Neuropsychology
2005, Vol. 19, No. 3, 353–361

0894-4105/05/$12.00 DOI: 10.1037/0894-4105.19.3.353

Failing to Get the Gist: Reduced False Recognition of Semantic Associates in Semantic Dementia

Jon S. Simons
University College London

Andy C. H. Lee and Kim S. Graham
Medical Research Council Cognition and Brain Sciences Unit

Mieke Verfaellie
Boston University School of Medicine

Wilma Koutstaal
University of Minnesota

John R. Hodges
Medical Research Council Cognition and Brain Sciences Unit

Daniel L. Schacter
Harvard University

Andrew E. Budson
Edith Nourse Rogers Memorial Veterans Hospital and Brigham and Women's Hospital

In 2 experiments involving patients with semantic dementia, the authors investigated the impact of semantic memory loss on both true and false recognition. Experiment 1 involved recognition memory for categories of everyday objects that shared a predominantly semantic relationship. The patients showed preserved item-specific recollection for the pictorial stimuli but, compared with control participants, exhibited significantly reduced utilization of gist information regarding the categories of objects. The latter result is consistent with the patients' degraded semantic knowledge. Experiment 2 involved categories of abstract objects that were related to one another perceptually rather than semantically. Patients with semantic dementia obtained item-specific recollection and gist memory scores that were indistinguishable from those of control participants. These results suggest that the reduction in gist memory in semantic dementia is largely specific to semantic representations and cannot be attributed to general difficulty with abstracting and/or utilizing gistlike commonalities between stimuli.

Keywords: frontotemporal dementia, temporal lobe, episodic memory, semantic memory, false memory

Over the last decade or so, false recognition has become one of the most extensively studied topics in memory research. The observation that, in certain circumstances, individuals can very often incorrectly claim to have previously encountered a novel word or object has led to a vast array of experimental work in which researchers have investigated distortions and illusions of remembering and have theorized about how they might inform the understanding of human memory processes. One widely used method for systematically producing false recognition of novel stimuli involves presenting an individual with a set of semantically related words or objects during a study phase. A remarkably robust finding is that, during a subsequent memory test, individuals are considerably more likely to claim to have encountered nonstudied items that are related to studied items than they are to claim to have encountered unrelated novel items (Deese, 1959; Roediger & McDermott, 1995). Moreover, false recognition is particularly evident when a large number of items from a given category are presented during the study phase, and indeed, false recognition often varies as a direct function of category size (see Schacter & Dodson, 2001, for a recent review).

To account for these results, some researchers have suggested that when an item is studied, such as the word *sugar,* individuals might implicitly think of a related item, such as the word *sweet.* If *sweet* is then presented as a related nonstudied item in the subsequent memory test, individuals might mistakenly claim to have encountered it in the study list because of their earlier implicit response (Roediger & McDermott, 1995; Underwood, 1965). An alternative explanation is that when multiple related items are studied, individuals have difficulty recollecting distinctive characteristics of specific studied items and instead tend to respond on the basis of general similarities between the related items—what has been called "gist" information (Brainerd, Reyna, & Kneer, 1995). It is difficult to distinguish between these two interpretations in the semantic associates false recognition paradigm used by Roediger and McDermott (1995). However, Koutstaal and Schacter (1997)

Jon S. Simons, Institute of Cognitive Neuroscience, University College London, London, England; Andy C. H. Lee, Kim S. Graham, and John R. Hodges, Medical Research Council Cognition and Brain Sciences Unit, Cambridge, England; Mieke Verfaellie, Memory Disorders Research Center, Boston University School of Medicine; Wilma Koutstaal, Department of Psychology, University of Minnesota; Daniel L. Schacter, Department of Psychology, Harvard University; Andrew E. Budson, Geriatric Research Education Clinical Center, Edith Nourse Rogers Memorial Veterans Hospital, Bedford, Massachusetts, and Division of Cognitive and Behavioral Neurology, Department of Neurology, Brigham and Women's Hospital, Boston, Massachusetts.

Additional materials are on the Web at http://dx.doi.org/10.1037/0894–4105.19.3.353.supp

This work was supported by the Medical Research Council, Wellcome Trust Grant 061171, and National Institute on Aging Grant AG08441. We are grateful to Netali Levi, Alison Sullivan, Kelly Giovanello, and Sharon Davies for assistance with participant testing and data processing.

Correspondence concerning this article should be addressed to Jon S. Simons, Institute of Cognitive Neuroscience, University College London, Alexandra House, 17 Queen Square, London WC1N 3AR, England. E-mail: jon.simons@ucl.ac.uk

presented evidence that false recognition can be based on gist information using a paradigm involving categorized pictures that individuals would be unlikely to themselves spontaneously generate during the study phase. For example, a number of different highly detailed pictures of chairs might have been studied in Koutstaal and Schacter's experiment. When, during the test phase, a nonstudied picture of a chair was presented, participants tended to make the mistaken claim to have studied the picture, suggesting that false recognition can occur even for items that are unlikely to have been thought of implicitly during the study phase. Instead, the authors proposed that participants may have been unable to recollect each of the specific instances of chairs that were studied and might have remembered only that numerous chairs were encountered. As a consequence of the lack of item-specific recollection for each studied chair and of relying instead on gist memory about the various chairs presented, the individuals tended incorrectly to endorse the nonstudied picture as having been encountered during the study phase (Brainerd et al., 1995; Koutstaal & Schacter, 1997).

