively in patients with amnesia concerns the phenomenon of false recognition—the mistaken endorsement on a recognition test of items similar to those that were studied. Several studies (for review, see [40]) have demonstrated that under conditions in which normal participants show high levels of false recognition, amnesic patients show markedly reduced levels of false recognition. This pattern, identical to that seen for true recognition of studied items, has been interpreted to suggest that the medial temporal/diencephalic regions that are critical for veridical recognition are also important for the storage and/or retrieval of the semantic or perceptual information that drives false recognition in healthy controls.

* Corresponding author. Tel.: +1-617-232-9500x4031; fax: +1-617-278-4490.
E-mail address: verf@bu.edu (M. Verfaellie).

0028-3932/02/$ – see front matter. Published by Elsevier Science Ltd.
PII: S0028-3932(02)00074-X

Findings of reduced false recognition in amnesia have been obtained primarily in the context of a converging associates paradigm.[1] This paradigm, originally designed by Deese [9], has recently been revived and modified by Roediger and McDermott [30]. In an initial study, Schacter et al. [41] exposed amnesic patients and matched control participants to lists of semantic associates (e.g. *candy*, *sour*, *sugar*, *bitter*, *good*, *taste*, etc.), all of which converge on a non-presented theme word (e.g. "*sweet*"). As expected, amnesic patients endorsed fewer studied words but more unrelated new words than did controls. More importantly, they also endorsed fewer non-presented theme words than did controls, who showed high levels of false recognition of these words (for similar findings, see [22]). Subsequent studies have extended these findings of reduced false recognition in amnesia to tasks in which study items were perceptually, rather than semantically related [18,38]. Taken together, these results suggest a pervasive reduction in false recognition in amnesia in the converging associates paradigm.

Schacter and coworkers [38,41] have interpreted these findings with reference to group differences in the encoding, storage and/or retention of gist information (cf. [29]). When numerous associated items are presented at study, normal individuals establish and retain a well-integrated trace of the features that are shared among different items on the list—the semantic or perceptual gist of the studied items. When a theme word is presented on a recognition test, normal participants experience a strong sense of familiarity or recollection, because the theme word is consistent with the gist of the study list. Amnesic patients, in contrast, extract or retain less gist information, and consequently, are relatively less likely to endorse non-studied theme words on a recognition test.

While findings of reduced false recognition in amnesia point to impairment in gist memory, the relationship between false recognition and gist memory is complicated by the fact that normal individuals can in some conditions use item-specific, veridical memory to counter or oppose false recognition. Schacter et al. [39] created conditions that encouraged the use of veridical memory by providing participants with five repetitions of the same list of converging semantic associates. As expected, normal controls showed increasing veridical recollection of previously presented items across trials. Of greater interest, false recognition of theme words in these subjects declined steadily—consistent with the notion that control participants can use their item-specific memory to suppress false recognition. Because of their poor item-specific memory, amnesic patients were much less able to suppress theme words consistent with the gist, and their false memory showed a flat or increasing pattern across trials (for details, see [39]; for a similar pattern of results in patients with memory disorders attributable to Alzheimer's disease, see [6]).

These findings illustrate the difficulty inherent in drawing inferences about the magnitude of gist impairment in amnesic patients under conditions in which item-specific memory can be used to suppress false recognition. To evaluate gist memory in amnesia more precisely, what is needed is a condition in which false memory is not opposed by item-specific memory. Such a condition is provided by the "meaning recognition" instructions previously used by Brainerd and Reyna [2]. In the meaning retrieval condition of their study, participants were instructed to ignore whether an item was actually studied and to endorse any item that shared the meaning of studied items. Under meaning instructions, participants endorsed significantly more theme words than they did under standard instructions, supporting the notion that opposing influences of item-specific memory are operative in the standard old/new recognition test. Such influences are removed under meaning instructions, where gist memory is the only criterion for responding (see also [34]).

In addition to allowing a more accurate and direct assessment of gist memory, the use of meaning instructions in amnesic patients provides an opportunity to gain insight into the possible bases of the gist memory impairment in amnesia. One possibility, emphasized by Schacter and coworkers [19,39] so far, is that amnesic patients are unable to *form or maintain* robust representations of semantic gist because they are impaired at encoding and storing the semantic or associative information that relates words on a study list to one another. An alternative possibility, however, is that patients fail to *gain access* to relatively intact gist representations. Such a scenario could occur because of a mismatch between the encoding and retrieval demands. Even if subjects successfully encoded gist information, that information might be difficult to access in the standard old/new recognition paradigm because the instructions emphasize the retrieval of distinctive, item-specific information. Because of those instructions, participants may attempt to focus on the semantic and perceptual features that distinguish an individual item from others on the study list, rather than on the gist information that is shared among items. Admittedly, this mismatch between processing at encoding, emphasizing information shared between studied items, and processing at retrieval, emphasizing item-specific cues to memory, should affect the performance of non-amnesic participants as well as that of amnesic patients. However, such an arrangement could be especially deleterious for amnesic patients: because their memory is generally depressed, amnesics should have less ability than controls to compensate for an encoding/retrieval mismatch.

