Anomaly Judgments of Subject–Predicate Relations in Alzheimer’s Disease

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Claims that patients with probable Alzheimer’s disease (AD) have semantic memory difficulty have received equivocal support. A common assumption has been that defining or core information determines the truth value of word meaning on measures requiring semantic memory such as category membership judgments or confrontation naming, but this assumption may not be valid. In the present study, we assessed the comprehension of subject–predicate sentences independent of their truth value by asking AD patients to judge the coherence of statements such as ‘‘The tulip is tall’’ or ‘‘The tulip is jealous.’’ We found that AD patients are significantly more impaired than controls at judging the coherence of these simple subject–predicate sentences. Moreover, AD patients were more successful at judging the coherence of statements that contain attributes with a narrow scope of reference compared to attributes with a broad scope of reference. These findings support the hypothesis that AD patients have a semantic memory impairment and suggest a specific deficit processing the network of semantic relations underlying word meaning in semantic memory.

INTRODUCTION

Semantic memory is the mental representation of word, object, and action meaning in long-term memory (Jackendoff, 1983; Tulving, 1972). Semantic memory difficulty is thought to interfere with language comprehension in probable Alzheimer’s disease (AD) (Bayles, Tomoeda, & Trosset, 1990; Chan, Butters, Paulsen, Salmon, Swenson, & Maloney, 1993; Chertkow, Bub, & Seidenberg, 1990; Albert & Milberg, 1989; Grossman & Mickanin, 2005). This work was supported in part by funding from the US Public Health Service (DC00039 and AG09399) and the Charles A. Dana Foundation. We express our appreciation to Patricia Giampapa for her assistance in preparing the manuscript. Dr. Robinson’s current address is Department of Rehabilitation Medicine, Hospital of the University of Pennsylvania, 3400 Spruce Street, Philadelphia, PA 19104-4283. Address reprint requests to Murray Grossman, Cognitive Neurology Section, Department of Neurology, Hospital of the University of Pennsylvania, 3400 Spruce Street, Philadelphia, PA 19104-4283. Fax: (215)349-5579. E-mail: mgrossma@mail.med.upenn.edu.

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ANOMALY JUDGMENTS IN AD

1994; Hodges, Salmon, & Butters, 1992). However, there is little agreement on the nature, the extent, or even the existence of this semantic memory deficit in AD (Nebes & Brady, 1990; Nebes, Boller, & Holland, 1986; Ober, Shenaut, Jagust, & Stillman, 1991; Smith, Faust, Beeman, Kennedy, & Perry, 1995). A common but controversial assumption underlying many studies of semantic memory has been that defining or core attributes allow a truth value to be assigned to word meaning on tasks such as category membership judgments, semantically guided category naming fluency, or judgments of attributes associated with an object. The purpose of this study was to obtain converging evidence for a lexical semantic impairment in AD from a different theoretical perspective that is less dependent on truth values.

Several different approaches have been brought to bear in an attempt to define the presence and nature of semantic memory difficulty in AD. For example, reports have described the production of semantically related paraphasic errors in spontaneous speech, semantically guided category naming fluency, and confrontation naming tasks (Butters, Granholm, Salmon, Grant, & Wolfe, 1987; Chan et al., 1993; Martin & Fedio, 1983; Mickanin, Grossman, Onishi, Auriacombe, & Clark, 1994; Troster, Salmon, McCullough, & Butters, 1989), the selection of semantically related foils on multiple-choice naming recognition, word-word matching, and word-picture matching tasks (Bayles & Tomoeda, 1983; Chertkow & Bub, 1990; Flicker, Ferris, Crook, & Bartus, 1987; Huff, Corkin, & Growdon, 1986; Martin, 1987), and incorrect judgments on tasks assessing category membership and the properties associated with particular words and objects (Chertkow & Bub, 1990; Chertkow et al., 1989; Grossman & Mickanin, 1994; Martin, 1987; Warrington, 1975). Many of these semantic memory studies have assumed that the defining or core features underlying a word determine whether it is an exemplar of a concept, can be used to name an object, or is associated with certain attributes (Katz, 1972; Miller & Johnson-Laird, 1976). The defining or core features, although quite elusive (Fodor, Garrett, Walker, & Parkes, 1980), are thus said to allow a truth value to be assigned to subject–predicate statements describing category inclusion relations such as “Tulips are flowers” or “?Tulips are fruit,”1 to attribute statements like “Tulips are red” or “?Tulips are black,” or to other tasks dependent in part on semantic memory. According to this approach, positive truth values reflect the belief that a word is an exemplar of a category or that an attribute is associated with a named object; a negative truth value indicates the belief that a word is not an exemplar of a category or that an attribute is not associ-