The characteristics of false recognition phenomena have been examined in a variety of neuropsychological populations, including those associated with temporal lobe disruption, such as amnesic patients with medial temporal lobe damage (Koutstaal, Schacter, Verfaellie, Brenner, & Jackson, 1999; Koutstaal, Verfaellie, & Schacter, 2001; Melo, Winocur, & Moscovitch, 1999; Schacter, Verfaellie, & Pradere, 1996) and patients with Alzheimer's disease (Balota et al., 1999; Budson, Desikan, Daffner, & Schacter, 2001; Budson et al., 2003). The common finding in these studies is that, in addition to the impaired true recognition of studied items compared with that of control participants that is the hallmark of amnesia, these patient groups typically exhibit reduced false recognition of novel items that were related to studied items. These results have been interpreted as reflecting impaired item-specific recollection and diminished ability to utilize gist information relative to that of control participants (e.g., Schacter et al., 1996). The impaired item-specific recollection means that patients are, for example, less likely than control participants to remember specific instances of chairs they encountered at study and may thus fail to respond correctly when these items are presented again at test. Conversely, patients' diminished ability to utilize gist information means that they are less likely than control participants to remember that they encountered a number of chairs during the study phase, and as a result of not utilizing the gist representation relating the studied chairs, they may exhibit reduced false recognition in comparison with control participants.

From the above description, it is apparent that one difficulty with investigating the effects of temporal lobe damage on false recognition is that in studies of patients with medial temporal lobe amnesia or Alzheimer's disease, researchers have typically observed impairment in memory for both specific instances of items and gist information about related items. However, recent evidence suggests that medial temporal lobe damage might in fact have dissociable effects on item-specific recollection and gist memory, raising the possibility that the two forms of memory may draw on processes supported by different temporal lobe regions (Koutstaal, Verfaellie, & Schacter, 2001). One neuropsychological population that might potentially prove valuable in addressing this question is patients with semantic dementia (Hodges, Patterson, Oxbury, & Funnell, 1992; Snowden, Goulding, & Neary, 1989). These patients, who have atrophy that principally affects the anterolateral temporal lobe, typically exhibit preserved true recognition and item recollection for pictures of everyday objects, animals, and faces, despite severely degraded semantic knowledge about the remembered items (Graham, Becker, & Hodges, 1997; Graham, Simons, Pratt, Patterson, & Hodges, 2000; Simons, Graham, Galton, Patterson, & Hodges, 2001; Simons, Graham, & Hodges, 2002; Simons, Verfaellie, et al., 2002). Their performance on tests of false recognition has yet to be examined, however. On the basis of the preserved item recollection often observed, it might be predicted that for small categories of pictorial items, for which gist representations linking commonalities within categories make less of a contribution, patients with semantic dementia would show false recognition comparable to that of control participants. The degraded semantic knowledge that is characteristic of the disorder may, however, lead to reduced ability to abstract and/or utilize gist information. If, for example, patients' semantic knowledge about chairs has degraded, they may be less likely to be able to identify or activate associated knowledge about chairs when they encounter pictures of chairs during the study phase and thus also less likely than control participants to form a strong gist representation about the studied chairs. If this is the case, it can be predicted that patients with semantic dementia should show reduced false recognition particularly for large categories of semantically related items.

In this study, we investigated false recognition in patients with semantic dementia in two experiments. In Experiment 1, we used the paradigm devised by Koutstaal and Schacter (1997) involving categories of everyday objects that share a predominantly semantic relationship to examine whether, as predicted, patients with semantic dementia would exhibit reduced utilization of gist information as a result of degraded semantic knowledge, while still showing preserved item-specific recollection relative to that of control participants. In Experiment 2, we used categories of abstract objects that were related to one another perceptually rather than semantically and for which there were no real-world referents or preexisting semantic knowledge (Koutstaal et al., 1999) to investigate whether patients with semantic dementia would be able to utilize gist information relating to perceptual commonalities between stimuli to levels similar to that of control participants. In this way, we could address the question as to whether any reduction in gist memory observed in semantic dementia was specific to semantic gist representations or could be attributable to general difficulty with abstracting and/or utilizing gistlike commonalities between stimuli.

Experiment 1

Method

Participants. Sixteen participants were involved in Experiment 1, 8 with semantic dementia (4 men and 4 women) and 8 healthy control participants, who were matched by age and gender to the patients with semantic dementia. Mean (and standard deviation) ages for the two groups were as follows: semantic dementia, 59.6 years (SD = 6.0 years), and control participants, 59.0 years (SD = 5.4 years).

The patients with semantic dementia were identified through Memory Disorders clinics in Cambridge, England, and in Boston, MA. They all fulfilled the criteria for a diagnosis of semantic dementia (Hodges et al., 1992; Snowden, Neary, & Mann, 1996), as determined by senior

neurologists on the basis of neuropsychological test results and examination of structural MRI scans. A summary of the patients' performance on a battery of neuropsychological tests is shown in Table 1, with details of individual patient data documented in Table S1 on the Web at http://dx.doi.org/10.1037/0894–4105.19.3.353.supp.

It can be seen that the patients showed significant impairment on subtests from the Hodges and Patterson semantic battery (Hodges & Patterson, 1995), such as Picture Naming, Word–Picture Matching, and Category Fluency. Similarly, all of the patients with semantic dementia were impaired on the Pictures version of the Pyramid and Palm Trees test (Howard & Patterson, 1992). Consistent with this diagnosis, there was little or no evidence of impairment on tests tapping cognitive domains other than semantic memory, such as visuospatial and perceptual ability (Rey Figure test, copy: Osterrieth, 1944; Visual Object and Space Perception Battery: Warrington & James, 1991) and working memory (Digit Span subtest, Wechsler Adult Intelligence Scale; Wechsler, 1981). Of importance, in contrast to the patients' profound semantic knowledge degradation, episodic memory was relatively preserved, at least for nonverbal, pictorial stimuli (Rey Figure test, delayed recall: Osterrieth, 1944; Recognition Memory Test: Warrington, 1984). In structural brain imaging with MRI, we found focal atrophy involving anterior and inferolateral regions of one or both of the temporal lobes in all cases (see Figure S1 on the Web at http://dx.doi.org/10.1037/0894–4105.19.3.353.supp).