A comparison of the performance of amnesic patients and controls in a standard retrieval condition and a meaning retrieval condition allowed us to distinguish between these two possible bases of gist memory impairment in amnesia. If amnesic patients are unable to encode or store strong gist

[1] These findings differ from those obtained in a study [8] in which lures were preceded by a single semantically, associatively, or physically similar word. Under those conditions, amnesic patients showed enhanced false recognition to both homophones and semantic associates. For discussion of the differences between these paradigms, see [39,40].

information, then the reduction in false recognition should be at least as pronounced in the meaning retrieval as in the standard retrieval condition. In fact, to the extent that gist memory in normal participants is underestimated in the standard retrieval condition, amnesics' reduction in false recognition might be even more pronounced in the meaning retrieval condition. In contrast, if amnesic patients are able to encode and store relatively strong gist information, but are unable to access this information in the standard retrieval condition because of a mismatch between the processes engaged at encoding and retrieval, then the reduction in false recognition in amnesia should be less apparent, or possibly eliminated, in the meaning condition.

2. Methods

2.1. Participants

Sixteen amnesic patients and sixteen individuals with intact memory functioning participated in the experiment. Seven patients had a diagnosis of alcoholic Korsakoff syndrome and nine patients had a variety of non-alcoholic etiologies, including anoxia, encephalitis and bithalamic stroke (see Table 1 for details concerning individual patients). This combined group of amnesics had a mean age of 60 and a mean of 14 years of education. The amnesics' group mean verbal IQ score as measured by the Wechsler Adult Intelligence Scale-III (WAIS-III) was 99. Their attentional abilities as measured by the Wechsler Memory Scale-III (WMS-III) Working Memory Index were also intact, as indicated by a mean score of 98. Their memory functioning was severely compromised, as indicated by a mean General Memory Index of 62, Visual Delay Index of 65 and Auditory Delay Index of 64 on the WMS-III.

The control group consisted of seventeen participants, eight with a history of alcoholism and nine without a history of alcoholism. The control participants had a mean age of 62 and a mean of 14 years of education. They had a mean WAIS-III Verbal IQ score of 104, which did not significantly differ from that of the amnesic group ($t(31) = 1.36$).

2.2. Materials and design

The stimuli consisted of 32 lists of 16 words selected from the materials of Stadler et al. [44]. Each list contained 15 words to be presented for study and a critical lure that was not presented for study. The study words were all highly associated to the critical lure and were ordered such that the strongest associates occurred first in the list. The 32 lists were divided into four sets of eight lists, set A1, set A2, set B1, and set B2. These sets were matched in terms of their probability of false recognition of the critical lure, as indicated by the norms assembled by Stadler et al. [44].

All participants were tested in a standard retrieval condition and a meaning retrieval condition. For half the participants, the A sets were used in the standard retrieval condition and the B sets in the meaning retrieval condition, whereas for the other half of the participants, the reverse was true. Also, for half of the participants sets A1 and B1 were used to create the studied lists and sets A2 and B2 formed the unstudied lists, whereas for the other half of the participants this assignment was reversed. Thus, four study lists were created, each of which comprised 120 target words (eight lists of 15 words each).

Four test lists each composed of 48 words were constructed, one corresponding to each of the study lists. Twenty-four of these words were studied words (targets), taken from serial positions 1, 8, and 10 of each 15-item

Table 1
Characteristics of Korsakoff and mixed etiology amnesic patients

	Etiology	Age	ED	VIQ	WMS-III			
					GM	V DLY	A DLY	WM
PB	Korsakoff	72	14	99	59	65	58	115
RD	Korsakoff	69	12	77	72	65	74	96
RM	Korsakoff	79	14	105	66	62	64	121
WK	Korsakoff	58	16	92	47	56	58	85
RG	Korsakoff	81	9	100	72	75	74	91
ML	Korsakoff	55	12	97	66	62	74	108
PR	Korsakoff	50	18	111	69	72	64	81
CL	Encephalitis	57	12	106	69	68	77	111
CW	Bithalamic stroke	58	12	84	73	84	67	99
JM	Anoxia	49	12	82	52	56	55	91
PS	Anoxia	42	14	90	45	53	52	93
WS	Anoxia	54	14	111	59	73	52	96
DS	Anoxia	46	16	86	49	53	52	93
AB	Anoxia	59	16	110	64	75	58	108
PD	Anoxia	62	20	111	52	56	64	83
RL	Anoxia	70	18	113	75	72	80	102

ED: years of formal education. VIQ: verbal IQ from the Wechsler Adult Intelligence Scale-III. WMS-III: Wechsler Memory Scale-III; scores are presented separately for indices of general memory (GM), visual delay (V DLY), auditory delay (A DLY) and working memory (WM).

word list. The remaining 24 words, which were not studied, comprised the eight non-presented theme words corresponding to the studied lists (lures), eight target distractors, taken from serial position 6 of the unstudied lists, and eight lure distractors (the theme words corresponding to the unstudied lists). The order of test words was randomized for each test list, with the exception of the fact that the position of the lure relative to the three targets from the corresponding list was systematically varied, so that the lure appeared equally often in positions 1–4.

