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Recognizing Identical Versus Similar Categorically Related Common Objects: Further Evidence for Degraded Gist Representations in Amnesia

Wilma Koutstaal
Harvard University

Mieke Verfaellie
Veterans Affairs Medical Center, Boston, Massachusetts, and Boston University School of Medicine

Daniel L. Schacter
Harvard University

Studies have shown lower false recognition of semantically related lure words in patients with global amnesia than in matched controls. This pattern has been interpreted as suggesting that medial temporal and diencephalic structures that are damaged in amnesia and that contribute to veridical memory also contribute to false recognition. It has been argued that whereas controls form and retain a well-organized representation of the semantic gist of studied items, patients with amnesia can retain only a degraded gist representation. However, these studies are subject to an alternative interpretation involving greater source confusions in controls. The authors used a categorized-pictures paradigm to test recognition under conditions in which source confusions were unlikely to occur. Relative to controls, patients with amnesia showed reduced false recognition of categorically related pictorial lures, thereby supporting the notion of degraded gist representations in amnesia.

Although neuropsychological investigations of memory distortions have long focused on unusual or bizarre forms of errors, such as confabulations, that are only relatively rarely observed in individuals with intact cognitive and brain function, several recent investigations have adopted a different approach—exploring the memory performance of patients with brain damage in relation to more mundane forms of memory distortion that are also commonly found in healthy individuals with no known cognitive or neuropsychological impairments (for reviews, see Kopelman, 1999; Schacter, 1995; Schacter, Norman, & Koutstaal, 1998). Perhaps most prominent among these more common forms of errors are the phenomena of *false recall*—occurring when new (nonstudied) items that are conceptually or perceptually similar to studied items are mistakenly intruded or produced during attempted recall—and *false recognition*—occurring when new items that are in some way similar to studied items are mistakenly identified as having been previously encountered during episodic recognition testing (for reviews, see Estes, 1997; Roediger, 1996; Schacter, Norman, & Koutstaal, 1998). These investigations have used the combined information from measures of memory for the studied items (targets) and false recall or recognition of nonstudied items (intrusions or lures) in patients versus matched controls to attempt to elucidate the nature of the memory representations and processes supporting performance in patient groups such as those with Alzheimer's disease (e.g., Balota et al., 1999; Budson, Daffner, Desikan, & Schacter, 2000; Budson, Desikan, Daffner, & Schacter, 2001) or frontal lobe damage (e.g., Curran, Schacter, Norman, & Galluccio, 1997; Delbecq-Derouesné, Beauvois, & Shallice, 1990; Parkin, Bindschaedler, Harsent, & Metzler, 1996; Schacter, Curran, Galluccio, Milberg, & Bates, 1996).

A number of recent investigations have focused on the false recognition performance of individuals with global amnesia: persons who, as a result of damage to medial temporal regions, the diencephalon, or both, show marked impairment in the ability to retain information about recently experienced facts and events, despite performance within the normal range on tests of perception, language, and intelligence (Parkin & Leng, 1993; Squire, 1994). These studies have demonstrated that under conditions in which participants with intact memory show high levels of false recognition, the level of false recognition in patients with amnesia is reduced (Koutstaal, Schacter, Verfaellie, Brenner, & Jackson, 1999; Melo, Winocur, & Moscovitch, 1999; Schacter, Verfaellie, & Anes, 1997; Schacter, Verfaellie, Anes, & Racine, 1998; Schacter, Verfaellie, & Pradere, 1996). This pattern of reduced false recognition (fewer

Wilma Koutstaal and Daniel L. Schacter, Department of Psychology, Harvard University; Mieke Verfaellie, Psychology Research, Veterans Affairs Medical Center, Boston, Massachusetts, and Memory Disorders Research Center, Boston University School of Medicine.

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Correspondence concerning this article should be addressed to Wilma Koutstaal, who is now at the Department of Psychology, University of Reading, Earley Gate, Reading RG6 6AL, United Kingdom. Electronic mail may be sent to w.koutstaal@reading.ac.uk.

false-positive errors) in patients with amnesia relative to controls has been interpreted as suggesting that the medial temporal and diencephalic structures that are damaged in amnesia and that are responsible for impairments in veridical memory performance (for target items) in patients with amnesia also are involved in the storing and/or retrieval of the semantic or perceptual information that drives false recognition (for related lure items) in matched controls (e.g., Schacter, Verfaellie, et al., 1998).

Most (although not all) of the evidence for reduced false recognition in patients with amnesia derives from studies using a verbal converging semantic-associates paradigm that was initially developed by Deese (1959) and recently extended by Roediger and McDermott (1995). In this paradigm, participants are presented with a series of words, such as *candy*, *sour*, *sugar*, *bitter*, and *taste*, each of which is associatively related to a particular theme word or "critical lure" (e.g., *sweet*) that is never presented. A highly reliable finding from this paradigm is that normal participants, with intact memory and brain function, later often falsely claim to remember the critical lure items, frequently incorrectly producing these items during free-recall testing and also mistakenly claiming to recognize or "remember" the lures (often with high confidence) on an old–new recognition test (e.g., Payne, Elie, Blackwell, & Neuschatz, 1996; Read, 1996; Roediger & McDermott, 1995).

Schacter, Verfaellie, and Pradere (1996) found that patients with amnesia who were exposed to word-associate lists of this form and asked to remember them showed—as expected—fewer hits than did matched control participants. However, relative to matched controls, patients with amnesia also showed reduced false recognition of the semantically related critical lure items. Largely similar findings of reduced false recognition of semantically related lures in patients with amnesia compared with controls have been obtained in additional studies (see the results for the first trial reported in Schacter, Verfaellie, et al., 1998; also see Melo et al., 1999; Schacter et al., 1997, Experiment 1). By contrast, for new items that were semantically *unrelated* to the presented items, patients with amnesia tended to show somewhat higher levels of false alarms than did controls (i.e., patients with amnesia showed somewhat elevated baseline false alarms). In a similar manner, an early study using a continuous recognition format, but in which lure items were related to only one of the study items (Cermak, Butters, & Gerrein, 1973), likewise showed higher false alarms among patients with amnesia (patients with Korsakoff's syndrome) than controls.

One plausible account of these findings, proposed by Schacter, Verfaellie, and Pradere (1996), involves an appeal to group differences in the retention, integration, and/or retrieval of the semantic or conceptual gist of the studied items (cf. Brainerd, Reyna, & Kneer, 1995; Brainerd, Reyna, & Mojardin, 1999; Reyna & Brainerd, 1995). If the control participants formed and retained a strong and well-organized representation of each set of associated words, then this could make rejecting the semantically related lures quite difficult: Such related lures are highly consistent with the remembered studied items, share many semantic features with those items, and are likely to invoke a strong sense of familiarity or recollection (yielding high levels of false recognition for related lures in controls). By contrast, if patients with amnesia were able to form and retain only a relatively degraded or poor representation of the conceptual and semantic gist of the lists, this might make mistaken recognition of semantically related lures relatively less likely. Differences in gist retention or retrieval might also explain the converse pattern for the unrelated items: Whereas strong and well-integrated gist representations among control participants might facilitate rejection of unrelated new items because those unrelated items seem to be incongruent with the studied items (yielding low baseline levels of false alarms in controls), weak or degraded gist representations among patients with amnesia could make rejection of completely unrelated lures more difficult because those unrelated items would not be as clearly incongruent with what was remembered of the study list (yielding increased false alarms to baseline items in patients with amnesia).

However, there is an alternative account of these findings, emphasizing source confusion errors (Johnson, Hashtroudi, & Lindsay, 1993), that also has considerable support from the experimental literature. According to this account, it is possible that individuals themselves may spontaneously generate or think of the lure word during the study phase: Hearing *candy*, *sour*, *sugar*, and so on may lead one to consciously think of the critical lure word, *sweet*. If so, participants may later experience considerable difficulty in distinguishing those items that were actually presented during the study phase from those that they themselves happened to generate in response to the presented items. Several researchers have emphasized that, in addition to reflecting errors due to gist-like processing, false recognition and recall errors in the converging semantic-associates paradigm may arise from such "implicit associative responses"[1] (Bousfield et al., 1958; Deese, 1959; Hall & Kozloff, 1970;

[1] The term *implicit associative responses* was used to refer to the possibility that when a word is presented for learning, words that are associatively related to the presented word might be elicited as implicit responses. These responses were thought to be "encoded and stored along with the word to be learned" and thus influenced the "perceived situational frequency" of a word (Hall & Kozloff, 1970, p. 272; also cf. Ekstrand, Wallace, & Underwood, 1966). The extent to which such implicit associative responses were necessarily thought to be consciously experienced as associates at the time of study is not always clear; however, several factors suggest that *implicit* was a term used simply in opposition to overt or behaviorally manifested responses (rather than to designate processes that occurred outside of awareness). For example, Underwood (1965) differentiated between "two kinds of implicit responses made to a verbal unit," one of which was "the response made to the unit itself as the act of perceiving it" (p. 122; termed the "representational response" by Bousfield, Whitmarsh, and Danick, 1958, and presumably experienced consciously) versus the implicit associative response, which was thought to be "produced by the stimulus properties of the RR [representational response]" and which could be "another word which is associated with the actual word presented" (Underwood, 1965, p. 122).

Underwood, 1965), which may then lead to source confusion errors (cf. Gallo, Roberts, & Seamon, 1997; McDermott, 1997; McDermott & Roediger, 1998; Read, 1996; Roediger & McDermott, 1995).

It is critical that if false recognition in this paradigm is partially driven by confusions of responses that were spontaneously generated during study with actually presented items, higher levels of false recognition in controls than in patients with amnesia may reflect a greater likelihood of such source confusions among control participants. Indeed, to the extent that patients with amnesia remember less overall, and also remember the lures less well, they may also be less likely to confuse the origins of information (and so show reduced levels of false recognition). From this perspective, rather than arising from the degraded storage or retrieval of gist or general similarity information, reduced false recognition by patients with amnesia in the converging semantic-associates paradigm might be seen as (at least in part) deriving from an impairment in recollective or source memory—with false recognition errors that depend on the misassignment of the source of the "remembered" items less likely to occur for patients with amnesia than for controls.[2]

By contrast, a possible contribution of source confusions appears to be much less likely in another paradigm that has shown decreased false recognition in patients with amnesia. The paradigm involves perceptually similar, novel abstract patterns (objects)—complex, multifeatured shapes constructed from different prototype forms (Koutstaal, Schacter, Verfaellie, et al., 1999); this experiment also involved a manipulation of transformational distance (the degree of perceptual similarity between the items and prototypes of the categories) and category size (the number of related items presented at study). In this study, false recognition was numerically depressed among patients with amnesia for the categories in which numerous similar items were presented and significantly reduced for the prototypes. This finding supports the notion that, indeed, retention and/or retrieval of general similarity information is impaired in patients with amnesia. However, here the lures and studied items shared only, or primarily, perceptual similarity. Thus, no study has yet determined whether patients with amnesia show decreased false recognition for materials that share conceptual similarity (or both conceptual and perceptual similarity) under circumstances in which the possible contribution of source confusions of the form described earlier is minimized. One purpose of the present research was to examine this question.

In the research reported here, we used a categorized-pictures paradigm that was developed to examine the influence of general similarity or gist-based responding on memory, under conditions in which errors are unlikely to derive from source confusions (Koutstaal & Schacter, 1997; Koutstaal, Schacter, Galluccio, & Stofer, 1999). In this approach, participants are shown detailed colored pictures of common objects, such as teapots, teddy bears, or cats, with some of the categories including many different exemplars (e.g., 9 or 18 different teapots) and other categories including relatively fewer exemplars (e.g., only 1 teapot). Later, participants are given an old–new recognition test for the studied items, together with categorically related lures (e.g., new or nonstudied exemplars of teapots) and novel items (items that are unrelated to the studied categories). Because the lure items are detailed pictures that were never previously presented, and thus are unlikely to be spontaneously imagined or otherwise generated by participants during the study phase, false recognition in this paradigm provides a cleaner measure of general similarity or gist-based false recognition—that is, mistaken identifications of items as having been previously encountered that derive from the general conceptual and perceptual similarity of the studied items and the lure items. Thus, this approach allows assessment of the levels of gist-based false recognition in patients with amnesia and controls, under conditions in which both conceptual and perceptual similarity could contribute to false recognition.