Design and materials. The stimuli used in the experiment were colored pictures of single objects (or, in a few cases, coherent groups of objects), which were first used in the study by Koutstaal and Schacter (1997). The pictures were selected from various object categories (e.g., boats, cats, chairs), each category consisting of 21 different exemplars, with 10 categories assigned to a *large* category size condition, 10 categories to a *single* category size condition, and 5 categories to a *novel* condition. During the study phase, 18 exemplars from each large category were presented, along with 1 exemplar from each single category and 24 miscellaneous noncategorized unrelated items. In the test phase, 3 studied exemplars and 3 nonstudied exemplars from each large category were presented, along with the 1 studied exemplar and 1 nonstudied exemplar from each single category and the 24 studied and 24 nonstudied unrelated items. In addition, 3 exemplars from each novel category were presented during the test phase to provide estimates of baseline false recognition. The assignment of categories was systematically counterbalanced across studied and nonstudied status separately for each condition, and items from the various categories and category sizes were randomly intermixed throughout the study and test phases.

Procedure. The experiment involved a study and a test phase. During the study phase, participants were presented with 214 color pictures one after the other on a monitor screen and were asked to rate whether they liked each picture. Each item was presented for 2 s before the screen went blank, but participants could take as long as they needed to make the liking judgment. No mention was made of a subsequent memory test. A 15-min retention interval followed the study phase, during which participants undertook abstract problem solving tasks, such as Raven's (1962) progressive matrices.

In the test phase, 143 pictures were presented, and participants were asked to decide whether each item had been shown during the previous study phase. There was no time pressure on participants to make their recognition memory decisions.

Results

The proportions of "old" responses to studied and nonstudied items in each condition are presented in Table 2. Looking first at incorrect "old" responses to nonstudied novel items, there was no

Table 1
Performance of Patients With Semantic Dementia and Control Participants on a Range of Neuropsychological Tests

	Group					
	Semantic dementia					
	Experiment 1		Experiment 2		Control (n = 24)	
Test	*M*	*SD*	*M*	*SD*	*M*	*SD*
Semantic memory						
Picture naming (64)	22.6	19.4	23.2	20.2	62.3	1.6
Word–picture matching (64)	43.6	18.7	45.3	14.9	63.7	0.5
Category fluency	21.8	17.0	21.5	20.5	113.9	12.3
PPT–Pictures (52)	40.9	7.0	41.9	5.5	51.2	1.4
Episodic memory						
Rey Figure—delayed recall (36)	14.8	7.5	16.5	9.7	15.3	7.4
RMT–Faces (proportions)	0.8	0.1	0.7	0.1	0.9	0.1
RMT–Words (proportions)	0.8	0.1	0.7	0.2	1.0	0.1
Visuoperceptual ability						
Rey Figure—copy (36)	34.0	2.3	35.4	1.8	34.0	2.9
VOSP						
Incomplete Letters (20)	19.0	1.4	18.3	1.4	19.2	0.8
Object Decision (20)	16.8	2.1	17.6	2.3	16.9	2.3
Dot Counting (10)	9.8	0.5	8.5	3.2	9.9	0.3
Cube Analysis (10)	9.8	0.5	9.6	0.5	9.7	2.5
Working memory						
Digit Span—Forward	6.4	1.2	6.1	1.7	6.8	0.9
Digit Span—Backward	4.8	1.2	4.2	2.2	4.7	1.2

Note. Values in parentheses indicate maximum scores on each test. Control participants' data are from Hodges and Patterson (1995). PPT = Pyramid and Palm Trees Test; RMT = Recognition Memory Test; VOSP = Visual Object and Space Perception battery.

Table 2
Uncorrected True and False Recognition in Experiment 1

	Group			
	Semantic dementia		Control	
Condition	*M*	*SD*	*M*	*SD*
True recognition				
Large	.75	.12	.87	.09
Single	.81	.16	.90	.12
False recognition				
Large	.46	.16	.54	.14
Single	.15	.11	.05	.05
Novel	.11	.09	.05	.05

significant difference between the group of patients with semantic dementia and the control participants in terms of baseline false responding to items for which no category-related exemplars were presented at study, $F(1, 14) = 2.59$, *ns.* Nevertheless, it is possible for each individual that true and false alarm rates to categorized items might have been influenced by differences in baseline tendency to falsely respond to nonstudied items. To address this possibility, we corrected participants' scores for each category condition by subtracting the proportion of "old" responses to novel items from the proportions of "old" responses to categorized items, both studied items (true recognition) and nonstudied items (false recognition).

Turning first to true recognition, corrected proportions for the large and single item categories were .82 and .85 for the control participants and .65 and .70 for the patients with semantic dementia. There was a significant effect of group on the large categories, $F(1, 14) = 9.24$, $p < .01$, but not on the single item categories, $F(1, 14) = 2.25$, *ns* (although a nonsignificant numerical difference was apparent on the latter). In terms of false recognition, corrected proportions for the large and single item categories were .49 and .00 for the control participants and .35 and .04 for the patients with semantic dementia. There was a significant difference between the two groups in false recognition of the large categories, $F(1, 14) = 5.42$, $p < .05$, but not of the single item categories, $F(1, 14) = 0.57$, *ns.*

As described in the introduction, recognition of items in this categorized pictures task is considered to be supported by a combination of gist memory and item-specific recollection (Brainerd et al., 1995). In contrast, false recognition of nonstudied related lure items is thought to reflect gist memory minus any item-specific memory that is available to counteract the effect of gist (Koutstaal & Schacter, 1997). To assess whether the diminished performance in the large category conditions by the patients with semantic dementia might be attributable to reduced item-specific memory or to reduced gist memory, we performed an analysis using signal detection methods that provide estimates of sensitivity and response bias (A' and B''_D, respectively; Donaldson, 1992). Values of A' can vary between 0 and 1, with higher values indicating greater sensitivity and .5 representing chance performance. Values of B''_D can vary between -1 and $+1$, with negative values indicating liberal responding, positive values indicating a conservative criterion, and 0 indicating neutral bias. Following previous practice, we estimated item-specific memory by comparing studied items and nonstudied related lure items, and we estimated gist memory by comparing related lure items and novel lure items (Koutstaal & Schacter, 1997; Koutstaal, Schacter, & Brenner, 2001).