2.3. Procedure

The standard instruction condition was always administered first and was separated from the meaning instruction condition by a 10 min break. During the study phase of each condition, participants listened to a list of words presented by a MacIntosh Powerbook G3 computer. Words were digitized using SoundEdit™ 16 and presented at a rate of 1 per 1500 ms. There was a 10 s pause between consecutive 15-item word lists.

Approximately 2 min after the study phase, the test phase was initiated. During the test phase, participants were informed that they would be presented with a series of words, some of which had been heard on the study list and some of which had not been heard. The retrieval instructions varied as a function of condition and were modeled after those used by Brainerd and Reyna [2]. In the standard retrieval condition, participants were asked to respond "old" if an item had been presented on the study list and "new" if an item had not been presented on the study list. In the meaning retrieval condition, participants were asked to respond "old" if they recognized an item as an example of any of the themes or concepts from the study list, and to respond "new" if an item did not fit any of the themes from the study list. Several examples were provided in each condition to ensure that participants understood the instructions. Verbatim instructions are provided in Appendices A and B.

3. Results

Table 2 presents the proportion of "old" responses given to targets, target distractors, critical lures and critical lure distractors as a function of retrieval instructions. These results are shown separately for the amnesic subgroups and their respective controls. Preliminary analyses revealed similar patterns of results for the two amnesic subgroups for veridical memory, therefore, we present analyses of these data collapsed across the two amnesic subgroups. There were, however, significant differences between the two subgroups for false recognition. Therefore, in addition to analyses of the two amnesic subgroups collapsed, we also present analyses of each amnesic subgroup separately.

3.1. Veridical memory

As can be seen in Table 2, amnesic patients obtained fewer hits to true targets and more false alarms to target distractors than did participants in the non-amnesic control group. This was true both in the standard condition (hits: 0.54 versus 0.77, $t(31) = 4.47$, $P < 0.001$; false alarms: 0.15 versus 0.06, $t(31) = 2.21$, $P < 0.05$) and in the meaning condition (hits: 0.54 versus 0.79, $t(31) = 3.98$, $P < 0.001$; false alarms: 0.28 versus 0.17, $t(31) = 1.73$, $P < 0.10$). Analysis of variance on the hit rates to targets revealed a significant main effect of group, $F(1, 31) = 23.82$, $P < 0.002$, a non-significant effect of retrieval instructions, $F < 1$, and a non-significant group × retrieval instructions interaction, $F < 1$. Analysis of false alarm rates to target distractors revealed a significant effect of group, $F(1, 31) = 6.61$, $P < 0.02$, a significant effect of

Table 2
Proportion of items judged "old" in the standard and meaning retrieval condition

Item type	Retrieval condition	Group			
		Mixed amnesics	Nonalcoholic controls	Korsakoff's amnesics	Alcoholic controls
Target	Standard	0.60	0.79	0.47	0.75
	Meaning	0.58	0.81	0.48	0.76
Target distractor	Standard	0.12	0.05	0.19	0.06
	Meaning	0.25	0.19	0.32	0.16
Veridical memory	Standard	0.48	0.74	0.28	0.69
	Meaning	0.33	0.62	0.16	0.60
Lure	Standard	0.64	0.70	0.71	0.76
	Meaning	0.74	0.96	0.63	0.85
Lure distractor	Standard	0.33	0.12	0.23	0.08
	Meaning	0.32	0.22	0.30	0.11
False memory	Standard	0.31	0.58	0.48	0.68
	Meaning	0.42	0.74	0.33	0.74

retrieval instructions, $F(1, 31) = 11.86$, $P < 0.01$, and a non-significant group × retrieval instructions interaction, $F < 1$. Applying the standard high-threshold procedure, we subtracted false alarm rates to target distractors from hit rates to corresponding targets. Results of this analysis revealed a highly significant effect of group, $F(1, 31) = 31.19$, $P < 0.001$, illustrating the severe memory impairment in the amnesic patients, and a significant effect of retrieval instructions, $F(1, 31) = 6.93$, $P < 0.02$, indicating that item memory for both groups was poorer in the meaning condition than in the standard condition. The group × retrieval instructions interaction was non-significant, $F < 1$.