The inclusion of a manipulation of category size (with some categories represented by many exemplars and others by fewer items at study) also allows for examination of the levels of false recognition in patients with amnesia and controls under conditions that should provide varying levels of opportunity for the development of conceptual and/or perceptual gist. Robust effects of category size have been found in several previous studies of false recognition in individuals with intact memory functioning, with higher rates of false recognition found following the presentation of increasing numbers of semantically related words (e.g., Arndt & Hirshman, 1998; Robinson & Roediger, 1997; Shiffrin, Huber, & Marinelli, 1995) and abstract patterns (e.g., Homa, Cross, Cornell, Goldman, & Schwartz, 1973; Omohundro, 1981). It is important that, in studies of older and younger adults, consistent and pronounced effects of category size on false recognition have been found for the categorized pictures of common objects stimuli used here (Koutstaal & Schacter, 1997; Koutstaal, Schacter, & Bren-

Underwood (1965) further seemed to underscore that the key distinction was between responses that were overt (behaviorally manifested) and responses that were covert (mentally manifested) in emphasizing that the implicit associative response,

> in most theoretical formulations, is conceived of as actually occurring. This is to say, it is not a hypothetical construct. It is hypothetical only in the sense that it is assumed to occur in a particular situation where it cannot be observed directly, and this assumption is made because it *has* been observed to occur overtly with a certain frequency in other situations (e.g., word-association procedures). (p. 122)

[2] Note that these considerations do not rule out the possibility that other factors might also contribute to false memory in this paradigm, including processes (e.g., automatic associative priming, which does not lead to conscious awareness of the associated items) that may operate in a largely similar manner in patients with amnesia and controls (see Balota et al., 1999; Seamon, Luo, & Gallo, 1998, for discussions). The important point that there may be a differential contribution of source confusions to false recognition responding in controls does not depend on this being the only operative factor contributing to false recognition in this paradigm.

ner, 2001; Koutstaal, Schacter, Galluccio, & Stofer, 1999). The question therefore arises as to how category size affects false recognition in amnesia. When the effects of category size on false recognition were examined among patients with amnesia and controls for the perceptually similar abstract objects stimuli described earlier (Koutstaal, Schacter, Verfaellie, et al., 1999), although a reliable overall effect of category size was found, the interaction of group (amnesic vs. control) with category size (many vs. few exemplars) was not significant. Although, relative to controls, patients with amnesia tended to show a somewhat more pronounced reduction in false recognition for many-exemplar categories composed of 6 or 9 related items (patients with amnesia = .17, controls = .26) than fewer-exemplar categories composed of 1 or 3 related items (patients with amnesia = .08, controls = .06), the reduction in false recognition for the many-exemplar category items was not reliable.

On the basis of the "degraded gist" account of Schacter, Verfaellie, and Pradere (1996), we expected that, in the present experiment, patients with amnesia should show lower rates of false recognition than controls for the large or many-exemplar categories (9 or 18 items)—categories for which control participants should build up a strong and robust representation of gist. However, for items that do not belong to salient perceptual or conceptual study categories (i.e., for items for which no categorically similar items are studied, as for novel items), either patients with amnesia and controls should not differ or patients with amnesia should show elevated false recognition. The expectation for single-item lures (i.e., new items that are conceptually and perceptually similar to only 1 studied item) was unclear. On the basis of the earlier findings of Cermak et al. (1973), it might be anticipated that patients with amnesia would show significantly greater false recognition than controls for these items; yet, this pattern was not found for items that were perceptually similar to only 1 of the presented items in the novel abstract objects experiment of Koutstaal, Schacter, Verfaellie, et al. (1999), in which patients with amnesia and controls showed similar rates of false recognition for such "single" exemplar-related lures.

Experiment 1

Method

Participants

Sixteen patients with amnesia (11 male, 5 female) and 16 individuals with intact memory functioning (12 male, 4 female) took part in the main experiment. Both patients with amnesia and their controls were screened at the Memory Disorders Research Center at the Veterans Affairs Medical Center in Boston, Massachusetts. A subgroup of 8 patients with amnesia had mixed etiology (anoxia and encephalitis), and 8 had a diagnosis of alcoholic Korsakoff's syndrome. Each subgroup of patients was matched to a corresponding control group on the basis of age, education, and verbal IQ (Wechsler Adult Intelligence Scale—Revised; Wechsler, 1981); the patients with alcoholic Korsakoff's syndrome were matched to individuals with a history of alcoholism, whereas patients with mixed-etiology amnesia were matched to controls with no history of alcoholism. Table 1 presents the characteristics of the individual patients with amnesia, including their performance on the Wechsler Memory Scale—Revised (Wechsler, 1987). The controls for the subgroup with mixed-etiology amnesia had a mean age of 55.3 years, with an average of 13.9 years of education and an average verbal IQ of 106.5. Controls with a history of alcoholism had a mean age of 63.5 years, an average

Table 1
Characteristics of Patients With Amnesia in Experiment 1

					WMS–R		
Patient	Etiology	Age (years)	Education (years)	Verbal IQ	General memory	Delay	Attention
A.B.	Anoxia	59	16	105	76	51	92
D.F.	Anoxia	48	16	111	81	69	107
S.S.	Encephalitis	71	18	126	102	50	114
P.D.	Anoxia	61	20	109	65	61	89
R.L.	Anoxia	69	18	103	68	66	93
P.S.	Anoxia	40	14	95	90	50	115
J.M.	Anoxia	49	12	89	70	52	92
C.C.	Anoxia	40	12	104	88	71	108
M		54.6	15.8	105.3	80.0	58.8	101.3
R.D.	Korsakoff	68	12	83	66	50	99
W.R.	Korsakoff	70	7	88	76	53	96
J.G.	Korsakoff	82	12	108	67	54	104
P.B.	Korsakoff	72	14	87	82	60	93
R.M.	Korsakoff	78	14	111	91	68	95
R.G.	Korsakoff	80	9	94	61	66	104
W.K.	Korsakoff	57	16	94	59	57	93
W.S.	Korsakoff	53	12	91	76	58	95
M		70.0	12.0	94.5	72.3	58.3	97.4

Note. Verbal IQ was measured with the Wechsler Adult Intelligence Scale—Revised. The Wechsler Memory Scale—Revised (WMS–R) does not provide scores below 50, and 50 was the lowest score used to compute means. Korsakoff = Korsakoff's syndrome.

of 13.0 years of education, and an average verbal IQ of 103.4. In addition, for comparison purposes, a group of 16 younger controls (undergraduates or summer school participants at Harvard University) was also included.

Experimental Design

The experimental design included a between-subjects variable of group (mixed-etiology amnesic, Korsakoff amnesic, normal control, alcoholic control, or young control) and a within-subjects variable of category size. However, because analyses for the two subgroups with amnesia yielded very similar patterns of performance (see the *Results* section below), the subgroups and their corresponding controls were combined, yielding three groups: patients with amnesia, controls, and young controls. For studied items, category size had three levels, with 1, 9, or 18 category exemplars presented during the study phase; for nonstudied items, category size had four levels, with 0, 1, 9, or 18 related items presented at study. (False alarms to the condition with 0 related items presented at study provided a baseline measure of false recognition. False alarms to these items are referred to as "novel" false alarms because they entailed false alarms to categories that were novel at the time of test.) In addition, miscellaneous unrelated items were also included (see description in the *Stimuli* section).

Stimuli

The stimuli were identical to those used in an earlier experiment (Koutstaal & Schacter, 1997, Experiment 3) and consisted of detailed colored pictures of individual objects (or, in a few cases, coherent groupings of objects), without background, taken from various illustrated books for children and adults. All pictures were initially mounted on white index cards and then scanned and converted to digital format using VistaScan (UMAX Technologies, Inc., Fremont, CA) and a UMAX Vista-S6E scanner (UMAX Technologies, Inc.). At both study and test, the pictures were displayed in the center of a color computer monitor, using a powerbook computer, 256-color lookup table, and PsyScope experimental software (Cohen, MacWhinney, Flatt, & Provost, 1993).

The pictures portrayed objects from 20 different object categories, with each category composed of a total of 21 different exemplars (21 cars, 21 children, etc.). In addition, there were 30 pictures of unrelated objects (e.g., a painted wine jar and a unicycle) and additional categorized objects that were used as filler items (see below).

The 20 categories were first assigned to four equal sets of 5 categories each (P, Q, R, and S), for example, Set P, composed of cars, cats, children, clocks, and flowers, or Set Q, composed of birds, shelves, teapots, teddy bears, and whales. These four sets were then rotated through the four experimental conditions such that each set equally often served as nonstudied or novel items (presented only at test) or served as a study category composed of 1, 9, or 18 related items. When a given category served as a large (18-exemplar) category, all but 3 of the items were presented at study—the remaining 3 items were reserved to be presented during the recognition test as new but related items; likewise, when a given category served as a medium (9-exemplar) or single (1-exemplar) category, only a subset of the total pool of items from that category was presented at study. In the latter cases, the particular items that were excluded were determined randomly, with the same items always excluded whenever a category composed a 9-exemplar or 1-exemplar category.

As in previous experiments (e.g., Koutstaal & Schacter, 1997), to avoid confounding the number of items per category that were presented at study with the number of items per category that were presented at test, each studied category (with one exception, noted below) was tested an equal number of times: three times with a studied item and three times with a lure item. This aim was accomplished by selecting a subset of items from each category, which always served as the critical study and test items. For each category, 6 items were initially randomly selected to serve as the critical target and lure items. These items were then assigned to two subsets (Subsets A and B) and were rotated through the study and test lists such that each subset equally often served as targets and lures for the studied categories or as novel items for the nonstudied categories. The novel categories were also tested three times.

The one exception concerned single-item categories. These categories were tested twice: once with the single presented study item (the target) and once with a related lure. For these purposes, 1 item from each of the two subsets (designated as A1 and B1) was randomly selected and rotated across the study–test conditions in the same manner as the 3-item sets.

Each study list consisted of a total of 215 items, including 140 critical items (5 single, 45 medium, and 90 large category exemplars), 54 filler items (two 9-item and two 18-item categories), 6 buffer items, and 15 unrelated items. Each test list consisted of a total of 115 items, including 85 critical items, 15 studied unrelated items, and 15 unrelated new items. (The filler items were included to increase the variety and length of the study lists so as to maintain acceptable levels of recognition and also to match conditions of the earlier experiments; these items were not scored.)

Procedure

The experimental procedure involved two main phases: a study phase and a test phase, separated by a retention interval of 20–30 min. All participants were tested individually, either in their home or at the Memory Disorders Research Center at the Veterans Affairs Medical Center in Boston.

In the study phase, participants were presented the pictures, one at a time, and were asked to rate their liking for each item. The pictures from different object categories were randomly intermixed (i.e., not blocked by category), and the encoding task was incidental—no mention was made of a subsequent memory test. Each picture was presented for 2 s in the center of the computer monitor and was followed by a prompt, requesting participants to provide their liking rating (*do not like*, *neutral*, or *like*). Participants had 4 s to give their liking ratings, which they stated orally and which were then entered by the experimenter. Following presentation of the last picture, participants performed an unrelated task for 20–30 min.

In the test phase, participants were given an old–new recognition test composed of a subset of the pictures from the liking rating task, together with new (nonstudied) pictures. In the recognition test, participants indicated whether each item was "old" (previously presented during the liking encoding task) or "new" (not previously presented during the experiment) and then rated their confidence in their recognition judgment on a 3-point scale (1 = *just guessing*, 2 = *moderately sure*, and 3 = *very sure*). The recognition test was self-paced.

Results

We first performed separate analyses on the two subgroups with amnesia and their respective controls, but because these subgroups showed very similar patterns, we combined the subgroups.[3] However, for the sake of completeness of reporting, the corrected recognition data for the two subgroups with amnesia and their controls are presented separately in Table 2. Outcomes for the young normal control group are included in the figures and tables but were analyzed separately rather than with the other groups. Performance for the unrelated items is also included in the figures, but results for these items were also analyzed separately. Finally, results considering confidence judgments of patients with amnesia and their controls, particularly recognition judgments accompanied by *very sure* responses, corrected for baseline false alarms also made as *very sure* responses, are briefly presented in the Appendix.