The measures of sensitivity and response bias for item-specific memory and gist memory for the large category items are shown in Table 3. There was no significant difference in sensitivity between the groups in terms of item-specific memory, $F(1, 14) = 1.49$, *ns*, but the patients with semantic dementia were significantly less likely than the control participants to use gist memory in their recognition judgments, $F(1, 14) = 8.77$, $p = .01$. Looking next at response bias, there was a trend for the patients with semantic dementia toward using a less lenient response criterion than did control participants in terms of item-specific memory, $F(1, 14) = 3.65$, $p = .08$, but in terms of gist memory, both groups used a similar, relatively conservative criterion, $F(1, 14) = 0.46$, *ns.*

Discussion

In this first experiment, patients with semantic dementia showed significant reductions compared with control participants in recognition of both studied and nonstudied exemplars from large object categories. True and false recognition of single category exemplars was not significantly impaired (although a nonsignificant numerical difference was observed for true recognition). On the basis that control participants produce false alarms on this task because they rely on "gist" representations, it follows that studying a large number of categorically related items can be expected to lead to a greater accumulation of gist information than would studying single category items. The observed pattern of results suggests, therefore, that the patients with semantic dementia were not as capable as control participants of extracting and/or utilizing gist information, and thus, they were impaired at both true and false recognition of items from large categories. The analysis of sensitivity measures was consistent with this possibility, indicating that patients with semantic dementia were significantly less likely than control participants to use gist memory to support their recognition judgments. In contrast, the patients' item-specific recollection was not significantly less sensitive than that used by control participants.

Table 3
Measures of Item-Specific Memory and Gist Memory for the Large Item Categories in Experiment 1

	Group			
	Semantic dementia		Control	
Condition	*M*	*SD*	*M*	*SD*
Item-specific memory[a]				
Sensitivity (A')	.73	.07	.77	.05
Bias (B''_D)	−.39	.40	−.71	.24
Gist memory[b]				
Sensitivity (A')	.78	.05	.84	.04
Bias (B''_D)	.72	.34	.81	.15

[a] Studied items versus nonstudied lure items. [b] Related lure items versus novel lure items.

Given that patients with semantic dementia are characterized by degraded semantic memory, one might surmise from the present results that, when studying large categories of related objects, the patients do not develop semantic gist representations concerning the objects to the same extent as do control participants. However, the object exemplars used in the present experiment are likely to have been related to one another perceptually as well as semantically. For example, even the most varied selection of chairs may share multiple perceptual features between exemplars, such as a seat, a back, legs, and so forth. It is possible, then, that it is not the patients' semantic knowledge impairment that results in their reduced gist memory but rather an impairment in abstracting and/or utilizing any kind of gist information.

One way to address the extent of the patients' impairment is to assess true and false recognition with the use of stimuli that are related to each other perceptually but not semantically. This was the aim of Experiment 2. Categories of abstract objects (i.e., novel objects for which there were no real-world referents or preexisting semantic knowledge) were used as stimuli in a recognition memory test, with exemplars in each category created by manipulating various perceptual features of a prototype abstract object. If patients with semantic dementia have a general impairment in the use of gist information, then we predicted similar results to Experiment 1, with significant reductions in gist memory and thus in recognition of large category exemplars relative to that of control participants. If, however, the deficit in semantic dementia is specific to the use of semantic gist information, then we predicted that the patients would not be significantly impaired in their true and false recognition of these stimuli and would show similar effects of category size on gist memory as the control participants.

Experiment 2

Method

Participants. Twenty participants were involved in Experiment 2, 11 patients with semantic dementia (7 men and 4 women) and 9 healthy control participants, who were matched as a group by age and gender to the patients with semantic dementia. Mean (and standard deviation) ages for the two groups were as follows: semantic dementia, 62.2 years ($SD = 4.8$ years), and control participants, 62.2 years ($SD = 5.5$ years). Four of the patients with semantic dementia were also involved in Experiment 1, with a gap of 18 to 24 months between experiments. The remaining patients were identified and diagnosed according to the same criteria as in Experiment 1. Table 1 and Table S2 on the Web at http://dx.doi.org/10.1037/0894–4105.19.3.353.supp show that the performance of the patients on standard neuropsychological tests was similar to that typically observed, with significant impairment on tests of semantic memory and relative preservation of nonverbal episodic memory, visuoperceptual skills, and working memory.

Design and materials. The stimuli used in this experiment were colored pictures of complex, multifeatured, abstract objects, which were first used in the study by Koutstaal et al. (1999). Categories of abstract objects were produced by creating a novel prototype object using a computer graphics program and then generating additional exemplars that belonged to the same category by manipulating various physical features of the prototype object, such as shape, color, outline, size, and placement. Categories were assigned to one of 4 category size conditions for studied items: 3 categories to a *large* category size condition, 3 to a *medium* category size condition, 3 to a *small* category size condition, and 6 to a *single* category size condition. There were 5 conditions for nonstudied items: the aforementioned 4 size conditions plus 3 categories that were assigned to a *novel* condition.

During the study phase, 9 exemplars from each large category were presented, along with 6 exemplars from each medium category, 3 exemplars from each small category, and 1 exemplar from each single category, as well as 12 noncategorized unrelated items and 3 buffer items at the start and end of the list. In the test phase, 3 studied exemplars, 3 nonstudied exemplars, and the nonstudied prototype from each category size were presented, with the exception of the single categories, for which only the single studied exemplar, 1 nonstudied exemplar, and the nonstudied prototype were shown. The 12 studied and 12 nonstudied unrelated items were presented, as were 3 exemplars and the prototype from each of the novel categories, which were included to provide estimates of baseline false recognition. In all, therefore, 45 studied and 72 nonstudied items were shown during the test phase. The assignment of categories to each condition was systematically counterbalanced across studied and nonstudied status, and items from the various categories and category sizes were randomly intermixed throughout the study and test phases.