3.2. False memory

The critical results concern the proportion of lures and lure distractors endorsed by the two groups in the two retrieval conditions. Combined across the two patient subgroups, amnesic patients gave a roughly similar proportion of "old" responses to lures as did controls in the standard condition (0.73 versus 0.67, $t < 1$), but they gave a smaller proportion of "old" responses to lures than did controls in the meaning condition (0.69 versus 0.91, $t(31) = 3.41$, $P < 0.001$). Furthermore, in both retrieval conditions, amnesic patients endorsed more lure distractors than did controls (standard: 0.29 versus 0.10, $t(31) = 2.77$, $P < 0.01$; meaning: 0.31 versus 0.17, $t(31) = 2.5$, $P<0.01$). Analysis of "old" responses to lures revealed a significant effect of group, $F(1, 31) = 7.14$, $P < 0.02$, and a significant effect of retrieval instructions, $F(1, 31) = 5.23$, $P < 0.03$. The group × retrieval instructions interaction approached significance, $F(1, 31) = 3.24$, $P = 0.08$. Analysis of "old" responses to lure distractors revealed a significant effect of group, $F(1, 31) = 11.2$, $P < 0.01$. To obtain a measure of false memory,[2] we subtracted the proportion of "old" responses to lure distractors from "old" responses to lures. Amnesic patients showed significantly reduced false memory both in the standard condition (0.38 versus 0.63, $t(31) = 2.89$, $P < 0.01$) and in the meaning condition (0.38 versus 0.74, $t(31) = 6.16$, $P < 0.001$). An ANOVA on these data revealed a significant effect of group, $F(1, 31) = 28.5$, $P < 0.001$. The group × retrieval instructions interaction was not significant, $F(1, 31) = 1.57$, $P = 0.22$, but planned comparisons indicated that gist memory in the control group was influenced by retrieval instructions (standard = 0.63 versus meaning = 0.74, $t(31) = 2.21$, $P < 0.05$). Gist memory in the amnesic group was not similarly affected.

Although both amnesic subgroups had lower false memory scores than their controls in both retrieval conditions, Table 2 reveals that the effect of retrieval instructions differed for the amnesics of mixed etiology and the Korsakoff patients. Comparing mixed etiology amnesics to their control group, an analysis of false memory scores[3] revealed a significant effect of group, $F(1, 16) = 15.0$, $P < 0.002$. The effect of retrieval instructions approached significance, $F(1, 16) = 4.23$, $P = 0.06$, while the group × retrieval instructions interaction was non-significant, $F < 1$. Thus, false memory was clearly impaired in mixed etiology amnesics, but like their controls, they had higher false recognition scores in the meaning condition than in the standard condition. In contrast, an analysis of false memory scores[4] in the Korsakoff amnesics compared to their alcoholic control group, revealed a significant effect of group, $F(1, 13) = 11.9$, $P < 0.005$, and a significant group × instructions interaction, $F(1,13) = 4.8$, $P < 0.05$. This interaction reflected the fact there was a decrease in false recognition with meaning instructions in the Korsakoff amnesics, $t(7) = 2.01$, $P < 0.05$. The alcoholic control group showed a numerical, albeit not statistically significant, increase in false recognition, $t < 1$.

4. Discussion

Replicating previous results [22,38,39,41], we found that in the standard retrieval condition, amnesics' false recognition was significantly lower than that of controls. Extending earlier findings, we observed that amnesics' false memory remained reduced in a meaning retrieval condition, in which participants were asked to endorse any item that matched the gist or the theme of words on the study list. Not only did meaning retrieval instructions fail to eliminate the reduction in false recognition in amnesia, the size of the reduction was numerically larger, albeit non-significantly so. The use of meaning retrieval instructions eliminated the need for strategic processes that allow gist-memory to be opposed by item-specific memory. Although our findings suggest that in the standard retrieval condition, suppression had at most a modest effect (under the current conditions of single presentation of the study list), the false recognition data in the meaning retrieval condition nonetheless provide a more accurate measure of available gist memory. Our findings point unequivocally to an impairment in gist memory in amnesia.

The failure of retrieval instructions to lessen or eliminate the reduction in false memory in amnesia provides further insight into the mechanisms underlying the impairment in gist memory in the amnesic group. Importantly, our findings

[2] We maintain the convention of referring to memory for critical lures as "false memory", although it should be kept in mind that in the meaning retrieval condition acceptance of lures is not really false as gist memories are the criterion for acceptance.

[3] The analysis of "old" responses to lures in the mixed amnesic subgroup revealed a marginal effect of Group, $F(1, 16) = 3.5$, $P = 0.08$, and a significant effect of Retrieval Instructions, $F(1, 16) = 7.13$, $P < 0.05$. In the analysis of "old" responses to lure distractors, only the effect of Group approached significance, $F(1, 16) = 4.1$, $P = 0.06$.

[4] The analysis of "old" responses to lures in the Korsakoff amnesic subgroup revealed a marginal effect of Group, $F(1, 13) = 3.4$, $P = 0.09$, and a significant Group × Retrieval Instruction interaction, $F(1, 13) = 4.99$, $P < 0.05$. In the analysis of "old" responses to lure distractors, only the effect of Group was significant, $F(1, 13) = 8.99$, $P < 0.02$.

cannot be ascribed to the fact that amnesic patients were generally insensitive to retrieval instructions or failed to comply with these instructions. Like controls, amnesic patients showed poorer veridical memory for studied items in the meaning retrieval condition than in the standard retrieval condition. This finding suggests that the performance of amnesics, like that of controls, is influenced by the match between the processes engaged at encoding and at retrieval: under meaning instructions, which emphasize the retrieval of gist information, access to item-specific information is more difficult than under standard retrieval instructions, which emphasize retrieval of verbatim information.[5] Despite the effect of retrieval instructions on amnesics' veridical memory, meaning instructions did not affect the level of false recognition in patients as compared to controls. Thus, even though meaning retrieval encouraged reliance on gist information, patients' false memory remained as reduced in the meaning retrieval condition as in the item retrieval condition. This finding suggests that the reduction in false recognition in amnesia is not simply the result of patients' inability to access gist information. Rather, it supports the notion that amnesic patients are unable to encode, store or maintain robust gist information in the same way normal participants do. Because of the study-test delay employed in the current study, it remains for future studies to determine exactly which stage is responsible for patients' impaired performance.