Figure 1 presents the proportion of veridical and false recognition responses separately as a function of group (amnesic, control, or young control) and category size (0, 1, 9, or 18 related exemplars presented at study). As one can see in Figure 1, the group with amnesia showed—as we expected—impaired veridical recognition relative to their controls; this impairment was apparent regardless of category size (single, medium, or large) but was somewhat more pronounced for the single items (and the unrelated items) than for the many-exemplar categories. Also—and in contrast to the outcomes observed in earlier studies using the converging semantic-associates paradigm—for these raw (uncorrected) scores, Figure 1 shows quite similar levels of illusory recognition for patients with amnesia and their controls, particularly for the large categories; patients with amnesia showed somewhat less false recognition than controls for the medium categories, but (consistent with earlier studies discussed in the introduction) this pattern was slightly reversed for the novel items, for which patients with amnesia showed slightly higher baseline rates of false alarms than controls. (The trend toward higher false alarms to novel category items for patients with amnesia [$M = .20$] than for controls [$M = .11$] yielded $F[1, 30] = 1.78$, $MSE = .03$, $p = .19$.) Figure 2 presents veridical and false recognition results after we corrected for these differences in the level of novel false alarms.

Novel-Corrected Veridical Recognition

We first considered veridical recognition for the categorized items (excluding unrelated items) after correction for differences in novel false alarms (referred to as "novel-corrected"). A 2 (group) × 3 (category size: single, medium, or large) mixed-factor analysis of variance (ANOVA), treating group as a between-subjects variable and category size as a within-subjects variable, showed an (expected) main effect of group, $F(1, 30) = 26.95$, $MSE = .14$, $p < .0001$; a main effect of category size, $F(2, 60) = 18.39$, $MSE = .02$, $p < .0001$; and a trend toward a Group × Category Size interaction, $F(2, 60) = 2.50$, $MSE = .02$, $p = .09$. This trend toward an interaction of group with category size arose because patients with amnesia showed somewhat greater recognition impairment for the one-of-a-kind single items (control – amnesic difference of .49) than for the many-exemplar categories (control – amnesic difference of .38 and .32 for medium and large categories, respectively).

A separate one-way analysis on novel-corrected veridical recognition for the young control participants showed a significant effect of category size, $F(2, 30) = 17.57$, $MSE = .004$, $p < .0001$. Pairwise comparisons showed no difference between the large and medium categories (.81 vs. .78, respectively; $F < 1.5$) but a highly significant elevation in novel-corrected veridical recognition for the single items (.91) relative to the large and medium categories (smallest $F = 24.91$).

Separate consideration of veridical recognition for the unrelated items, after correction for false alarms to the unrelated lures ("unrelated-corrected"), showed a pattern similar to that for the single items, with the group with amnesia impaired relative to their controls (patients with amnesia = .28, controls = .62), $F(1, 30) = 13.00$, $MSE = .07$, $p = .001$. The highest level of recognition for unrelated items was shown by young controls (.81).

Novel-Corrected False Recognition

Turning next to novel-corrected false recognition, a 2 (group) × 3 (category size) mixed-factor ANOVA showed only a main effect of category size, $F(2, 60) = 59.25$, $MSE = .02$, $p < .0001$ (reflecting higher false recognition rates for many-exemplar than one-of-a-kind related lures); a trend toward an effect of group, $F(1, 30) = 3.43$, $MSE = .10$, $p = .07$; and no Group × Category Size interaction ($F < 1.3$). However, because this comparison included false recognition for single items (for which the amnesic and control groups showed roughly similar performance), we also performed an analysis including only the many-exemplar (medium and large) categories. This more focused analysis, excluding the single items, likewise yielded an effect of category size, $F(1, 30) = 19.60$, $MSE = .009$, $p = .0001$, but here again, there was only a trend toward an effect of group, such that control participants showed modestly higher levels of novel-corrected false recognition ($M = .37$) than patients with amnesia ($M = .23$), $F(1, 30) = 3.42$, $MSE = .096$, $p = .07$. There was, again, no Group × Category Size interaction ($F = 1.83$). Likewise, an analysis averaging the medium and large categories, and then contrasting novel-corrected false recognition of these categories with that for single items, showed no Group × Category Size interaction; the difference between many- and one-exemplar categories was 28% for patients with amnesia and 36% for controls ($F = 1.13$ for the interaction).

[3] Analyses of the raw and novel-corrected true and false recognition measures, including the two subgroups with amnesia and their controls, showed no interactions, with only one exception. The exception was a Subgroup × Category Size interaction for raw and novel-corrected true recognition, reflecting a greater decrease in recognition for one-of-a-kind items for controls with alcoholism than normal controls. This interaction disappeared after the single items were excluded.

Table 2
Novel-Corrected True and False Recognition for Subgroups in Experiment 1

Group	True recognition				False recognition				
	Single (1)	Medium (9)	Large (18)	*M*	Single (1)	Medium (9)	Large (18)	*M*	Novel (0)
Amnesic									
Korsakoff	.13	.30	.42	.28	−.04	.22	.38	.18	.17
Mixed etiology	.07	.31	.42	.26	−.06	.11	.22	.09	.23
Control									
Alcoholic	.43	.68	.73	.62	.03	.33	.41	.26	.09
Normal	.74	.68	.73	.72	−.008	.35	.41	.25	.13
Young	.91	.78	.81	.83	−.004	.15	.20	.12	.03

Note. Numbers in parentheses indicate the number of category exemplars presented during the study phase. Korsakoff = Korsakoff's syndrome.

A separate one-way analysis on novel-corrected false recognition for the young controls showed an effect of category size, $F(2, 30) = 17.69$, $MSE = .01$, $p < .0001$. Pairwise comparisons showed similar levels of false recognition for the medium and large categories (.15 and .20, respectively; $F = 1.99$), together with markedly lower novel-corrected false recognition for the single items ($M = -.004$; smallest $F = 23.39$ for the pairwise comparisons against the medium and large categories).

Discussion

This experiment provided some—albeit relatively weak—evidence for impaired gist memory in patients with amnesia. Relative to controls, patients with amnesia showed a trend toward reduced false recognition for the many-exemplar lures, with novel-corrected false recognition for the medium and large categories falling some 14% behind that of controls.

Considering the effects of category size on false recognition, as we expected, both patients with amnesia and control participants showed increasing false recognition with increased category size. However, relative to controls, patients with amnesia did not show a particularly pronounced drop-off in false recognition for the many-exemplar (9- and 18-item) categories: The increment in novel-corrected false recognition from single- to many-exemplar categories for patients with amnesia was 28% compared with 36% for controls. This latter finding of a largely similar influence of category size on both groups is consistent with earlier findings obtained using perceptually similar abstract objects (Koutstaal, Schacter, Verfaellie, et al., 1999) for which participants had no preexisting conceptual or perceptual knowledge. For abstract objects, a comparison of category sizes of relatively few (1 or 3) versus relatively more (6 or 9) related exemplars indicated that patients with amnesia and controls showed similar effects of category size (with only a slight numerical attenuation in patients with amnesia). This finding led Koutstaal, Schacter, Verfaellie, et al. (1999) to propose that the processes of extracting and/or retaining gist information regarding the studied items in amnesia were less efficient than, but nonetheless similar to, those of individuals with intact memory. (Possible similarities and differences in factors supporting gist extraction under these different procedures are considered in the General Discussion section.)

A factor that may have contributed to the relatively weak evidence of gist memory impairment in the group with amnesia involves the possible countervailing effects of detailed or item-specific memory for the studied items in the control participants. During recognition testing, for any particular categorically or thematically related lure item, it may happen that participants are aware of the thematically or categorically related nature of the lure item but—in the face of specific, detailed memory for the study items—nonetheless realize that the item is new, and so they correctly reject the lure. That is, detailed memory for the actually studied items may allow correct rejection of related lures, even though the relatedness of the lure to studied items is fully identified by the participant. For example, evidence from experimental manipulations designed to increase the extraction and retention of item-specific information for the studied items in the converging semantic-associates paradigm, such as presenting the study items repeatedly rather than only once (Kensinger & Schacter, 1999; McDermott, 1996) or accompanying studied words with black-and-white line drawings (Israel & Schacter, 1997; Schacter, Israel, & Racine, 1999), demonstrates that increases in the specificity of memory for the studied items may lead to decreases in the incorrect endorsement of lures.

The question of how these two factors might relate to the recognition performance of patients with amnesia compared with controls is important in the present study because an outcome showing equivalent false recognition responding in patients with amnesia and controls need not indicate that patients with amnesia have intact or unimpaired gist retention. Equivalent (or even higher) levels of false recognition among patients with amnesia than controls might be observed even if controls extracted and retained greater levels of gist information than patients with amnesia, but the control participants (unlike the patients with amnesia) used detailed item-specific memory to suppress positive recognition responses to categorically related lures.

Several considerations—both from prior studies and from further analyses of the outcomes of the present exper-

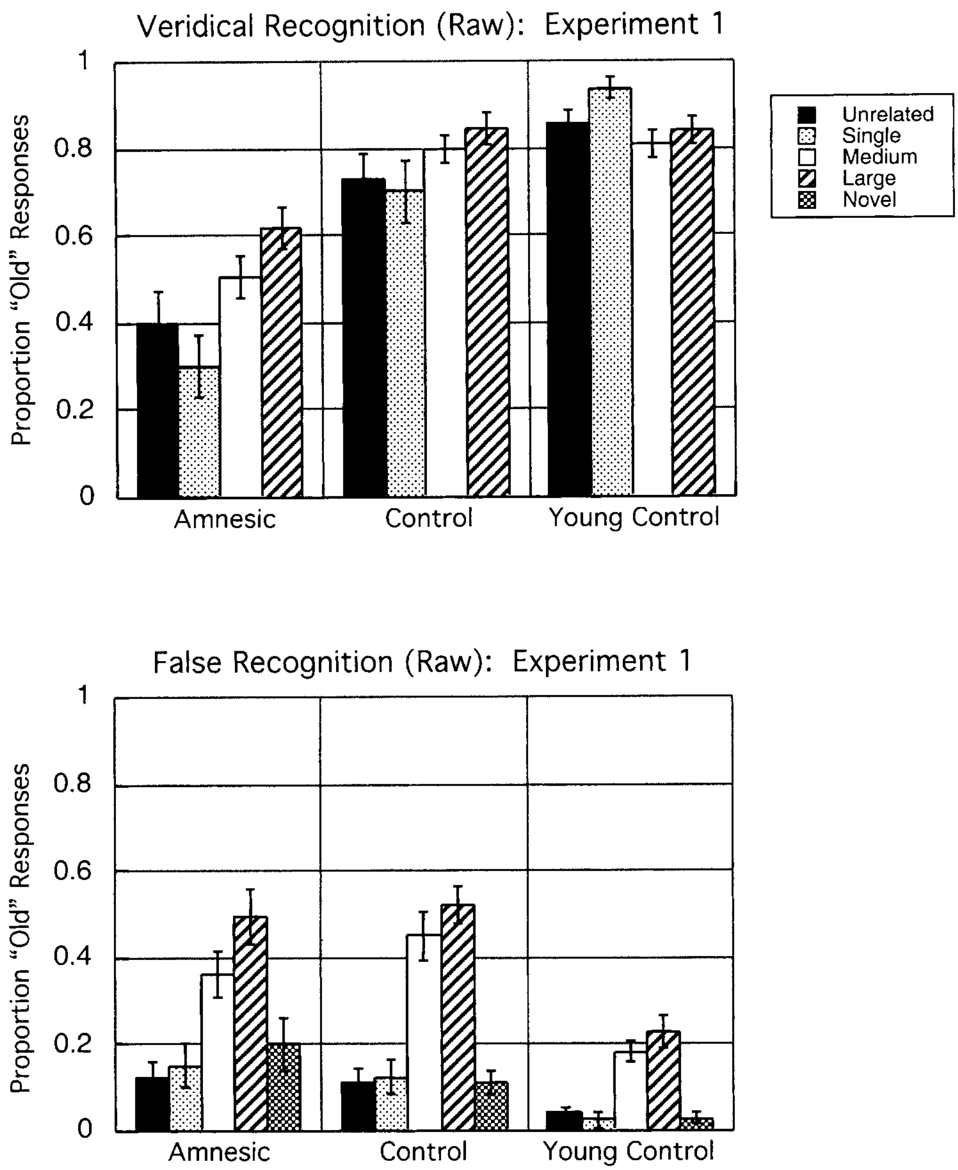

Figure 1. Mean proportion of old responses in Experiment 1 for studied items (veridical recognition) and nonstudied items (false recognition) as a function of category size and group. Category size, or the number of categorically related items presented during study, was 0 (unrelated items and novel items), 1 (single), 9 (medium), or 18 (large). Responses to the novel items represent the baseline false-alarm rate. Error bars represent standard errors of the means.

iment—suggest that this could be a real factor at play under the present experimental conditions. First, the nature of the materials (detailed colored pictures) clearly provides the opportunity for rich item-specific memory. Previous experiments with older and younger adults have shown that—at least for younger adults—although false recognition for related lures clearly does occur, particularly when many related exemplars are presented, illusory recognition rates do not approach the levels of veridical recognition. Although this difference in veridical versus false recognition is less marked for older adults, who show notably higher levels of false recognition and whose age is more similar to that of the patients with amnesia and their controls tested here, some suppression of false recognition might still occur for relatively older control participants.