Procedure. In the study phase, 78 abstract object pictures were presented one after the other on a monitor screen, and as before, participants were asked to rate whether they liked each picture. Each item was presented for 2 s before the screen went blank, but participants could take as long as they needed to make the liking judgment. No mention was made of a subsequent memory test. A 15-min retention interval followed the study phase, during which participants undertook unrelated tasks.

A total of 117 pictures were presented in the test phase, and participants were asked to decide whether each item had been presented during the previous study phase. Just as in the previous experiment, the test phase was self-paced, with no time pressure on participants to make their recognition memory decisions.

Results

The proportions of "old" responses to studied and nonstudied items in each condition are presented in Table 4. Looking first at baseline false responding to nonstudied novel items, there was no significant difference between the group of patients with semantic dementia and the control participants, $F(1, 18) = 0.39$, *ns.* Despite this result, the possible influence of differences in the participants'

Table 4
Uncorrected True and False Recognition in Experiment 2

	Group			
	Semantic dementia		Control	
Condition	*M*	*SD*	*M*	*SD*
True recognition				
Large	.65	.24	.79	.14
Medium	.59	.26	.74	.17
Small	.60	.28	.73	.15
Single	.53	.29	.61	.26
False recognition				
Large	.60	.17	.71	.16
Medium	.57	.30	.69	.17
Small	.51	.26	.56	.17
Single	.38	.20	.36	.22
Novel	.40	.29	.31	.34

baseline tendency to falsely respond to nonstudied items was controlled for, as in the previous experiment, by subtracting the proportion of "old" responses to novel items from the true and false recognition proportions.

Turning first to true recognition, corrected proportions for the large, medium, small, and single item categories were .48, .43, .42, and .30, respectively, for the control participants and .25, .19, .20, and .13, respectively, for the patients with semantic dementia. A Group × Category Size analysis of variance revealed no significant effects of group, $F(1, 18) = 3.12$, *ns,* or of category size, $F(3, 54) = 2.25$, *ns,* and no interaction between the two, $F(3, 54) = 0.16$, *ns.* We note that although the tests for main effects were not significant, numerical differences did exist. To examine these more closely, we compared large and single item categories directly. There remained no significant effect of group, $F(1, 18) = 2.20$, *ns,* but a significant main effect of category size emerged, $F(1, 18) = 4.74$, $p < .05$. There was no interaction between the two factors, $F(1, 18) = 0.22$, *ns.* Looking at the category size conditions individually, there was no effect of group on the large categories, $F(1, 18) = 1.76$, *ns,* or on the single item categories, $F(1, 18) = 1.84$, *ns.*

In terms of false recognition, corrected proportions for the large, medium, small, and single item categories were .40, .38, .25, and .05, respectively, for the control participants and .20, .17, .11, and −.02, respectively, for the patients with semantic dementia. A Group × Category Size analysis of variance revealed no significant effect of group, $F(1, 18) = 3.07$, *ns,* and a significant main effect of category size, $F(3, 54) = 12.64$, $p < .01$, but no interaction, $F(3, 54) = 0.84$, *ns.* To examine the nonsignificant main effect of group more closely, we compared the large and single item categories directly. This analysis produced a similar result to the first: no effect of group, $F(1, 18) = 1.89$, *ns,* a significant effect of category size, $F(1, 18) = 34.81$, $p < .01$, and no interaction, $F(1, 18) = 1.90$, *ns.* Looking at the category size conditions individually, there was no significant effect of group on the large item category, $F(1, 18) = 2.73$, *ns,* or the single item category, $F(1, 18) = 0.52$, *ns.*

Despite the patients with semantic dementia showing no statistically significant impairment on true or false recognition in Experiment 2, inspection of the data reveals that the two groups did not perform identically, with differences of around 0.2 between some of the group means. To investigate performance in more detail, we performed analyses of item-specific memory and gist memory similar to those of Experiment 1. The measures of sensitivity (A') and response bias (B''_D) for item-specific memory and gist memory for the large category items are shown in Table 5. It can be seen that there were no significant differences in sensitivity between the groups in terms of item-specific recollection (memory for studied items as opposed to nonstudied related lure items), $F(1, 18) = 0.10$, *ns,* or gist memory (distinguishing between related lure items and novel lure items), $F(1, 18) = 1.43$, *ns.* The results with regard to response bias were similar to the previous experiment, with the patients with semantic dementia showing a trend toward using a less lenient response criterion than did control participants in terms of item-specific memory, $F(1, 18) = 4.08$, $p = .06$, but no difference in terms of gist memory, $F(1, 18) = 0.01$, *ns.*

Table 5
Measures of Item-Specific Memory and Gist Memory for the Large Item Categories in Experiment 2

	Group			
	Semantic dementia		Control	
Condition	*M*	*SD*	*M*	*SD*
Item-specific memory[a]				
Sensitivity (A')	.54	.21	.56	.17
Bias (B''_D)	−.39	.53	−.77	.22
Gist memory[b]				
Sensitivity (A')	.65	.20	.75	.21
Bias (B''_D)	.00	.69	.02	.75

[a] Studied items versus nonstudied related lure items. [b]Related lure items versus novel lure items.

Comparison Between Experiments 1 and 2

To establish the veracity of the apparent difference between experiments in terms of the utilization of gist memory by the patients with semantic dementia, we converted measures of sensitivity to gist from both experiments into z scores to enable comparison across tasks for the two semantic dementia groups. This analysis confirmed that the patients with semantic dementia were indeed more impaired in their use of gist information in Experiment 1 ($M = -1.49$) than in Experiment 2 ($M = -0.52$), Mann–Whitney $U = 19.0$, $p < .05$.