Although false recognition following meaning retrieval was substantially lower in both Korsakoff and non-Korsakoff amnesics compared to their respective controls, the effect of retrieval instructions differed in the two patient subgroups. Non-Korsakoff amnesics showed a pattern similar to that of normal controls, in that false recognition was greater following meaning retrieval than following standard retrieval. This finding suggests that, for non-Korsakoff amnesics as well as for controls, retrieval instructions that emphasize reliance on meaning provide better cues for gist memory than do standard instructions [2]. Korsakoff patients, in contrast, showed reduced false recognition following meaning retrieval compared to standard retrieval. We explored several possible reasons for this unexpected decrease. One possibility, suggested by the fact that Korsakoff amnesics required generally more extensive explanation of the meaning retrieval instructions, was that the study-test delay for this group was inadvertently longer in the meaning retrieval condition than in the standard retrieval condition. A decrease in false recognition in the meaning retrieval condition, then, might reflect forgetting over time rather than the effect of varying retrieval instructions. To evaluate this possibility, we re-tested the Korsakoff group in the meaning retrieval condition, taking care to match the study-test delay closely to that used in the standard retrieval condition. Korsakoff patients again showed lower false recognition given meaning retrieval (mean $= 0.25$) compared to standard retrieval instructions (mean $= 0.48$), suggesting that the original pattern of findings was not due to differences in study-test delay.

A second possible reason for Korsakoff patients' decrease in false recognition following meaning retrieval instructions concerns the presence of frontal deficits in this patient group (e.g. [25,42]). Recent neuroimaging studies have highlighted the role of the left inferior frontal lobe in explicit access to word meanings [5,26]. In addition, based on their findings of reduced recall of false memories in frontal compared to medial temporal amnesics, Melo et al. [22] have suggested that frontal processes may play a critical role in the extraction and utilization of gist information. We examined, therefore, whether the failure to show increased false recognition under meaning retrieval in the Korsakoff group, but not in the mixed amnesia group, was related to compromised frontal lobe functioning. We did so in two ways. First, we directly compared the performance of the two subgroups of amnesic patients on four measures of frontal functioning derived from the Wisconsin Card Sorting Task (number of categories and percent perseverative errors), the Controlled Oral Word Association Test (total number of appropriate responses), and Trails B (reaction time). The performance of the Korsakoff patients differed from that of the mixed amnesics in terms of percent perseverative errors on the Wisconsin Card Sorting Test (Korsakoff mean $= 29.4\%$; mixed amnesics mean $= 13.8\%$, $t(14) = 2.3$, $P < 0.05$), but there were no differences on any of the other measures. Second, we calculated for each patient the difference in false recognition between the meaning and the standard retrieval condition and correlated this score with a composite frontal score, consisting of patients' mean rank on the four frontal measures. This correlation was non-significant ($r = -0.15$). We also calculated the correlation between the size of false recognition in the meaning retrieval condition and patients' frontal rank score. Again, this correlation was non-significant ($r = -0.16$).[6] Therefore, our data do not provide support for the notion that Korsakoff patients' failure to benefit from meaning retrieval instructions was attributable to concomitant frontal impairment. Future studies will be necessary to examine the conditions that elicit different patterns of false memory in Korsakoff and non-Korsakoff amnesics (see also [39]) and to elucidate possible mechanisms responsible for these differences.

Leaving aside subgroup differences, the current findings clearly demonstrate that in both patient subgroups,

[5] Our finding of lower veridical memory in the meaning retrieval condition than in the standard retrieval condition is at odds with the findings of Brainerd and Reyna [2] and Rotello [32], but may be due to the fact that meaning instructions in the present study placed less emphasis on retrieval of targets than was the case in these other studies.

[6] We also calculated correlations with the percent perseverative errors in isolation, as this was the one measure that distinguished Korsakoff patients from the other amnesics. These correlations were again non-significant ($r = -0.02$ for the correlation between perseverative errors and the difference between meaning and standard retrieval; $r = -0.27$ for the correlation between perseverative errors and meaning retrieval).

the reduction in false recognition was not lessened by the use of meaning retrieval instructions. This finding suggests that both patient subgroups are impaired in their ability to encode or store and maintain a well-organized gist representation that captures the general similarity or theme that links a set of associated words. Encoding of gist information may depend in part on automatic activation processes [3,21,31], whereby activation of the meaning of one item spreads to related concepts. In this way, the gist or theme of a list might be activated by a number of studied items and become part of the memory representation of the study list. Such automatic activation processes, however, are unlikely to be the cause of amnesics' impairment in gist memory, because semantic priming has been shown to be intact in amnesia [46]. Equally important, the ability to process and encode thematic information requires inferential processes, whereby different items and generated associates are related to one another and organized into a focused representation [4,29,40]. One possibility is that amnesics' impairment in gist memory reflects defective relational and elaborative processing.