1 In this paper, we use “?” to indicate a negative truth value in a statement, that is, the belief that a predicate is related to the subject of a statement in a coherent fashion but is factually false; we use “*” to indicate a category violation, that is, the belief that a predicate is not plausibly associated with the subject of a statement and therefore that a truth value cannot be assigned.
ated with a named object. Truth value judgments thus are the basis for the rich, hierarchically organized semantic networks that subcategorize words into finer and finer semantic domains that are marked by progressively narrower sets of associated attributes (Collins & Loftus, 1975; Miller & Fellbaum, 1991).

Several problems have emerged in studies that are based on truth values (Fodor et al., 1980; Fodor, 1977; Komatsu, 1992). This is demonstrated most clearly in judgments of category membership and attribute association. For example, truth value criteria allow any set of objects to be classified in multiple ways. Consider the objects "caviar," "tar," "emerald," and "lettuce." A truth value categorization based on color would group "caviar" and "tar" separately from "emerald" and "lettuce," but a truth value categorization based on monetary worth would group "caviar" and "emerald" separately from "tar" and "lettuce" (Keil, 1981). Investigations of neurologically intact adults have demonstrated considerable inconsistency in category membership judgments of familiar concepts across subjects and within subjects (McCloskey & Glucksberg, 1978), as well as between-subject and within-subject variability in definitions and attributes of common concepts (Barsalou, 1989; Bellezza, 1984a; Bellezza, 1984b). Indeed, recent studies have found a dissociation between the similarity judgments that make these concepts cohere and the categorization judgments we use to probe patients' concepts (Rips, 1989; Smith, 1995). A similar argument concerning the potential shortcomings of truth values can be fashioned for any of the tasks typically used to assess semantic memory. On confrontation naming or multiple-choice recognition naming tasks, for example, an object could have the appearance of a pumpkin, even though it is in reality a genetically engineered cucumber or a cleverly manufactured toy. On semantically guided category fluency tasks, a pumpkin could be a piece of furniture if sat upon, and a pumpkin could be a weapon if thrown at a speaker by an unadmiring spectator.

Consider in more detail several pathbreaking studies explicitly assessing truth value judgments of attributes associated with a word in AD. Assumptions concerning the role of truth values in word meaning have made studies such as these difficult to interpret. For example, one study (Chertkow & Bub, 1990) presented a word or a picture along with one of seven types of probes assessing AD patients’ appreciation of the target’s perceptual attributes (e.g., for “saw,” the authors probed whether it is made of metal or wood, and whether it is sharp or dull) and its functional attributes (e.g., for “saw,” the authors probed whether it is used for cutting or lifting, and whether it is used on a piece of wood or a stone). AD patients were found to be impaired. One source of ambiguity in this study is that a saw can be dull, can be used for lifting, and can even be used on stone without being any less of a saw. Similar difficulties with interpretation apply to a more recent study (Smith, Faust, Beeman, Kennedy, & Perry, 1995) in which AD patients were asked to judge
the truth value of statements such as “The apple is red.” The authors manip-
ulated factors such as the typicality of the statement’s subject and the domi-
nance of the predicate. The investigators found that AD patients are as accu-
rate as control subjects at judging properties of objects, although they take
disproportionately more time than controls to verify statements with low
typicality objects or less dominant properties. To be sure, the most common
association is that apples are red, but apples also can be green or yellow,
caramelized apples can be brown, the meat of an apple is off-white, a rotten
apple can be black, and a painted apple can be any color without being any
less an apple.