Discussion

In Experiment 2, patients with semantic dementia were not significantly impaired compared with control participants in the recognition of either studied or nonstudied exemplars from categories of abstract objects. There was evidence from both groups that increased category size was associated with increases in both true and false recognition, suggesting that both groups were similarly able to utilize information about the perceptual commonalities or "gist" linking the exemplars within the categories. Analysis of each of the category sizes individually failed to reveal significant group differences for either true or false recognition, although inspection of the group means did suggest possible differences in performance that did not reach the threshold for statistical significance. Further analyses indicated that these numerical disparities were not due to differences in sensitivity between the groups, but might be attributable to the adoption of a more conservative response criterion by the patients with semantic dementia. It should be borne in mind, however, that lack of power and variability between patients may also have contributed to the nonsignificance of these effects. Of importance, there were no significant gist memory differences between the groups in either sensitivity or response bias, results that are consistent with the idea that the patients with semantic dementia were able to utilize the perceptual gist available in the stimuli to an extent similar to that of control participants. We compared the results with those of the previous experiment using a nonparametric test that takes variance differences between experiments into account, confirming that gist uti-

lization in semantic dementia was significantly greater when categories were related perceptually rather than semantically.

General Discussion

The present experiments produced two findings of particular interest. First, patients with semantic dementia, who have deficits in semantic memory associated with temporal lobe atrophy, were significantly impaired in their ability to utilize gist information available from semantically related categories of visual objects. Second, this impairment appeared to be relatively specific to semantic aspects of gist, as there was no significant difference between patients with semantic dementia and control participants when, instead, gist memory for categories of perceptually related abstract objects, without any real-world referents or preexisting semantic knowledge, was assessed. This dissociation in semantic dementia was confirmed by direct comparison between the tasks, with semantic dementia patients demonstrating significantly greater utilization of gist when objects were related perceptually rather than semantically.

The patients in the present experiments were not significantly impaired in terms of item-specific recollection, performing similarly to control participants on measures of sensitivity both for pictures of everyday objects and for pictures of abstract shapes—results that are consistent with several previous studies of recognition memory in semantic dementia. These studies have demonstrated intact recognition memory for line drawings and color photographs of everyday objects, animals, and faces in patients with semantic dementia (Graham et al., 1997, 2000; Simons et al., 2001; Simons, Graham, & Hodges, 2002). In a recent study, item memory performance was shown to be supported in many patients by preservation of both familiarity and recollection components of recognition (Simons, Verfaellie, et al., 2002). Assessments of response bias have not been made before in studies of recognition memory in semantic dementia. In the present study, we identified trends in both experiments toward less lenient responding by the patients with semantic dementia on measures of item-specific recollection, although there were no differences in response bias for gist memory, for which both groups were relatively conservative (Experiment 1) or essentially unbiased (Experiment 2). It is important to note, however, that there were several nonsignificant numerical differences between groups in these experiments, possibly due to the lack of power and variability between patients that are among the difficulties of investigating such a rare progressive disorder. Further studies of false recognition in semantic dementia are therefore required to establish the reliability and generalizability of the present findings.

There is accruing evidence that the typical pattern of atrophy in semantic dementia, although originating in the anterior lateral temporal lobe, eventually spreads posteriorly and medially to involve the rest of the temporal cortex (Chan et al., 2001; Galton et al., 2001). Evidence also suggests progression of atrophy into the frontal lobes, with significant gray-matter reductions found in the ventromedial prefrontal cortex with the use of the voxel-based morphometry technique (Mummery et al., 2000), and with impairments being reported on standard tests of frontal lobe function (Perry & Hodges, 2000; Simons, Verfaellie, et al., 2002). In several previous studies, researchers have reported that patients with frontal lobe lesions showed high levels of false recognition. For example, Schacter and colleagues described a patient with right frontal lobe damage who made a pathologically high number of false alarm responses to nonstudied verbal and visual stimuli (Curran, Schacter, Norman, & Galluccio, 1997; Schacter, Curran, Galluccio, Milberg, & Bates, 1996), and other studies have documented similar performance patterns (Budson et al., 2002; Delbecq-Derouesné, Beauvois, & Shallice, 1990; Parkin, Bindschaedler, Harsent, & Metzler, 1996; Ward et al., 1999). On the basis of these studies, one might expect that patients with semantic dementia would also show higher levels of baseline false responding than would control participants. However, this was not the case in either of the present experiments, with no significant differences being observed between the groups in false recognition of novel items for which no related items were presented at study. This suggests that any frontal lobe atrophy in the patients with semantic dementia may have relatively spared the particular frontal regions implicated in the lesion studies described above (e.g., Budson et al., 2002), although future neuroradiological studies are required to confirm this possibility.

Despite the fact that the patient and control groups showed similar baseline levels of false alarms to novel items, significant group differences emerged in Experiment 1 in recognition of both studied and nonstudied exemplars from object categories for which a large number of related exemplars had been presented at study. No significant differences were seen for categories for which only a single item was presented at study, although, as noted, the performance of patients and control participants was not identical. A clearer picture emerged from the analyses of item-specific recollection and gist memory. These confirmed that item-specific recollection was preserved in the patients with semantic dementia, in contrast to the performance previously observed in patients with Alzheimer's disease on the same paradigm, whose item-specific recollection was consistently impaired (Budson et al., 2003). This type of pattern—superior memory for objects in semantic dementia compared with that found in Alzheimer's disease—has been observed a number of times on tests of recognition memory (Graham et al., 1997, 2000; Simons, Graham, & Hodges, 2002). The reason for such consistently divergent patterns of memory performance in disorders that both involve some degree of medial temporal lobe atrophy is unclear. In semantic dementia, there is evidence that atrophy of this region may be more asymmetric than in Alzheimer's disease, affecting the left hemisphere more than the right and with perhaps more marked atrophy anteriorly than posteriorly within the medial temporal lobe (Chan et al., 2001; Galton et al., 2001). Future investigations are required to evaluate whether these differences, or perhaps variation at the histopathological level, can explain the often contrasting patterns of memory performance in the two disorders. In terms of cognitive theories of episodic memory function, the fact that in semantic dementia, relatively accurate item-specific recollection for such stimuli can be maintained in the context of severely degraded semantic knowledge, is inconsistent with theories suggesting that episodic memory is solely dependent on semantic knowledge (Tulving, 1995; Tulving & Markowitsch, 1998). Instead, the present data showed that the patients' semantic impairment was associated with reduced ability to utilize the semantic gist information present in the large categories of objects.