Second, evidence consistent with the possibility that—given high levels of item-specific memory—control participants might show lower levels of gist-based responding than patients with amnesia has been provided by Schacter, Verfaellie, et al. (1998). Using a procedure involving repeated study presentations followed by repeated recognition tests of the study lists (i.e., study–test, study–test, for a total

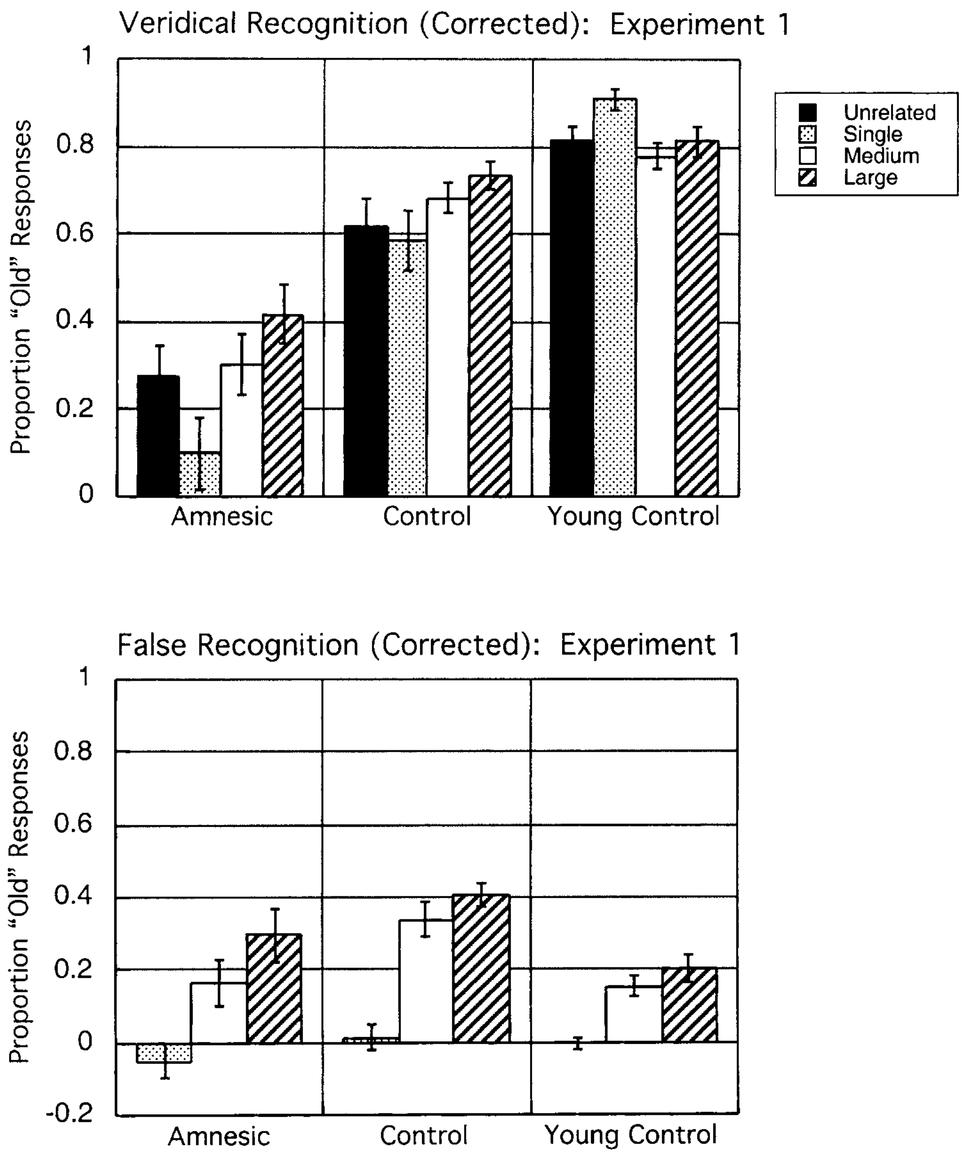

Figure 2. Mean proportion of old responses in Experiment 1 for studied items (veridical recognition) and nonstudied items (false recognition) as a function of category size and group, after correction for the baseline false-alarm rate. Category size, or the number of categorically related items presented during study, was 0 (unrelated items), 1 (single), 9 (medium), or 18 (large). Error bars represent standard errors of the means.

of five trials), these researchers demonstrated a "crossover" pattern in the level of false recognition of controls versus patients with amnesia. Whereas, on the first study–test trial, control participants showed numerically higher false recognition than patients with amnesia, this pattern changed across the five study–test trials such that, across trials, control participants showed linearly decreasing false recognition rates and patients with amnesia showed either linearly increasing false recognition (patients with amnesia due to Korsakoff's syndrome) or a fluctuating pattern (patients with amnesia of mixed etiology). By contrast, veridical recognition increased across trials for all groups. Although various accounts of these results are possible (see Schacter, Verfaellie, et al., 1998, for a discussion), one possibility is that, on the later trials, control participants used their increased item-specific memory (shown in increased veridical recognition) to more effectively counteract gist-based responding.

Third, and most important, further analyses of the outcomes of the present experiment, directly comparing the levels of veridical and false recognition in patients with amnesia and controls, yielded outcomes that are in line with this interpretation. If control participants were using item-specific memory to suppress false recognition responses, they should have demonstrated higher levels of veridical than false recognition; furthermore, if they were suppressing false recognition responding (whereas patients with amnesia were not), we might have expected to see an interaction of item type (veridical recognition vs. false recognition) and group (amnesic vs. control) such that the magnitude of the difference between veridical and false recognition would be greater for control participants than patients with amnesia. Consistent with this expectation, an analysis performed on the average of the medium and large categories (excluding single items) comparing the amnesic and control groups showed a significant Group × Item Type interaction, $F(1, 30) = 14.25$, $MSE = .01$, $p = .0007$. Whereas, overall, patients with amnesia showed a difference of 13%, favoring novel-corrected veridical over false recognition, the corresponding difference shown by control participants was more than twice as large (34%).

This difference in veridical versus false recognition for the two groups is shown graphically in the top panel of Figure 3, which presents, in a single graph, novel-corrected veridical and false recognition for the medium and large categories for all three groups (patients with amnesia, matched controls, and young controls). As is clear from Figure 3, the magnitude of the veridical over false recognition difference was smallest for the group with amnesia, larger for the matched controls, and still larger for the young

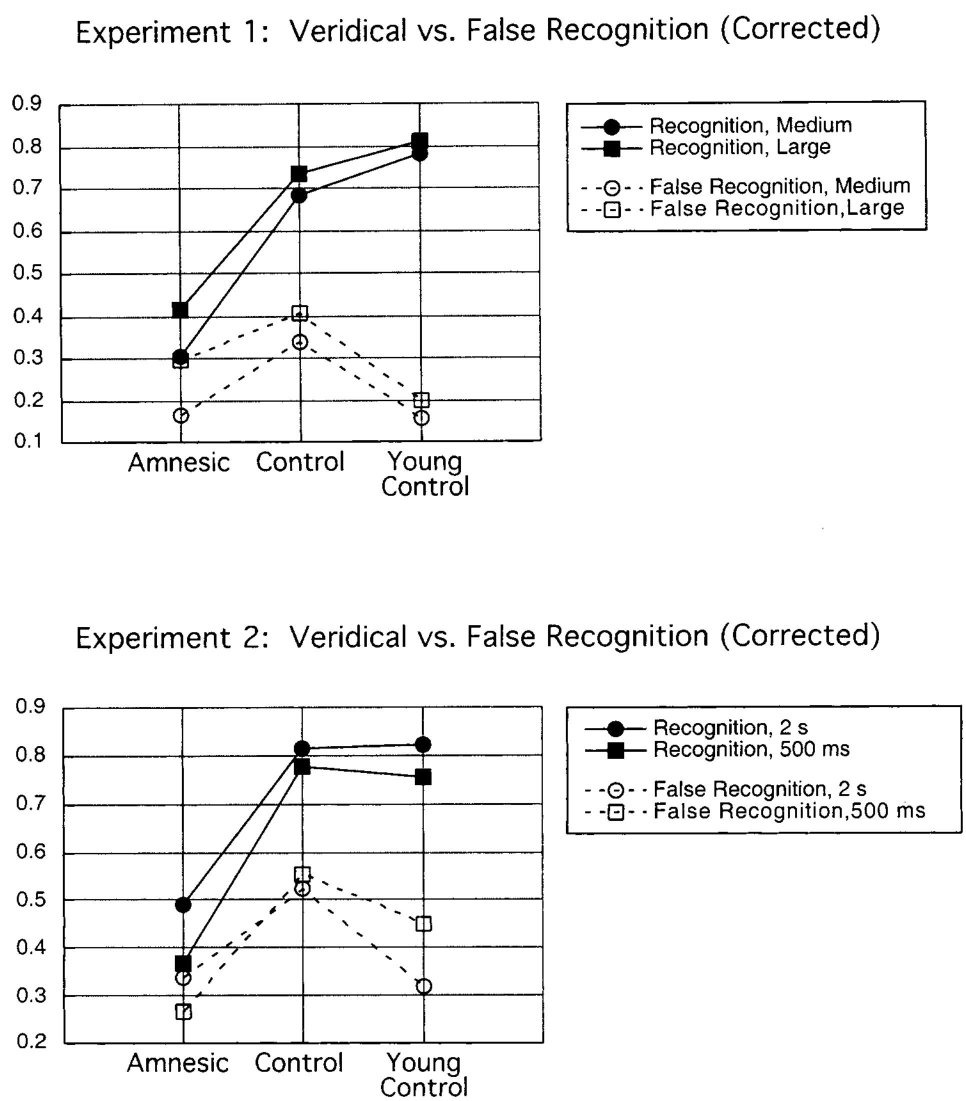

Figure 3. Comparison of veridical versus false recognition, after correction for the baseline false-alarm rate, in Experiment 1 (upper panel) and Experiment 2 (lower panel). Results for Experiment 1 are shown for the category size conditions in which 9 (medium) and 18 (large) categorically related items were presented during study. Results for Experiment 2 are shown for the category size condition in which 18 categorically related items were presented, separately for the condition in which the stimulus presentation rate at study was 2 s and 500 ms.

controls. Figure 3 also clearly underscores the probable need to take multiple factors into account in explaining false recognition levels: Although younger controls and patients with amnesia showed quite similar levels of corrected false recognition for the medium and large categories, this finding is unlikely to reflect parallel mnemonic and decision processes in the two groups, given the very marked difference in veridical recognition for these same groups. Nonetheless, though showing the least successful differentiation of studied items from nonstudied related lures, patients with amnesia still demonstrated above-chance levels of discrimination of targets from related lures for all three category sizes (single, medium, and large), smallest one-sample $t(15) = 2.32$, $p = .03$.