Kitchener and Squire [16] have also alluded to the role of inferential processes in new thematic learning in an attempt to account for the performance of amnesic patients in various category learning tasks. In several studies using non-verbal materials, amnesic patients have shown intact prototype classification [17,27,43], but in a recent study in which exemplars were described verbally, amnesics' prototype classification was found to be impaired [16]. Kitchener and Squire [16] suggested that this impairment might be attributable to the fact that verbal category learning requires participants to compare and contrast exemplars across learning trials—a process that may not be necessary in non-verbal category learning tasks, where similarity may be apprehended directly, without the need for relational processing.

In light of this proposal, it will be of interest to examine further amnesics' false recognition for non-verbal stimuli. Using both abstract patterns [18] and pictures of common objects [19], we have demonstrated that false recognition in the non-verbal domain is impaired in amnesia following standard retrieval instructions, but it remains to be seen whether this finding will also occur following meaning retrieval instructions. If inferential processes by which different items are compared and related to one another are less important for the extraction of gist from non-verbal information than from verbal information, meaning instructions may be more successful in alleviating the false memory deficit for non-verbal material in amnesia.

Another possible reason for the impairment in gist memory in amnesia is that patients may be unable to store and maintain the products of the relational processing that leads to the formation of a strong gist representation [22]. By this view, false recognition might be intact in amnesia when tested immediately after presentation of the converging associates, but impaired following a delay or following administration of multiple lists of associates. Although the effect of delay on amnesics' false recognition has not been directly examined, the finding of normal [37] or enhanced [22] false recall of critical lures in amnesic patients when recall was tested immediately following exposure to a single list of converging associates is consistent with this view (for similar findings in Alzheimer's disease, see [1,48]). Future studies will be needed to directly examine the effect of delay or memory interference on false memory in amnesia.

At first sight, our findings may appear to contradict the results of several studies by Haslam and coworkers [11,12] emphasizing the preservation of memory for generalities in amnesia. Haslam and coworkers [11,12] demonstrated that with multiple presentations, several patients were able to learn the general category to which novel items belonged, despite being unable to learn more specific, detailed information. It should be pointed out, however, that even learning of general information was quite laborious, as evidenced by the fact that amnesic patients required more presentations than normal participants. These findings, therefore, merely suggest a *relative* preservation of memory for generalities in amnesia. The results of the current study do not allow us to directly compare memory for item-specific information and gist information, as it is likely that gist information might also help support veridical recognition of related list items. Relevant evidence, however, comes from a study of false memory using categorized pictures [19] that also included one-of-a-kind pictures (single-item categories). In that study, we found that although both item-specific memory and gist memory were impaired in amnesia, item-specific memory was even more impaired than was gist memory—a finding consistent with the conclusion of Haslam and coworkers.

Finally, in addition to clarifying the cognitive basis of the gist memory impairment in amnesia, our findings also provide further insight into the brain mechanisms of false memory. Our results suggest that the same medial temporal/diencephalic regions that are involved in memory for studied items are also involved in the encoding and storage of semantic gist. Melo et al. [22] hypothesized that the extraction of semantic gist depends on lateral temporal lobe structures, and possibly also on the integrity of prefrontal regions. Lateral temporal structures are important in the processing of semantic information [13,45], but were intact in all but one of our patients (patient CL). Prefrontal regions may play a role in the organization of thematic information and the creation of a focused gist representation. However, there was no evidence in the current study that impairments in gist memory were directly linked to prefrontal deficits. Therefore, it appears that the medial temporal lobes and their diencephalic afferents are also critical for the extraction and maintenance of gist information, possibly through their role in the encoding of relational and elaborative information that allows a set of associated words to be linked. Our findings, indicating a role for limbic structures in the encoding and storage of gist memory, extend previous findings emphasizing the role of the medial temporal lobes in the retrieval of false memories [7,33,37]. Furthermore, they are consistent with a general emphasis on the role of the hippocampus and related structures in relational processing and the establishment of flexible links between separately encoded items [10,14].

Acknowledgements

This research was supported by National Institute of Mental Health grant MH 57681, National Institute of Neurological Disease and Stroke grant NS 26985, and National Institute on Aging grant AG08441.

Appendix A. Instructions for the standard retrieval condition

You will be presented with a series of words. Some of these words were presented on the previous lists. Other words were not presented earlier. If you do recognize the word as one that you heard on an earlier list, please say "OLD". When you think that a word is new, meaning it was not presented on an earlier list, please say "NEW".

For example, suppose you were presented a list like "pine, maple, elm, spruce". If, on the test, you are presented with "pine" you would say "OLD". However, if you are presented with "oak", you would respond "NEW", or if presented with "computer", you would respond "NEW".

Please summarize these instructions before we begin.