Several philosophers (Aristotle, 1963; Russell, 1924; Ryle, 1953) have
been concerned instead with ontological categories, attribute associations,
and other tasks requiring semantic memory that are derived from anomaly
judgments rather than truth values. Categories and associations based on
anomaly judgments are much coarser than those generated by truth values
since coherent statements can be factually true or factually false as long as
they are sensible. The advantage of this approach is that judgments of sub-
ject–predicate relations based on anomaly are less open to the ambiguity
and debate often associated with a particular truth value. Consider the attrib-
ute “tall.” Certain named objects can be “tall” or “not tall,” including
“cup,” “tulip,” “cow” and “girl.” Regardless of the truth value or the
facts associated with a particular object’s size, clearly the height of these
objects can be discussed sensibly. By comparison, it is anomalous to speak
of “ideas,” “dreams,” “hours,” “sauses,” and the like as “tall” or “not
tall.” It is plausible to say that “the cup is tall” or that “the cow is short,”
but it is anomalous to state that “*The sauce is tall” or “*The hour is not
tall.” This restriction on predictability has been used to create a hierarchi-
cally organized set of object–attribute pairs that is represented as a spanning
relationship (Keil, 1979; Keil, 1981; Sommers, 1963). An attribute thus is
said to span an object if it is licensed to be associated with—if it can have
a positive truth value or a negative truth value for—that object and all objects
that are subordinate in a hierarchical organization such as that illustrated in
Fig. 1. Subject–predicate statements such as “The cow is tall” or “The cup
is short” are sensible, for example, even if there is disagreement about the
height of the cow or the cup. A word related to an attribute that is superordi-
nate in the hierarchical tree, such as “*The hour is tall,” violates allowable
predicate relations since it is anomalous—it has neither a positive truth value
nor a negative truth value—and is termed a “category mistake” (Ryle,
1953).

A small number of investigations have assessed anomaly judgments in
AD. For example, AD patients were impaired in their anomaly judgments
of line drawings where an element of the depicted object was omitted (Shut-
tleworth & Huber, 1989). AD patients also were impaired in their anomaly
judgments of animal line drawings where the stimuli display the head of one
animal associated with the body of a different animal (Chertkow & Bub, 1990). Another study systematically varied the nature of the anomalous information represented in the stimulus picture (Grossman & Mickanin, 1994). The substitution of an attribute that is a property of an object taken from the same superordinate category, although not a property of the stimulus object under judgment (e.g., a potato hanging from a bush’s branch or a leafy mushroom), proved to be particularly difficult for AD patients to appreciate. However, AD patients were as accurate as control subjects in their judgments of stimuli exhibiting features that are rarely associated with an instance of the superordinate category (e.g., a pink lettuce).

Several studies also have attempted to assess AD patients’ appreciation of anomaly in language by probing judgments of sentence coherence. Unfortunately, the basis for poor performance in these reports was not clear because of several confounds. The technique typically assessed the ability to remember sentences with various combinations of semantic and grammatical errors (Kopelman, 1986; Nebes, Brady, & Jackson, 1989). For example, these studies presented “bizarre” sentences describing unlikely events and “syntactically anomalous” sentences that were said to be normal except for the rearrangement of word order. One study (Nebes et al., 1989) also presented “semantically anomalous” sentences that were said to violate selectional restrictions, somewhat akin to the sense of “category violation” used in the present study. AD patients were found to be significantly impaired in

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**Fig. 1.** A hierarchical tree adopted from Keil (1979) illustrating attributes that span various object names. This tree was derived from anomaly judgments of subject–predicate statements in neurologically intact adults.
one study (Kopelman, 1986). The Nebes (1989) study did not find differences between AD patients and controls for most items, although the demented patients were superior to controls for the “semantically anomalous” items. The confounding of structural and semantic violations in multiple sentence types makes it difficult to interpret the results. Another confound was the use of memory. Nebes and his co-workers varied the amount of interference time between presentation and recall of the stimulus sentence in an attempt to equate for memory difficulty across the groups of normal elderly subjects and AD patients, resulting in a 20-sec delay for the controls and no delay for the AD patients. The unequal reliance on episodic memory compared to working memory for sentence recall in the two groups limits interpretation of these findings. Notwithstanding these difficulties, studies of anomaly in AD suggest that this avenue may be a productive way to pursue the presence and nature of semantic memory difficulty in AD.