To address this concern regarding the relative contributions of item-specific and gist memory to the recognition performance of patients with amnesia and controls, in Experiment 2 we attempted to manipulate the ability of participants to use item-specific information to suppress false recognition. Here, we compared false recognition to related category lures under a condition similar to that of the first experiment (in which controls could extract item-specific information but there was no explicit encouragement to use such information) with a second condition in which—as a result of a briefer presentation of the items during encoding—it should have been relatively difficult for participants to extract item-specific information. This latter condition provided a test of whether gist memory in normal controls—when minimally opposed by item-specific memory—exceeded that of patients with amnesia.

Experiment 2

The primary purpose of this experiment was to further examine levels of gist-based false recognition in patients with amnesia versus controls by using the categorized-pictures stimuli but now incorporating a manipulation intended to reduce item-specific memory among control participants—thereby heightening the likelihood of observing significantly impaired gist memory among patients with amnesia. The manipulation that we chose was reduced study presentation time: Rather than presenting each item for 2 s, as in Experiment 1, items during the study phase in the experimental condition were presented for 500 ms. A similar reduction in study exposure time had been found previously, in younger adults, to lead to both decreased veridical recognition (particularly for one-of-a-kind items that may especially require item-specific memory) and modestly, but significantly, increased false recognition (Koutstaal et al., 2001).

In addition to the 500-ms presentation rate, we included a condition in which—as in Experiment 1—each item was presented for 2 s. This condition permitted a within-experiment assessment of the effects of the decreased study presentation time and, in particular, allowed for a within-experiment assessment of any differences in gist memory among patients with amnesia versus controls under conditions intended to allow suppression in controls (2-s rate) and conditions intended to minimize the opportunity for suppression (500-ms rate). We used a blocked study–test, study–test design: Participants first studied one set of pictures at the 2-s rate and then completed an old–new recognition test for those items (including related lures and novel items); thereafter, another (different) set of pictures was presented at the 500-ms rate, followed by an old–new recognition test for those (second set) items and, again, including related lures and a further set of novel items.

Method

Participants

Patients with amnesia and control participants were recruited and screened in the same manner as for Experiment 1. However, unlike in that experiment, it was not possible to achieve equal numbers of patients with mixed-etiology amnesia and patients with Korsakoff's syndrome. We tested 10 patients with amnesia of various etiologies and 10 normal controls, plus 5 patients with amnesia due to Korsakoff's syndrome and 8 controls with alcoholism; in addition, for comparison purposes, we again tested 16 young undergraduates (Harvard University students). Details concerning the patients are provided in Table 3. The controls for the patients with mixed-etiology amnesia (normal controls) had a mean age of 55.4 years, an average of 15.4 years of formal education, and an average verbal IQ of 110.6. The mean age of the controls for the patients with amnesia due to Korsakoff's syndrome (controls with alcoholism) was 63.0 years; they had, on average, 12.4 years of formal education and an average verbal IQ of 100.5.

Experimental Design

The experimental design included a between-subjects variable of group (mixed-etiology amnesic, Korsakoff amnesic, normal control, alcoholic control, or young control). However, because analyses for the two subgroups with amnesia yielded very similar patterns of performance (see the *Results* section below), the subgroups and their corresponding controls were combined, yielding three groups: patients with amnesia, controls, and young controls. In addition, there were two within-subjects variables: study presentation rate (2 s or 500 ms) and category type. For studied items, category type had two levels: large (18 related category exemplars presented) and unrelated (miscellaneous, noncategorically related items; see the *Stimuli* section below). For nonstudied items, category type had three levels: large, unrelated, and "novel" (no related items presented at study). As in Experiment 1, false alarms in the novel condition provided a baseline measure of false recognition.

Stimuli

Because many of the patients and control participants who took part in Experiment 2 also had taken part in Experiment 1, a new set of stimuli—entirely independent of the items used in Experiment 1—was gathered. However, given that participants in Experiment 1 had been exposed to a total of 20 different object categories, the number of new (nonoverlapping) categories for which pictures could be found was too few to also allow a manipulation of category size. We found a total of 16 new categories; these were separated into four sets composed of 4 categories each. These sets were then counterbalanced across study presentation rates (2 s or 500 ms) and across studied and nonstudied status, with two sets serving as large and nonstudied novel items for the 2-s presentation rate and two sets serving as large and nonstudied novel items

Table 3
Characteristics of Patients With Amnesia in Experiment 2

Patient	Etiology	Age (years)	Education (years)	Verbal IQ	WMS–R General memory	WMS–R Delay	WMS–R Attention
A.B.	Anoxia	59	16	105	76	51	92
D.F.	Anoxia	49	16	111	81	69	107
S.S.	Encephalitis	71	18	126	102	50	114
P.D.	Anoxia	62	20	109	65	61	89
R.L.	Anoxia	70	18	103	68	66	93
P.S.	Anoxia	41	14	95	90	50	115
J.M.	Anoxia	49	12	89	70	52	92
C.C.	Anoxia	41	12	104	88	71	108
C.W.	Stroke	58	12	87	79	89	80
D.S.	Anoxia	36	16	95	65	50	120
M		53.6	15.4	102.4	78.4	60.9	101.0
R.D.	Korsakoff	69	12	83	66	50	99
P.B.	Korsakoff	72	14	87	82	60	93
R.M.	Korsakoff	79	14	111	91	68	95
R.G.	Korsakoff	81	9	94	61	66	104
W.K.	Korsakoff	58	16	94	59	57	93
M		71.8	13.0	93.8	71.8	60.2	96.8

Note. Verbal IQ was measured with the Wechsler Adult Intelligence Scale—Revised. The Wechsler Memory Scale—Revised (WMS–R) does not provide scores below 50, and 50 was the lowest score used to compute means. Korsakoff = Korsakoff's syndrome.

for the 500-ms presentation rate. In addition, to allow assessment of veridical and false recognition under conditions in which no categorically related items were studied and also to increase the length and variety of the study lists, we included miscellaneous unrelated items. (Note that, for the most part, unrelated items and single items in Experiment 1 showed similar patterns.) These unrelated items were also divided into four sets, each composed of 12 items, and were counterbalanced so as to serve as unrelated studied items at each of the two presentation rates and as unrelated lures on each of the two recognition tests. These items were also entirely nonoverlapping with the stimuli used in Experiment 1.

The stimuli were converted into digital form and presented to participants in the same manner as in Experiment 1. Each of the two study lists consisted of a total of 90 items, including 18 items from each of 4 categories, 12 unrelated items, and 6 primacy and recency buffers. For the test lists, critical subsets of items were again selected to be tested, with 3 target items and 3 related lures tested for each studied category, plus 3 items from each of the 4 nonstudied novel categories. Thus, each of the two test lists consisted of 60 items, including 36 new and 24 old items: 4 × 3 large category targets, 4 × 3 large category lures, 4 × 3 novel items, 12 unrelated targets, and 12 unrelated lures.

Procedure

The experimental procedure involved four main phases: a study phase and a test phase in which the items at study were presented for 2 s each (Block 1) and a subsequent study phase and test phase in which the items were presented at study for 500 ms each (Block 2). Within each block, the study and test phases were separated by a brief interpolated filler task (3 min). In addition, a brief filler task and a somewhat longer break (about 5 min) were given between the end of the first block and the beginning of the second block. All participants were tested individually, either in their home or at the Memory Disorders Research Center at the Veterans Affairs Medical Center in Boston.

The study phase for both blocks was very similar to that used in Experiment 1: Participants were presented pictures, one at a time, on the computer monitor and were asked to rate their liking for each item. Also, as before, the pictures from different object categories were randomly intermixed (i.e., not grouped by category). However, because two study–test blocks were administered within the session, such that participants would be aware (after the first study–test block) that their memory for the items would be tested, the encoding instructions were changed. Specifically, participants were told (for both the first and second blocks) that they would be shown a number of pictures and that later they would be asked to remember the items. They were asked to perform the liking rating task for each item so as to help them to remember the items. In the first study–test block, each picture was presented for 2 s in the center of the computer monitor and was followed by a prompt, requesting participants to provide their liking rating (*do not like*, *neutral*, or *like*). Participants had 4 s to give their liking ratings, which they stated orally and which were then entered by the experimenter. In the second study–test block, each picture was presented for 500 ms and then was followed by the liking rating prompt.

In the test phase, participants were given an old–new recognition test composed of a subset of the pictures from the preceding study phase together with new (nonstudied) pictures. On this test, participants indicated whether each item was old (previously presented during the liking encoding task) or new (not previously presented during the experiment) and then rated their confidence in their recognition judgment (*just guessing*, *moderately sure*, or *very sure*). The recognition test was self-paced and (except for the inclusion of different items) was of a similar format for Block 1 and Block 2.

Results

As in Experiment 1, we first performed separate analyses on the two subgroups with amnesia and their respective controls, but because these subgroups showed similar patterns, we com-

Table 4
Novel-Corrected (and Unrelated-Corrected) True and False Recognition for Subgroups in Experiment 2

	True recognition				False recognition			
	Block 1 (2,000 ms)		Block 2 (500 ms)		Block 1 (2,000 ms)		Block 2 (500 ms)	
Group	Unrelated	Large	Unrelated	Large	Large	Novel	Large	Novel
Amnesic								
Korsakoff	.42	.48	.18	.35	.23	.10	.25	.15
Mixed etiology	.40	.49	.29	.38	.39	.18	.28	.28
Control								
Alcoholic	.70	.80	.65	.76	.57	.04	.54	.11
Normal	.86	.83	.76	.79	.48	.008	.57	.07
Young	.91	.82	.85	.76	.32	.02	.45	.05

Note. Korsakoff = Korsakoff's syndrome.

bined the subgroups.[4] However, for the sake of completeness of reporting, the means for the corrected recognition data for the two subgroups with amnesia and their controls are presented separately (see Table 4). Also, and again as in Experiment 1, the outcomes for the young normal control group are included in the figures and the tables but were analyzed separately rather than with the other groups. Results considering confidence judgments for patients with amnesia and their controls, that is, recognition judgments accompanied by *very sure* responses, corrected for baseline false alarms also made as *very sure* responses, are briefly presented in the Appendix.

Figure 4 presents the proportion of veridical and false recognition responses separately as a function of group (amnesic, control, or young control), category type (18 related exemplars presented at study or unrelated items), and study presentation rate (2 s or 500 ms). From Figure 4, it can be seen that, for veridical recognition, patients with amnesia showed the expected pattern of clearly depressed hits relative to control participants, with patients with amnesia showing lower hits than their controls for both large category and unrelated items at both the 2-s and 500-ms presentation rates. However, as in Experiment 1, patients with amnesia seemed to show somewhat more impaired true recognition for the one-of-a-kind items (unrelated items) than for the many-exemplar category items. It is important that veridical recognition in the control group for the one-of-a-kind items seemed to be reduced under the faster presentation rate, suggesting that the presentation duration manipulation did, indeed, affect item-specific memory in this group. Regarding false recognition responses, several patterns are apparent from Figure 4. First, all groups showed elevated false recognition for the many-exemplar lures relative to either unrelated items or novel category lures, with this pattern found for both the slower and faster presentation rates. Second, whereas the control participants showed somewhat higher levels of (raw) false recognition for the many-exemplar lures than did the patients with amnesia, the reverse pattern was obtained for the novel items and the unrelated items (patients with amnesia > controls for both the 2-s and 500-ms study presentation rates). Third, whereas patients with amnesia seemed to show a similar level of false alarms to many-exemplar lures under the slower and faster presentation rates, controls showed numerically increased (raw) false recognition under the faster rate. Fourth, both the group with amnesia and the control group tended to show somewhat higher rates of false alarms to unrelated and novel items under the faster presentation rate.

An analysis comparing the novel false alarms of the combined amnesic group and their controls showed significantly elevated baseline rates in the group with amnesia, both for the 2-s presentation rate, $F(1, 31) = 10.89$, $MSE = .01$, $p = .002$, and for the 500-ms presentation rate, $F(1, 31) = 6.83$, $MSE = .03$, $p = .01$.[5] Figure 5 presents veridical and false recognition after correction for baseline levels of novel false alarms.