Appendix B. Instructions for the meaning retrieval condition

You will be presented with a series of words. Some of these words were presented on the previous lists. Other words were not presented earlier. If you do recognize the word as an example of one of the old themes or concepts in the lists heard earlier please say "OLD". When you think that a word is not an example of one of the old themes or concepts, please say "NEW".

For example, suppose you were presented a list like "pine, maple, elm, spruce". If, on the test, you are presented with "pine", you would say "OLD", or if presented with "oak", you would say "OLD". However, if you are presented with "computer", you would respond "NEW".

For example, if the list contained the words "mug, saucer, tea, coffee" and, at test, you are presented with "tea", you would respond—(OLD). If, at test, you were presented with "cup", you would respond—(OLD). If, at test, you were presented with "radio", you would respond—(NEW).

Please summarize these instructions before we begin.

References

[1] Balota DA, Cortese MJ, Duchek JM, Adams D, Roediger III HL, McDermott KB, et al. Veridical and false memories in healthy older adults and in dementia of the Alzheimer's type. Cognitive Neuropsychology 1999;16:361–84.

[2] Brainerd CJ, Reyna VF. When things that were never experienced are easier to remember than things that were. Psychological Science 1998;9:484–9.

[3] Brainerd CJ, Reyna VF. Dual processes in memory, reasoning and cognitive neuroscience. Advances in Child Development and Behavior 2001;28:41–100.

[4] Brainerd CJ, Reyna VF. Kneer false-recognition reversal: when similarity is distinctive. Journal of Memory and Language 1995;34:157–85.

[5] Buckner RL, Koutstaal W. Functional neuroimaging studies of encoding, priming and explicit memory retrieval. Proceedings of the National Academy of Sciences 1998;95:891–8.

[6] Budson AE, Daffner KR, Desikan R, Schacter DL. When true recognition is unopposed by false recognition: gist-based memory distortion in Alzheimer's disease. Neuropsychology 2000;14:277–84.

[7] Cabeza R, Rao S, Wagner AD, Mayer A, Schacter DL. Can medial temporal lobe regions distinguish true from false memories? An event-related fMRI study of veridical and illusory recognition memory. Proceedings of the National Academy of Sciences USA 2001;98:4805–10.

[8] Cermak LS, Butters N, Gerrein J. The extent of the verbal encoding ability of Korsakoff patients. Neuropsychologia 1973;11:85–94.

[9] Deese J. Prediction of occurrence of particular verbal intrusions in immediate recall. Journal of Experimental Psychology 1959;58:17–22.

[10] Eichenbaum H, The hippocampal system and declarative memory in humans and animals: experimental analysis and historical origins. In: Schacter DL, Tulving E, editors. Memory systems 1994. Cambridge, MA: MIT press, 1994. p. 147–201.

[11] Haslam C, Coltheart M, Cook ML. Preserved category learning in amnesia. Neurocase 1997;3:337–47.

[12] Haslam C, Cook ML, McKone E. Memory for generalities: access to higher-level categorical relationships in amnesia. Cognitive Neuropsychology 1998;15:401–37.

[13] Hodges JR, Patterson K. Semantic memory disorders. Trends in Cognitive Sciences 1997;1:68–72.

[14] Johnson MK, Chalfonte BL, Binding complex memories: the role of reactivation and the hippocampus. In: Schacter DL, Tulving E, editors. Memory systems 1994. Cambridge, MA: MIT Press, 1994. p. 311–50.

[15] Johnson MK, Hashtroudi S, Lindsay DS. Source memory. Psychological Bulletin and Review 1993;114:3–28.

[16] Kitchener EG, Squire LR. Impaired verbal category learning in amnesia. Behavioral Neuroscience 2000;114:907–11.

[17] Knowlton BJ, Squire LR. The learning of categories: parallel brain systems for item memory and category knowledge. Science 1993;262:1747–9.

[18] Koutstaal W, Schacter DL, Verfaellie M, Brenner C, Jackson EM. Perceptually-based false recognition of novel objects in amnesia: effects of category size and similarity to category prototypes. Cognitive Neuropyschology 1999;16:317–41.

[19] Koutstaal W, Verfaellie M, Schacter DL. Recognizing identical versus similar categorically related common objects: further evidence for degraded gist representations in amnesia. Neuropsychology 2001;15:268–89.

[20] Kroll NEA, Knight RT, Metcalfe J, Wolf ES, Tulving E. Conjunction failure as a source of memory illusions. Journal of Memory and Language 1996;35:176–96.

[21] McDermott KB, Watson JM. The rise and fall of false recall: the impact of presentation duration. Journal of Memory and Language 2001;45:160–76.

[22] Melo B, Winocur G, Moscovitch M. False recall and false recognition: an examination of the effects of selective and combined lesions to the medial temporal lobe/diencephalon and frontal lobe structures. Cognitive Neuropyschology 1999;16:343–459.

[23] Moscovitch M, Melo B. Strategic retrieval and the frontal lobes: evidence from confabulation and amnesia. Neuropsychologia 1997;35:1017–34.