In the following report, we investigated anomaly judgments in language by asking AD patients to judge the coherence of simple, subject–predicate sentences such as “The girl is tall” and “*The door is asleep.” This approach allowed us to investigate sensitivity to anomaly in language using sentences with syntactically transparent structures while at the same time avoiding the potential confound of memory difficulty. We expected the results of this study to provide converging evidence to support the claim of a semantic memory deficit in AD, that is, without the need for a truth value judgment.

**METHODS**

*Subjects.* We studied 20 right-handed, high school educated, native English speakers (9 males, 11 females) with probable AD. The diagnosis was established by experienced physicians in the Cognitive Neurology Clinic of the Department of Neurology at the University of Pennsylvania Medical Center using NINCDS-ADRDA criteria (McKhann, Drachman, Folstein, Katzman, Price, & Stadian, 1984). All patients were judged to be mildly or moderately demented, according to the clinical evaluation and a score of 12 or greater on the Mini Mental State Examination (Folstein, Folstein, & McHugh, 1975). Clinical and demographic factors are summarized in Table 1. We excluded from consideration patients with evidence for other progressive neurodegenerative conditions such as Parkinson’s disease, patients with

### TABLE 1

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Controls</th>
<th>Alzheimer’s disease</th>
</tr>
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<tbody>
<tr>
<td>Age</td>
<td>67.72 (4.96)</td>
<td>71.70 (7.73)</td>
</tr>
<tr>
<td>Education</td>
<td>15.41 (2.74)</td>
<td>13.90 (2.10)</td>
</tr>
<tr>
<td>Disease duration</td>
<td>—</td>
<td>4.25 (1.83)</td>
</tr>
<tr>
<td>MMSE</td>
<td>—</td>
<td>19.23 (3.25)</td>
</tr>
</tbody>
</table>
other dementing conditions such as vascular dementia (Hachinski ischemia scores (Rosen, Terry, Fuld, Katzman, & Peck, 1980) were 2 or less), patients with a history or diagnosis of other neurological diseases such as stroke or hydrocephalus, patients with a history or diagnosis of a primary psychiatric disorder such as major depression or schizophrenia, patients taking centrally active medications such as neuroleptics or antidepressants, and patients with any metabolic or systemic disorder that might have affected their intellectual functioning. These AD patients were compared with 18 age-matched \( t(36) = 1.86; \text{ns} \) and education-matched \( t(36) = 1.92; \text{ns} \) control subjects that were recruited from the spouses of AD patients and from the community.

**Materials.** The subjects were asked to judge 144 simple, subject–predicate sentences of the form: “O is A,” where O is a named object acting as the sentence’s subject and A is an attribute acting as the sentence’s predicate. We used the object names and the attributes provided in Fig. 1. The object names and attributes were taken from Keil (1979). We selected these particular stimuli since they were familiar and were matched for frequency (Francis & Kucera, 1982), and we limited ourselves to this number of stimuli to avoid fatiguing the patients. These particular hierarchical levels were selected since half of the object names associated with these levels were natural kinds and all but 2 of the remaining stimuli were man-made artifacts. Every object name was paired with every attribute in a subject–predicate sentence, yielding four exemplars of each possible name–attribute pair at each combination of hierarchical levels. Each subject–predicate sentence was read twice to the patients in a naturalistic fashion, and a third repetition was allowed if requested by the patient. Additional repetitions were requested on less than 5% of the items. The procedure took place in a quiet testing room and required about 30 min to complete.

A training period preceded the experimental portion of the study. Patients judged sentences with an identical subject–predicate structure that were similar in content to the sentences in the experimental portion of the task. During the training session, each sentence and its response were discussed with the patients. We emphasized that we were not interested in the truth of a particular statement, but we wanted to probe whether the statement was sensible or not. We encouraged patients to interpret statements literally and not metaphorically. All patients appeared to understand the task.