Separate Analyses of Veridical and False Recognition

Novel-corrected veridical recognition. We first examined novel-corrected veridical recognition in the combined

[4] Analyses of the raw and novel-corrected true and false recognition measures, including the two subgroups with amnesia and their controls, as well as category size and study presentation rate showed no interactions, with only one exception. The exception was a Subgroup × Category Size interaction for raw (but not novel-corrected) false recognition, apparently reflecting an especially strong increase in false recognition of unrelated items by the patients with mixed-etiology amnesia under the faster presentation rate (shown in a significant Category Size × Subgroup interaction for the unrelated false alarms alone); this interaction was not found for the large category items alone or for novel items alone.

[5] Here we should note that although the numerical pattern of higher rates of novel false alarms among the group with amnesia than their controls held for each of the subgroups (2-s presentation rate: patients with amnesia due to Korsakoff's syndrome vs. controls with alcoholism = .10 vs. .04 and patients with mixed-etiology amnesia vs. normal controls = .18 vs. .008; 500-ms presentation rate: patients with amnesia due to Korsakoff's syndrome vs. controls with alcoholism = .15 vs. .11 and patients with mixed-etiology amnesia vs. normal controls = .28 vs. .07), the difference was strongly apparent (for both presentation rates) only for the subgroup with mixed-etiology amnesia (smallest $F = 8.32$); the differences for the subgroup with amnesia due to Korsakoff's syndrome were not significant (Fs < 1.6).

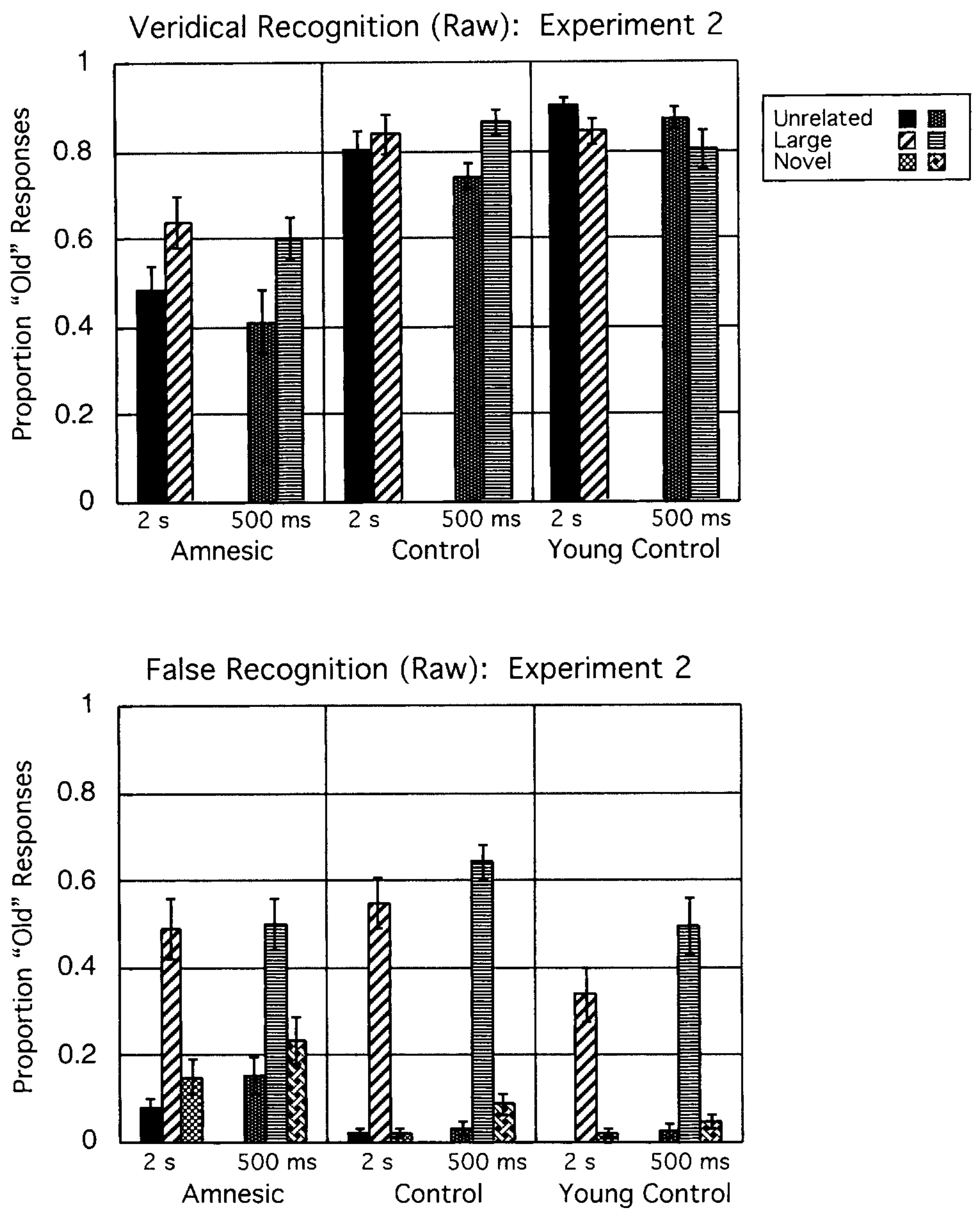

Figure 4. Mean proportion of old responses in Experiment 2 for studied items (veridical recognition) and nonstudied items (false recognition) as a function of category type, group, and stimulus presentation rate at study. Category type, or the number of categorically related items presented during study, was 0 (unrelated items and novel items) or 18 (large). Responses to the novel items represent the baseline false-alarm rate. Error bars represent standard errors of the means.

amnesic versus control groups (excluding young controls), performing separate analyses for the many-exemplar category items and the unrelated items. A 2 (group: amnesic vs. control) × 2 (study presentation rate: 2 s vs. 500 ms) mixed-factor ANOVA performed on novel-corrected veridical recognition for the many-exemplar category items showed, as we expected, a main effect of group (for patients with amnesia, $M = .43$; for controls, $M = .80$), $F(1, 31) = 70.22$, $MSE = .03$, $p < .0001$. There was also a marginally significant effect of study presentation time, with novel-corrected veridical recognition of the large category items under the faster presentation rate some 8% lower than under the slower presentation rate, $F(1, 31) = 3.89$, $MSE = .03$, $p = .06$ (Ms = .67 and .59, respectively). There was no differential effect of study presentation rate on veridical memory in the group with amnesia versus the controls ($F < 1.2$ for the Group × Presentation Rate interaction).

A largely similar pattern was observed for veridical recognition of the unrelated items following correction for

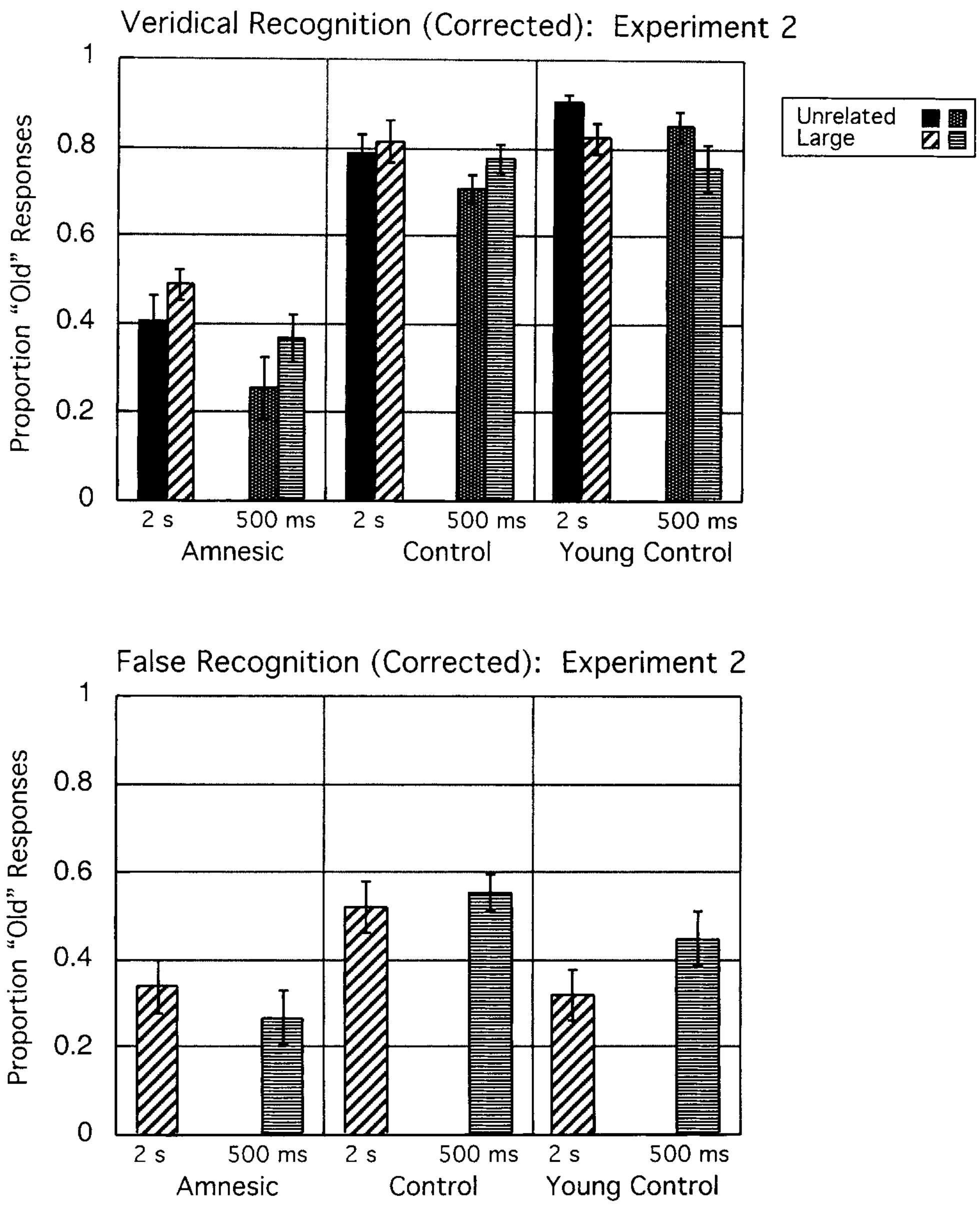

Figure 5. Mean proportion of old responses in Experiment 2 for studied items (veridical recognition) and nonstudied items (false recognition) as a function of category type, group, and stimulus presentation rate at study, after correction for the baseline false-alarm rate. Category type, or the number of categorically related items presented during study, was 0 (unrelated items) or 18 (large). Error bars represent standard errors of the means.

baseline rates of false alarms to the unrelated items (i.e., "unrelated-corrected"), except here there was a significant decrement in hits under the faster presentation rate. A 2 (group: amnesic vs. control) × 2 (study presentation rate: 2 s vs. 500 ms) ANOVA showed (as we expected) a main effect of group, $F(1, 31) = 42.93$, $MSE = .07$, $p < .0001$ (for patients with amnesia, $M = .33$; for controls, $M = .75$); there was also a main effect of presentation rate, $F(1, 31) = 11.96$, $MSE = .02$, $p = .002$ (for 2-s presentation rate, $M = .61$; for 500-ms presentation rate, $M = .50$), with no Group × Presentation Rate interaction ($F < 1.2$).

Finally, a separate one-way analysis performed on the novel-corrected veridical recognition of the many-exemplar category items for the young controls showed slightly, and nonsignificantly, depressed novel-corrected hits for the faster presentation rate (for 2-s presentation rate, $M = .82$; for 500-ms presentation rate, $M = .76$; $F = 1.62$ for the effect of presentation rate). A similar outcome was observed for the unrelated items (for unrelated-corrected recognition, Ms = .91 and .85 for the 2-s and 500-ms presentation rates, respectively; $F = 1.91$ for the effect of presentation rate).