[24] Moscovitch M, Vriezen E, Gottstein J, Implicit tests of memory in patients with focal lesions or degenerative brain disorders. In: Spinnler H, Boller F, editors. Handbook of Neuropsychology. Amsterdam: Elsevier, 1993. p. 133–73.

[25] O'Connor MG, Verfaellie M, The amnesic syndrome: overview and subtypes. In: Baddeley A, Wilson B, Kopelman M, editors. Handbook of Memory Disorders. Chichester: Wiley, 2002. p. 145–66.

[26] Poldrack RA, Wagner AD, Prull MW, Desmond JE, Glover GH, Gabrieli JDE. Functional specialization for semantic and phonological processing in the left inferior prefrontal cortex. NeuroImage 1999;10:15–35.

[27] Reed JM, Squire LR, Smith E, Jonides J, Patalono A. Learning about categories that are defined by object-like stimuli in the absence of declarative memory. Behavioral Neuroscience 1999;113:411–9.

[28] Reinitz MT, Verfaellie M, Milberg WP. Memory conjunction errors in normal and amnesic subjects. Journal of Memory and Language 1996;35:286–99.

[29] Reyna VF, Brainerd CJ. Fuzzy-trace theory: an interim synthesis. Learning and Individual Differences 1995;7:1–75.

[30] Roediger HL, McDermott KB. Creating false memories: remembering words not presented. Journal of Experimental Psychology: Learning, Memory and Cognition 1995;21:803–14.

[31] Roediger HL, McDermott KB. Tricks of memory. Current Directions in Psychological Science 2000;9:123–7.

[32] Rotello CM, Recall processes in recognition memory. In: Medin DL, editor. The psychology of learning and motivation, vol. 40. New York: Academic Press, 2001. p. 183–221.

[33] Schacter DL, Buckner RL, Koutstaal W, Dale AM, Rosen BR. Late onset of anterior prefrontal activity during true and false recognition: an event-related fMRI study. NeuroImage 1997;6:259–69.

[34] Schacter DL, Cendan DL, Dodson CS, Clifford ER. Retrieval conditions and false recognition: testing the distinctiveness heuristic. Psychonomic Bulletin and Review 2001;8:827–33.

[35] Schacter DL, Chiu PCY, Ochsner KN. Implicit memory: a selective review. Annual Review of Neuroscience 1993;16:159–82.

[36] Schacter DL, Norman KA, Koutstaal W. The cognitive neuroscience of constructive memory. Annual Review of Psychology 1998;49: 289–318.

[37] Schacter DL, Reiman E, Curran T, Yun LS, Bandy D, McDermott KB, et al. Neuroanatomical correlates of veridical and illusory recognition memory: evidence from positron emission tomography. Neuron 1996;17:267–74.

[38] Schacter DL, Verfaellie M, Anes M. Illusory memories in amnesic patients: conceptual and perceptual false recognition. Neuropsychology 1997;11:331–42.

[39] Schacter DL, Verfaellie M, Anes MD, Racine C. When true recognition suppresses false recognition: evidence from amnesic patients. Journal of Cognitive Neuroscience 1998;10:668–79.

[40] Schacter DL, Verfaellie M, Koutstaal W, Memory illusions in amnesic patients: findings and implications. In: Squire LR, Schacter DL, editors. The Neuropsychology of Memory. New York: Guilford Press, 2002. p. 114–29.

[41] Schacter DL, Verfaellie M, Pradere D. The neuropsychology of memory illusions: false recall and recognition in amnesic patients. Journal of Memory and Language 1996;35:319–44.

[42] Squire LR. Comparisons between forms of amnesia: some deficits are unique to Korsakoff's syndrome. Journal of Experimental Psychology: Learning, Memory and Cognition 1982;8:560–71.

[43] Squire LR, Knowlton BJ. Learning about categories in the absence of memory. Proceedings of the National Academy of Sciences USA 1995;92:12470–4.

[44] Stadler MA, Roediger HL, McDermott KB. Norms for word lists that create false memories. Memory and Cognition 1997;27:494–500.

[45] Vandenberghe R, Dupont P, Bormans G, Mortelmans L, Orban G. Blood flow in human anterior temporal cortex decreases with stimulus familiarity. NeuroImage 1995;2:306–13.

[46] Verfaellie M, Cermak LS, Blackford S, Weiss S. Strategic and automatic priming of semantic memory in alcoholic Korsakoff patients. Brain and Cognition 1990;13:178–92.

[47] Verfaellie M, Treadwell J. Status of recognition memory in amnesia. Neuropsychology 1993;7:5–13.

[48] Watson JM, Balota DA, Sergent-Marshall SD. Semantic, phonological, and hybrid veridical and false memories in healthy older adults and in individuals with dementia of the Alzheimer's type. Neuropsychology 2001;15:254–67.

[49] Yonelinas AP, Kroll NEA, Dobbins I, Lazzara M, Knight RT. Recollection and familiarity deficits in amnesia: convergence of remember-know, process dissociation, and receiver operating characteristic data. Neuropsychology 1998;12:323–39.