**RESULTS**

We evaluated patients’ judgments of all coherent and anomalous subject–predicate sentences using a mixed-model analysis of variance (MANOVA) with a group (2, between-subject factor) \( \times \) object name (6, within-subject factor) \( \times \) attribute (6, within-subject factor) design. This revealed a significant main effect for group \( [F(1, 36) = 19.06; p < .0001] \). AD patients were generally older and less educated than control subjects, but an analysis of covariance that included these factors could not fully account for the group differences \( [F(1, 34) = 15.89; p < .0001] \). Significant main effects were also seen for object name \( [F(5, 180) = 21.01; p < .0001] \) and attribute \( [F(5, 180) = 21.75; p < .0001] \). Overall, control subjects’ judgments of object name–attribute pairs were reasonable and conformed to the scheme in Fig. 1 with a mean ±SD of 89.29 ±5.04% of their answers. By comparison, AD patients’ judgments conformed to the hypothesized predicability constraints only on 77.04 ± 10.82% of their responses. These findings confirmed that AD patients encounter greater difficulty than control subjects in judging the coherence of simple subject–predicate sentences.
Fig. 2. The mean proportion of correctly judged coherent and anomalous subject–predicate statements in patients with Alzheimer’s disease and control subjects.

Significant interactions were seen in this MANOVA as well, including a group × attribute effect \( [F(5, 180) = 2.70; p < .02] \) and a group × object name effect \( [F(5, 180) = 3.82; p < .005] \). We also found significant interaction effects for object name × attribute \( [F(25, 900) = 15.76; p < .001] \) and group × object name × attribute \( [F(25, 900) = 2.08; p < .001] \). The interaction effects indicate that particular combinations of object names and attributes contribute to the compromised pattern of AD patients’ judgments. We performed separate analyses of object names used in coherent sentences or anomalous sentences and of attributes used in coherent sentences or anomalous sentences to help us interpret these interaction effects.

Consider first the nature of the attribute in AD patients’ coherence judgment patterns. We used a MANOVA with a group (2, between-subject factor) × coherence (2, within-subject factor) × attribute (6, within-subject factor) design. We found a significant main effect for group \( [F(1, 36) = 20.45; p < .001] \). We also found a significant group × coherence interaction effect \( [F(1, 36) = 4.59; p < .03] \). As summarized in Fig. 2, sentences that did not express coherent object name–attribute relations were significantly more difficult for AD patients to judge than control subjects \( [t(36) = 3.18; p < .005] \), although AD patients and controls did not differ in their judgments of subject–predicate sentences expressing coherent relationships \( [t(36) = 1.38; \text{ns}] \). Thus, AD patients were relatively insensitive to violations of coherence in object name–attribute relations.
This MANOVA also showed a significant group × attribute interaction effect \( [F(5, 180) = 3.98; p < .005] \). Figure 3 is a contour map of AD patients’ coherence judgments of anomalous associations between object names and attributes in subject–predicate sentences. As can be seen, there was a consistent trend toward more accurate judgments of subject–predicate relations involving attributes like ‘jealous’ that span few object names. Coherence judgments of object name–attribute pairs generally became less accurate as the attributes span a broader scope of object names. This was confirmed by \( t \) tests comparing the attributes at each of the hierarchical levels. Following Bonferroni correction for multiple comparisons, the coherence of subject–predicate statements mentioning distinctly human attributes like ‘jealous’ were judged significantly more accurately than all of the other attributes at least at the \( p < .05 \) level; color attributes like ‘brown’ have a very broad scope of reference, and these were judged significantly less accurately than all of the other attributes at least at the \( p < .05 \) level; attributes with an intermediate scope of reference such as ‘asleep’ and ‘alive’ did not differ from each other.