Novel-corrected false recognition. We next considered novel-corrected false recognition for the many-exemplar category lures. A 2 (group: amnesic vs. control) × 2 (study presentation rate: 2 s vs. 500 ms) mixed-factor ANOVA showed an overall effect of group: Combining across study presentation rate, we found that control participants (M = .54) demonstrated significantly greater false recognition than patients with amnesia (M = .30), $F(1, 31) = 14.94$, $MSE = .06$, $p = .0005$. This pattern is consistent with the notion of degraded gist memory in patients with amnesia and also with the trend (found in Experiment 1) for depressed false recognition among patients with amnesia versus controls for the many-exemplar categories (i.e., medium and large together). However, contrary to the expected pattern of greater false recognition in control participants under the faster study presentation rate, there was no overall effect of presentation rate (M = .44 for the 2-s presentation rate and M = .42 for the 500-ms presentation rate; $F < 1$), and, more important, there was no Group × Presentation Rate interaction ($F < 1.2$). Focused analyses on the novel-corrected false recognition rate for each of the presentation rates separately showed a significant impairment in false recognition in patients with amnesia relative to controls for both the 2-s study presentation rate (reduction in patients with amnesia of 18%), $F(1, 31) = 4.70$, $MSE = .06$, $p = .04$, and the 500-ms presentation rate (reduction in patients with amnesia of 29%), $F(1, 31) = 15.85$, $MSE = .04$, $p = .0004$.

Nonetheless, in contrast to the relatively slight effects of study presentation rate for the patients with amnesia and matched control participants, a separate one-way ANOVA examining the effect of presentation rate on false recognition of the young controls showed a significant main effect of presentation time. For young controls, novel-corrected false recognition of the many-exemplar category lures was some 13% greater under the faster study presentation rate than under the slower study presentation rate (Ms = .32 and .45 for the 2-s and 500-ms presentation rates, respectively), $F(1, 15) = 5.55$, $MSE = .03$, $p = .03$.

Analyses Combining Veridical and False Recognition

To examine whether veridical versus false recognition in the amnesic and control groups was differentially affected by the manipulation of study presentation time, we also conducted an analysis incorporating both veridical and false recognition, including the between-subjects variable of group (amnesic vs. control) and the two within-subjects variables of presentation time (2 s vs. 500 ms) and item type (novel-corrected veridical recognition vs. novel-corrected false recognition) for the large category items. This 2 × 2 × 2 ANOVA yielded (expected) main effects of group, $F(1, 31) = 42.66$, $MSE = .07$, $p < .0001$, and item type, $F(1, 31) = 52.46$, $MSE = .02$, $p < .0001$; there was also an important significant Group × Item Type interaction, $F(1, 31) = 6.26$, $MSE = .02$, $p = .02$. This interaction reflected a greater difference in the level of veridical versus false recognition for the control participants for the large category items (difference of 26%) than for the patients with amnesia (difference of 13%). No other differences, including the higher order interaction of Group × Item Type × Presentation Rate, were significant (Fs < 1.7).

The difference in veridical versus false recognition for the amnesic and control groups is shown graphically in the lower panel of Figure 3, which presents, in a single graph, novel-corrected veridical and false recognition for the large categories for the 2-s and 500-ms presentation rates for all three groups (patients with amnesia, matched controls, and young controls). As is clear from the lower panel of Figure 3, and as also found in Experiment 1, the magnitude of the veridical over false recognition difference was smallest for the group with amnesia, larger for the matched controls, and still larger for the young controls. For both the matched controls and the young controls, the separation of veridical and false recognition was numerically greater under the slower study presentation rate than under the faster study presentation rate. Also, in both control groups, whereas veridical recognition numerically decreased under the faster rate, false recognition numerically increased; however, separate within-group analyses performed on the corrected veridical and false recognition scores showed a significant interaction of Item Type (veridical or false recognition) × Study Presentation Rate (2 s or 500 ms) only for the younger controls, $F(1, 15) = 11.74$, $MSE = .01$, $p = .004$; the interaction for the matched control group was not significant ($F < 1$).

Nonetheless, although patients with amnesia, relative to their controls, showed a significantly reduced ability to discriminate the studied targets of many-exemplar categories from related lures, they continued to demonstrate above-chance levels of discrimination under both the slower and faster presentation rates, $t(14) = 3.20$, $p = .006$, and $t(14) = 3.15$, $p = .007$, respectively.

General Discussion

In contrast to the relatively weak and largely suggestive findings of Experiment 1, the outcomes of Experiment 2 provide clear support for reduced false recognition of conceptually and perceptually related lures—that is, lower levels of similarity or gist-based false recognition—in amnesia. Across the two study presentation rates, and within each separate study presentation rate, the group with amnesia showed significantly less false recognition of the many-exemplar lures than did their matched controls.

Because in the paradigm used here the lure items were detailed pictures that were never previously presented—and thus were unlikely to be spontaneously imagined or otherwise generated by participants during the study phase—these outcomes demonstrate that reduced false recognition of conceptually and perceptually related items in patients with amnesia may, indeed, arise from deficits in the storage and/or retrieval of general similarity or gist information. However, the pattern of outcomes for the study presentation manipulation does not appear to provide strong support for the proposal that the relatively modest magnitude of gist memory impairment that we observed in Experiment 1 resulted from suppression among the matched control participants. According to this proposal, false recognition of related lures for the many-exemplar categories (18 categorically similar items presented at study) by the control participants in Experiment 2 should have increased under the faster study presentation rate (which presumably minimized the opportunity for the extraction of item-specific details), relative to the slower study presentation rate that was used in Experiment 1 and in the parallel (2-s) presentation condition of Experiment 2. Indeed, this is exactly the pattern that was observed for the younger controls, who showed a significant elevation in false recognition under the faster presentation rate and who also showed an Item Type × Presentation Rate interaction (decreased true recognition but increased false recognition of the large category items under the 500-ms rate as compared with the 2-s rate). This outcome argues against an interpretation that attributes lower levels of false recognition responding among young controls to "impaired gist" (note that in both Experiment 1 and Experiment 2, young controls under the 2-s study presentation rate demonstrated a level of false recognition responding that was more similar to that of the patients with amnesia than to that of the controls for the group with amnesia). Rather, this differential pattern in veridical and false recognition suggests that the lower level of gist responding in young controls relative to the controls for the group with amnesia reflected suppression in the younger group. When experimental conditions made extraction of item-specific information more difficult, young controls showed both increased false recognition of many-exemplar lures and reduced veridical recognition of many-exemplar targets (significant Item Type × Presentation Rate interaction).

However, this pattern was not seen in older controls: Rather than showing particularly increased false recognition under the faster study presentation rate, novel-corrected false recognition in the control group was now consistently elevated above that for patients with amnesia, both under the same study presentation rate that was used in Experiment 1 (2 s per item) and under the faster presentation rate (500 ms per item). Nonetheless, it should be noted that subgroup analyses showed that this amnesic versus control group difference was not significant for the subgroup with mixed-etiology amnesia considered alone for the 2-s presentation rate, whereas it was significant for the faster rate, thus pointing to some effect of the presentation duration manipulation. Furthermore, consideration of only those large-category false recognition responses that were accompanied by high confidence (response of *very sure* on a 3-point scale, with 1 = *just guessing*, 2 = *moderately sure*, and 3 = *very sure*; see the Appendix) revealed a significant Group × Presentation Rate interaction, with high-confidence false recognition responses in patients with amnesia decreasing for the faster presentation rate (.24 vs. .17) but those for control participants increasing (.23 vs. .28).

Although the reasons for the absence of a more pronounced exacerbation of gist-based responding among matched control participants under the faster presentation rate are unclear (at least as indexed by novel-corrected false recognition scores), a number of observations might be made. First, although the presentation rate was held constant across Experiment 1 and the 2-s presentation condition of the second experiment, several other aspects relating to the study procedure were changed. Relative to Experiment 1, in Experiment 2 (a) the overall study list was shorter; (b) there were fewer object categories in the study list, and (except for the unrelated items) these were all many-exemplar categories; (c) the encoding task was somewhat different (although both experiments used the liking rating task, the second experiment also included intentional learning instructions); and (d) the study–test retention intervals also differed (the retention interval was longer in Experiment 1). Furthermore, (e) the stimulus items themselves differed for the two experiments. It is not clear how, relative to Experiment 1, these differences may have altered the encoding or retrieval processes of control participants. Although some of these differences might seem as though they ought to have worked to reduce false recognition among control participants in the 2-s study presentation condition of Experiment 2 relative to Experiment 1 (e.g., the shorter study lists and the shorter study–test retention interval), other factors may have operated in the direction of increasing false recognition. For example, it is quite possible that the stimulus items within each category were more similar to one another (i.e., were more confusable with one another) in Experiment 2 than in Experiment 1, thus making discrimination between studied items and related lures more difficult. In addition, the comparatively shorter study lists and reduced number of categories used in the second experiment, such that all of the many-exemplar category stimuli in a given study list belonged to one of four large categories, may have made the large categories more salient, thereby possibly encouraging conceptual processing of these items and yielding something closer to a "blocked" presentation of the items. It is notable that in the verbal converging semantic-associates paradigm, blocked presentation of the associate lists during study has been found to be related to increased false recognition relative to randomly intermixed presentation (cf. Mather, Henkel, & Johnson, 1997).

Consistent with these ideas, the control participants for the group with amnesia showed a higher overall level of false recognition for the many-exemplar lures in Experiment 2 (M = .54 overall and M = .52 for the 2-s presentation condition alone) than for the corresponding lures (for 18-item categories) in Experiment 1 (M = .41). This outcome, which shows significantly impaired gist memory in patients with amnesia primarily under conditions in which false recognition in control participants was at a relatively high level (Experiment 2 but not Experiment 1), parallels a pattern noted in previous experiments. Specifically, Schacter et al. (1997) reported two instances of nonsignificantly impaired gist memory in patients with amnesia. One case involved perceptually similar words (Experiment 1 of Schacter et al., 1997) and involved a situation in which the overall magnitude of the perceptual gist effect in the controls was somewhat modest; the other case involved conceptually similar words (Experiment 2 of Schacter et al., 1997) and also involved a somewhat smaller conceptual false recognition effect in controls. By contrast, in both of these earlier experiments, highly significant impairments were observed in patients with amnesia under conditions that elicited higher levels of gist memory in the controls (found for conceptually similar words in Schacter et al., 1997, Experiment 1, and for perceptually similar words in Schacter et al., 1997, Experiment 2).

The patterns of performance in Experiment 1 and Experiment 2 more generally point to the complexities involved in assessing gist memory, with levels of false recognition of related lures dependent on multiple factors—not only knowledge of the categorical or relational structure of the target items (the conceptual or perceptual categories of the study list) but also the extent to which participants may draw on knowledge of the target items, including item-specific knowledge, to counteract gist-based responding. Some more subtle aspects of the patterns of performance across all three groups were consistent with suppression-like processes in control participants (e.g., the significant Group × Presentation Rate interaction when considering high-confidence false recognition responses alone, with patients with amnesia showing a 7% decrease in false recognition under the faster presentation rate but control participants showing a 5% increase). Other aspects, such as the contrasting pattern found for the healthy younger controls and the older controls—with the former showing more pronounced effects of the presentation rate manipulation, consistent with more marked changes in suppression of false-positive responding—suggest that factors such as age also play an important role in determining the balance of outcomes.

Although the manipulation of study presentation time in Experiment 2 did not yield strong evidence to support the notion that control participants, under the slower presentation time, were using item-specific information to suppress false recognition, from a broader perspective, the numerical findings in both of the experiments reported here converge in demonstrating that patients with amnesia show impaired "memory" not only for actually presented target items but also for never-presented, but perceptually and conceptually related, lure items. This outcome is consistent with findings reported previously (Koutstaal, Schacter, Verfaellie, et al., 1999), which used perceptually similar abstract objects stimuli with which participants had no prior (extraexperimental) experience, but extends the conclusion to objects that also possess preexisting semantic, conceptual, and perceptual associations. This outcome also demonstrates that reduced false recognition in patients with amnesia may be found for items that are simply different exemplars or variants of the target items and not only for perceptual prototypes. (In the earlier experiment that used abstract objects, although patients with amnesia showed numerically reduced false recognition for the nonprototype lures from larger categories, these differences were not significant.)