The results of Experiment 2 demonstrated that patients with semantic dementia were not significantly impaired in their ability

to utilize other kinds of gist information. Relative to control participants, the patients showed no significant impairment in recognition of either studied or nonstudied exemplars from categories of abstract objects, although, as before, nonsignificant numerical differences (perhaps due to lack of power) restrict the conclusions that can be drawn from these scores. As in Experiment 1, however, the measures of item-specific recollection and gist memory provided clearer results, with no significant differences emerging on either component of memory. This pattern of results is, as in the previous experiment, in contrast to performance in Alzheimer's disease, in which significantly impaired item-specific recollection and gist memory have been observed (Budson et al., 2001). This relative preservation of recognition memory for abstract pictorial stimuli, which were designed to have reduced semantic associations compared with everyday objects, is consistent with previous observations of accurate recognition memory for unfamiliar faces (Simons et al., 2001) and novel patterns (Lee, Rahman, Hodges, Sahakian, & Graham, 2003) in semantic dementia. Taken together with the results of Experiment 1, these data are consistent with a view of episodic memory in which item memory is typically supported by information from perceptual and semantic systems, and in the context of degraded semantic knowledge, recognition memory for pictorial stimuli can be supported primarily on the basis of perceptual information (Graham et al., 2000; Simons et al., 2001, Simons, Verfaellie, et al., 2002).

The present data provide further evidence that it is possible to distinguish between components of recognition such as item-specific recollection and memory for various kinds of gist information (Brainerd et al., 1995; Koutstaal & Schacter, 1997). The patients with semantic dementia exhibited preserved item-specific recollection, as evidenced by preserved performance on the single item categories in both experiments. In terms of gist memory, a dissociation was observed between significantly impaired use of semantic gist information (Experiment 1) but relative preservation of perceptual gist utilization (Experiment 2). The evidence suggests that patients with semantic dementia were able to notice perceptual commonalities between objects and use that information in a manner similar to that of control participants to enhance their recognition memory for those items, but when it came to semantic associations between objects, the patients simply failed to get the gist.

References

Balota, D. A., Cortese, M. J., Duchek, J. M., Adams, D., Roediger, H. L., McDermott, K. B., & Yerys, B. E. (1999). Veridical and false memories in healthy older adults and in dementia of the Alzheimer's type. *Cognitive Neuropsychology, 16,* 361–384.

Brainerd, C. J., Reyna, V. F., & Kneer, R. (1995). False-recognition reversal: When similarity is distinctive. *Journal of Memory and Language, 34,* 157–185.

Budson, A. E., Desikan, R., Daffner, K. R., & Schacter, D. L. (2001). Perceptual false recognition in Alzheimer's disease. *Neuropsychology, 15,* 230–243.

Budson, A. E., Michalska, K. J., Sullivan, A. L., Rentz, D. M., Daffner, K. R., & Schacter, D. L. (2003). False recognition in Alzheimer's disease: Evidence from categorized pictures. *Cognitive and Behavioral Neurology, 16,* 16–27.

Budson, A. E., Sullivan, A. L., Mayer, E., Daffner, K. R., Black, P. M., & Schacter, D. L. (2002). Suppression of false recognition in Alzheimer's disease and in patients with frontal lobe lesions. *Brain, 125,* 2750–2765.

Chan, D., Fox, N. C., Scahill, R. I., Crum, W. R., Whitwell, J. L., Leschziner, G., et al. (2001). Patterns of temporal lobe atrophy in semantic dementia and Alzheimer's disease. *Annals of Neurology, 49,* 433–442.

Curran, T., Schacter, D. L., Norman, K. A., & Galluccio, L. (1997). False recognition after a right frontal lobe infarction: Memory for general and specific information. *Neuropsychologia, 35,* 1035–1049.

Deese, J. (1959). On the prediction of occurrence of particular verbal intrusions in immediate recall. *Journal of Experimental Psychology, 58,* 17–22.

Delbecq-Derouesné, J., Beauvois, M.-F., & Shallice, T. (1990). Preserved recall versus impaired recognition. *Brain, 113,* 1045–1074.

Donaldson, W. (1992). Measuring recognition memory. *Journal of Experimental Psychology: General, 121,* 275–277.

Galton, C. J., Patterson, K., Graham, K. S., Lambon Ralph, M. A., Williams, G., Antoun, N., et al. (2001). Differing patterns of temporal atrophy in Alzheimer's disease and semantic dementia. *Neurology, 57,* 216–225.

Graham, K. S., Becker, J. T., & Hodges, J. R. (1997). On the relationship between knowledge and memory for pictures: Evidence from the study of patients with semantic dementia and Alzheimer's disease. *Journal of the International Neuropsychological Society, 3,* 534–544.

Graham, K. S., Simons, J. S., Pratt, K. H., Patterson, K., & Hodges, J. R. (2000). Insights from semantic dementia on the relationship between episodic and semantic memory. *Neuropsychologia, 38,* 313–324.

Hodges, J. R., & Patterson, K. (1995). Is semantic memory consistently impaired early in the course of Alzheimer's disease? Neuroanatomical and diagnostic implications. *Neuropsychologia, 33,* 441–459.

Hodges, J. R., Patterson, K., Oxbury, S., & Funnell, E. (1992). Semantic dementia: Progressive fluent aphasia with temporal lobe atrophy. *Brain, 115,* 1783–1806.

Howard, D., & Patterson, K. (1992). *Pyramids and Palm Trees: A test of semantic access from pictures and words.* Bury St. Edmunds, United Kingdom: Thames Valley Test Company.

Koutstaal, W., & Schacter, D. L. (1997). Gist-based false recognition of pictures in older and younger adults. *Journal of Memory and Language, 37,* 555–583.

Koutstaal, W., Schacter, D. L., & Brenner, C. (2001). Dual task demands and gist-based false recognition of pictures in younger and older adults. *Journal of Memory and Language, 44,* 399–426.

Koutstaal, W., Schacter, D. L., Verfaellie, M., Brenner, C., & Jackson, E. M. (1999). Perceptually based false recognition of novel objects in amnesia: Effects of category size and similarity to category prototypes. *Cognitive Neuropsychology, 16,* 317–341.

Koutstaal, W., Verfaellie, M., & Schacter, D. L. (2001). Recognizing identical versus similar categorically related common objects: Further evidence for degraded gist representations in amnesia. *Neuropsychology, 15,* 268–289.

Lee, A. C. H., Rahman, S., Hodges, J. R., Sahakian, B. J., & Graham, K. S. (2003). Associative and recognition memory for novel objects in dementia: Implications for diagnosis. *European Journal of Neuroscience, 18,* 1660–1670.

Melo, B., Winocur, G., & Moscovitch, M. (1999). False recall and false recognition: An examination of the effects of selective and combined lesions to the medial temporal lobe/diencephalon and frontal lobe structures. *Cognitive Neuropsychology, 16,* 343–359.

Mummery, C. J., Patterson, K., Price, C. J., Ashburner, J., Frackowiak, R. S. J., & Hodges, J. R. (2000). A voxel-based morphometry study of semantic dementia: Relationship between temporal lobe atrophy and semantic memory. *Annals of Neurology, 47,* 36–45.

Osterrieth, P. A. (1944). Le test de copie d'une figure complexe [The test of copying a complex figure]. *Archives de Psychologie, 30,* 205–220.

Parkin, A. J., Bindschaedler, C., Harsent, L., & Metzler, C. (1996). Pathological false alarm rates following damage to the left frontal cortex. *Brain and Cognition, 32,* 14–27.

Perry, R. J., & Hodges, J. R. (2000). Differentiating frontal and temporal variant frontotemporal dementia from Alzheimer's disease. *Neurology, 54,* 2277–2284.

Raven, J. C. (1962). *Coloured progressive matrices.* London: H. K. Lewis.

Roediger, H. L., & McDermott, K. B. (1995). Creating false memories: Remembering words not presented in lists. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 21,* 803–814.

Schacter, D. L., Curran, T., Galluccio, L., Milberg, W. P., & Bates, J. F. (1996). False recognition and the right frontal lobe: A case study. *Neuropsychologia, 34,* 793–808.

Schacter, D. L., & Dodson, C. S. (2001). Misattribution, false recognition and the sins of memory. *Philosophical Transactions of the Royal Society of London Series B: Biological Sciences, 356,* 1385–1393.

Schacter, D. L., Verfaellie, M., & Pradere, D. (1996). The neuropsychology of memory illusions: False recall and recognition in amnesic patients. *Journal of Memory and Language, 35,* 319–334.

Simons, J. S., Graham, K. S., Galton, C. J., Patterson, K., & Hodges, J. R. (2001). Semantic knowledge and episodic memory for faces in semantic dementia. *Neuropsychology, 15,* 101–114.

Simons, J. S., Graham, K. S., & Hodges, J. R. (2002). Perceptual and semantic contributions to episodic memory: Evidence from semantic dementia and Alzheimer's disease. *Journal of Memory and Language, 47,* 197–213.

Simons, J. S., Verfaellie, M., Galton, C. J., Miller, B. L., Hodges, J. R., & Graham, K. S. (2002). Recollection-based memory in frontotemporal dementia: Implications for theories of long-term memory. *Brain, 125,* 2523–2536.

Snowden, J. S., Goulding, P. J., & Neary, D. (1989). Semantic dementia: A form of circumscribed cerebral atrophy. *Behavioural Neurology, 2,* 167–182.

Snowden, J. S., Neary, D., & Mann, D. M. A. (1996). *Fronto-temporal lobar degeneration: Fronto-temporal dementia, progressive aphasia, semantic dementia.* New York: Churchill Livingstone.

Tulving, E. (1995). Organization of memory: Quo vadis? In M. S. Gazzaniga (Ed.), *The cognitive neurosciences* (1st ed., pp. 839–847). Cambridge, MA: MIT Press.

Tulving, E., & Markowitsch, H. J. (1998). Episodic and declarative memory: Role of the hippocampus. *Hippocampus, 8,* 198–204.

Underwood, B. J. (1965). False recognition produced by implicit verbal responses. *Journal of Experimental Psychology, 70,* 122–129.

Ward, J., Parkin, A. J., Powell, G., Squires, E. J., Townshend, J., & Bradley, V. (1999). False recognition of unfamiliar people: "Seeing film stars everywhere." *Cognitive Neuropsychology, 16,* 293–315.

Warrington, E. K. (1984). *Recognition Memory Test.* Windsor, United Kingdom: NFER Nelson.

Warrington, E. K., & James, M. (1991). *The Visual Object and Space Perception Battery.* Bury St. Edmunds, United Kingdom: Thames Valley Test Company.

Wechsler, D. (1981). *Manual for the Wechsler Adult Intelligence Scale—Revised.* New York: Psychological Corporation.

Received December 10, 2003
Revision received April 28, 2004
Accepted May 20, 2004 ■