What factors might underlie this pattern of reduced false recognition in amnesia? Here, too, the findings from the present experiment seem to further extend and support suggestions made in the previous experiment using novel abstract objects (Koutstaal, Schacter, Verfaellie, et al., 1999). First, although, relative to their matched controls, patients with amnesia clearly showed impaired gist memory (numerically so in Experiment 1 and significantly so in Experiment 2), the qualitative pattern of performance they showed was in some respects quite similar to that of controls. In particular, category size generally affected the false recognition performance of the two groups in a similar manner, with greater false recognition for lures for which 9 or 18 categorically related target items had been encountered than when only 1 related target item had been presented. This common effect of category size (both groups showing greater false recognition for lures conceptually and perceptually associated with many relative to few target items) suggests that the processes supporting gist memory—the extraction, retention, and retrieval of generic similarity information—are qualitatively similar in the amnesic and control groups but are less efficient in the group with memory impairments.

On the one hand, this convergence of findings across several different paradigms, each showing (in at least one or more conditions) impaired gist memory in patients with amnesia relative to control participants, attests to the considerable generality of the finding: Patients with amnesia have been found to show reduced false recognition responding to many-exemplar categories under conditions in which the stimuli are (a) conceptually and associatively related lure words (Melo et al., 1999; Schacter et al., 1997, Schacter, Verfaellie, et al., 1998; Schacter, Verfaellie, & Pradere, 1996); (b) perceptually related lure words (Schacter et al., 1997, Experiment 2); (c) the (nonstudied) prototypes of perceptually related abstract visual objects (Koutstaal, Schacter, Verfaellie, et al., 1999; but see also Kolodny, 1994, and discussion of Kolodny's findings in Koutstaal, Schacter, Verfaellie, et al., 1999), and (d) in the present experiment, new exemplars of pictured common objects, sharing both perceptual and conceptual similarity. On the other hand—the similarity of the ultimate outcome notwithstanding—it also seems likely that the specific processes leading to the observed behavioral outcome to some extent differ across these different paradigms. For example, compared with the common objects paradigm, the factors contributing to the extraction of gist in the converging semantic-associates paradigm may involve more, so to speak, on-line or ongoing accumulation of the general theme of the list, particularly as no item (word) in the associate lists literally "repeats" something of an earlier item in quite the same manner that, for example, all teapots may be named in the same manner, or share very similar visual features. In a related manner, the differing stimulus presentation methods with these two paradigms—temporally blocked in the case of the converging semantic-associates paradigm but randomly intermixed and temporally distributed in the case of the common objects—presumably also affect the way in which thematic or categorical information is processed. These and other differences might also affect the ways in which reinstatement of the relevant category or theme may occur at retrieval. For example, whereas the mapping of the lures to the relevant categories may be largely automatic and stimulus-driven for the lures in the common objects paradigm (in most instances, the nonstudied lures might be expected to relatively directly elicit lexical and semantic information regarding the many-exemplar categories), the process involved for the critical lures in the converging semantic-associates paradigm might involve relatively more inferential processing. The observation of reliably impaired gist memory among patients with amnesia relative to controls in each of these cases suggests that, in the end, these many procedural differences (and also the possible contribution of source confusions in the converging semantic-associates paradigm) do not differentially affect the relative pattern of gist-based responding for patients with amnesia versus their controls. Nonetheless, across the paradigms, for the different stimulus types and conditions, this consistently observed group difference may reflect somewhat different processes in the extraction, retention, or retrieval of gist information, with impairment arising under several different specific instantiations of these processes.

Three further points should be made. One point concerns the relative contributions of perceptual and conceptual similarity in inducing false recognition. In the present paradigm, these two broad types of similarity generally covaried such that items within a category (e.g., teapots) shared features both at the level of conceptual or semantic representation and at a perceptual level (common visual features). However, it is also possible that conceptual and perceptual similarity could be varied independently. For instance, it might be possible to present a lure item (e.g., a particular teapot) that, although conceptually related to the presented items (other teapots), greatly differs on a perceptual level from the studied items or vice versa (testing a perceptually similar lure item that does not share conceptual relations with the presented items). Orthogonally varying these forms of similarity might yield insights into the degree of reliance on the two types of information in patients with amnesia and controls. For example, evidence to date suggests that the elevation in gist-based false recognition among older compared with younger adults consistently found in earlier research using categorized objects of the sort used here (Koutstaal & Schacter, 1997; Koutstaal et al., 2001; Koutstaal, Schacter, Galluccio, & Stofer, 1999) may be more pronounced in situations in which lures share both conceptual and perceptual similarity than when they share only perceptual similarity—even under conditions that present the same perceptual stimuli in both conditions (Koutstaal, Reddy, Prince, & Schacter, 2000). Presentation of lures that, though conceptually related to presented items, are comparatively perceptually distinct would also allow examination of the extent to which "gist-inconsistent" within-category perceptual details might be used to oppose general similarity responding (cf. Schacter et al., 1999).

A second point relates to the assessment of the extent to which item-specific memory versus more generic memory is differentially impaired in amnesia. The category size manipulation also allows contrasts of the amnesic and control groups' performance for target items that were one-of-a-kind during study (and thus minimally supported by categorical or generic information and maximally dependent on item-specific information) versus their performance for lure items that were similar to many of the presented items during the study phase (and thus could be strongly supported by categorical or generic information). This question is of interest for two reasons. First, early research by Verfaellie and Cermak (1994) using a rather different approach (Watkins & Kerkar, 1985) suggested that whereas patients with amnesia may show especially impaired memory for specific occurrences, memory for repeated occurrences may be "superadditive": Recall of twice-presented items was higher than would be expected on the basis of recall of one of two (different) once-presented items, but a particular feature concerning these items (color) was less likely to be recalled than was color of the once-presented items. Second, recent research examining the relative impairment of recollection versus familiarity in amnesia has suggested that, although both components are impaired, recollection is particularly adversely affected (Yonelinas, Kroll, Dobbins, Lazzara, & Knight, 1998). The comparison of veridical recognition for one-of-a-kind target items versus false recognition of many-exemplar lure items may partially map into a similar distinction, with successful recognition of one-of-a-kind targets especially (albeit not exclusively or entirely) drawing on recollection and incorrect identification of many-of-a-kind lures especially drawing on familiarity.

A comparison of the true recognition for one-of-a-kind items versus false recognition of many-exemplar items, after correction for baseline differences in false alarms, revealed that although (as documented above) gist-based memory was numerically or significantly impaired in the group with amnesia in both Experiment 1 and Experiment 2, the impairment in item-specific true recognition was differentially greater than that for gist-based false recognition: significant Item Type × Group interaction for Experiment 1, $F(1, 30) = 9.32$, $MSE = .04$, $p = .005$; for Experiment 2, combining across the study time manipulation, $F(1, 31) = 5.73$, $MSE = .02$, $p = .02$. (These interaction analyses were based on novel-corrected false recognition for large categories versus single-corrected true recognition of single items in Experiment 1 and novel-corrected false recognition for large categories versus unrelated-corrected true recognition of unrelated items in Experiment 2.) Stated differently, although patients with amnesia, relative to their matched controls, showed a reduced likelihood of generalizing recognition responses from studied items to nonstudied lures when those lures were similar but not identical to items they had experienced previously, this impairment in gist memory was substantially less pronounced than their impairment in item-specific memory, involving conditions that required successful identification of an item that was itself presented but when no other related items of that same sort had been presented.

Although somewhat speculative, these outcomes, showing both an impairment of gist memory in patients with amnesia and a disproportionate impairment in item-specific veridical memory, might reflect differences in the neural underpinnings contributing to these responses and the extent to which different brain regions are compromised in amnesia. Whereas familiarity-related processes, involving the extraction and retention of generalities across many instances, may strongly depend on medial temporal neocortical regions, successful recognition of one-of-a-kind items may more heavily draw on recollective processes that place higher demands on the hippocampus (Aggleton & Brown, 1999).

Finally, and more generally, the observation of quite substantial levels of false recognition in both the group with amnesia and their matched controls (as well as in the young control group, particularly in Experiment 2) points to important limitations on the extent to which human memory is characterized by exact or "verbatim" encoding, retention, or retrieval of information, either in populations with intact memory or in individuals with memory impairments. These limitations are particularly noteworthy here, given that (a) the stimuli used—detailed colored photographs of objects—were very rich with the potential for noting conceptual, semantic, and perceptual differences that could have permitted the differentiation of actually presented items from categorically related but not presented lures; (b) participants performed an encoding task that should have encouraged item-specific memory (rating the degree to which they liked the pictures; cf. Einstein & Hunt, 1980); and (c) encoding and recognition testing occurred in a single study–test session with a very modest retention interval of no more than 30 min (and considerably less in Experiment 2). The high level of incorrect endorsement of lures under these conditions among each of the groups—the matched controls (uncorrected rates of approximately 50% to 60% for the large categories), young controls (uncorrected rates of approximately 20% in Experiment 1 but approximately 30% to 50% in Experiment 2), and patients with amnesia (approximately 35% to 55%)—attests to the limits on verbatim or exact memory and points to the more near-but-not-exact constructive processes that underpin memory, both in individuals without clinically manifest memory impairment and in patients with amnesia who have such impairment.

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Appendix

Analyses of High-Confidence Responses (Responses Accompanied by a *Very Sure* Judgment, Corrected for *Very Sure* Baseline False Alarms)

Experiment 1: Veridical Recognition

A 2 (group: amnesic vs. control) × 3 (category size: single, medium, or large) ANOVA performed on the corrected high-confidence veridical recognition responses revealed a main effect of group (patients with amnesia = .20, controls = .58), $F(1, 30) = 28.83$, $MSE = .12$, $p < .0001$; a main effect of category size (single = .33, medium = .39, large = .45), $F(2, 60) = 4.23$, $MSE = .03$, $p = .02$; and a Group × Category Size interaction, $F(2, 60) = 4.46$, $MSE = .03$, $p = .02$. Whereas controls demonstrated essentially equivalent levels of highly confident true recognition regardless of category size (.59, .56, and .59 for single, medium, and large, respectively), patients with amnesia showed a strong effect of category size (.06, .22, and .32 for single, medium, and large, respectively).

Experiment 1: False Recognition

Consistent with the findings for overall responses, a 2 (group: amnesic vs. control) × 3 (category size: single, medium, or large) ANOVA performed on the corrected high-confidence false recognition responses revealed only a trend toward a main effect of group (patients with amnesia = .09, controls = .19), $F(1, 30) = 3.36$, $MSE = .07$, $p = .08$. There was also a main effect of category size (single = –.01, medium = .17, large = .27), $F(2, 60) = 31.87$, $MSE = .02$, $p < .0001$, with no Group × Category Size interaction ($F < 1$; highly confident false recognition for patients with amnesia = –.08, .12, and .23 and for controls = .05, .22, and .30 for single, medium, and large, respectively).

Experiment 2: Veridical Recognition

A 2 (group: amnesic vs. control) × 2 (category type: large vs. unrelated) × 2 (presentation rate: 2 s vs. 500 ms) ANOVA performed on the corrected high-confidence veridical recognition responses revealed a main effect of group (patients with amnesia = .24, controls = .60), $F(1, 31) = 34.44$, $MSE = .13$, $p < .0001$; a trend toward an effect of category type (large = .40, unrelated = .48), $F(1, 31) = 3.00$, $MSE = .06$, $p = .09$; and a Group × Category Type interaction, reflecting a greater effect of category type on controls than patients with amnesia (large and unrelated for patients with amnesia = .25 and .23 and for controls = .52 and .68, respectively), $F(1, 31) = 4.86$, $MSE = .06$, $p = .04$. There was also a main effect of presentation time (2 s = .47, 500 ms = .40), $F(1, 31) = 7.34$, $MSE = .02$, $p = .01$, with no other interactions (Fs < 1).

Experiment 2: False Recognition

A 2 (group: amnesic vs. control) × 2 (presentation rate: 2 s vs. 500 ms) ANOVA on corrected high-confidence false recognition responses revealed no overall effect of group or of presentation time (Fs < 1) but a significant Group × Presentation Rate interaction, $F(1, 31) = 4.92$, $MSE = .01$, $p = .03$. This interaction arose because patients with amnesia showed decreased false recognition under the 500-ms presentation rate (2 s = .24, 500 ms = .17), whereas controls showed the reverse: higher false recognition with decreased presentation time (2 s = .23, 500 ms = .28).

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