We also addressed the possibility that particular object names influence coherence judgments in AD. This was assessed with a MANOVA using a group (2, between-subject factor) × coherence (2, within-subject factor) × object name (6, within-subject factor) design. We observed a significant main effect for group \( [F(1, 36) = 12.04; p < .001] \), as well as a significant two-
way interaction effect for group × coherence \(F(1, 36) = 3.61; p < .05\) and a significant three-way interaction effect \(F(5, 144) = 3.26; p < .01\). This was due to the observation that AD patients appear to find a specific class of object names—mass items such as ‘‘milk’’ and ‘‘sauce’’—consistently more difficult to judge than other object names (all comparisons significant at least at the \(p < .05\) level following Bonferroni correction for multiple comparisons).

It has been reported that natural kinds are more difficult for AD patients to appreciate than man-made artifacts (Mauri et al., 1994; Montanes et al., 1995; Silveri et al., 1991). This was tested with a MANOVA using a group (2, between-subject factor) × subcategorized object name (natural kind vs. man-made, within-subject factor) design. We found a significant main effect for group \(F(1, 36) = 18.01; p < .001\), and a significant group × subcategorized object name interaction effect \(F(1, 36) = 11.23; p < .001\). As can be seen in Fig. 4, AD patients were significantly less accurate than controls in their judgments of subject–predicate sentences containing man-made artifacts \(t(36) = 4.31; p < .001\). Within-group analyses of AD patients’ judgments also revealed that they are significantly less accurate in their judgments of sentences containing man-made artifacts than their own judgments of sentences containing natural kinds \(t(19) = 5.12; p < .0001\). These findings emphasize that greater difficulty appreciating natural kinds cannot fully explain AD patients’ difficulty judging subject–predicate sentences.

**Fig. 4.** The mean proportion of correctly judged subject–predicate statements containing natural kinds and man-made artifacts in patients with Alzheimer’s disease and control subjects.
Individual patient analyses were performed to assess the interaction between object names and attributes in AD patients' coherence judgments. These analyses supported the general claim that impairments in AD depend in part on the scope of the spanning relationship between attributes and object names. Thus, 15 (75%) of 20 AD patients felt that the most superordinate attributes like “interesting” can span objects that are equally superordinate such as “idea” but cannot span subordinate objects. This was also true, albeit to a lesser extent, for color attributes like “brown,” where 7 of these 15 AD patients thought that color can span only an object that is equally superordinate such as “sauce” but not subordinate objects. By comparison, 18 (90%) of 20 AD patients felt that the four most subordinate attributes (such as “jealous” and “asleep”) can span objects that are equally subordinate.

DISCUSSION

Investigations of semantic memory in AD have been inconclusive. For example, several studies have reported that AD patients are impaired in their categorization or their judgments of attributes associated with a target object name (Bayles et al., 1990; Chan et al., 1993; Chertkow & Bub, 1990; Albert & Milberg, 1989; Grossman & Mickanin, 1994; Hodges et al., 1992), but others have failed to find significant deficits (Grober, Buschke, Kawas, & Fuld, 1985; Nebes et al., 1986, 1989; Ober et al., 1991; Smith et al., 1995). We have adopted a theoretical approach in the present study of semantic memory that has not assumed that truth values assigned to word meaning underlie the association of a name with an object attribute, the categorization of a word, or other measures of word meaning. In the present study, AD patients were probed for their judgments of anomaly. Thus, they were asked whether there is any coherent relationship—regardless of its truth value—between an object name and an attribute. Using this technique, we found that AD patients are significantly impaired in their appreciation of the relationship between a word and its attributes. Moreover, unlike previous assessments of language anomaly in AD (Kopelman, 1986; Nebes et al., 1989), our study was not confounded by the requirement for a memory component during performance or a syntactic element to the sentence violation. Our findings also may explain in part the paradoxically good performance of AD patients at recalling “semantically anomalous” sentences (Nebes et al., 1989). AD patients may have been relatively insensitive to this type of violation, allowing them to remember these sentences better than controls.

AD patients were not random in their sentence judgment performance. Instead, we observed a specific pattern of impaired judgments, suggesting that a particular component of semantic processing may be compromised in AD. In general, we found that attributes spanning a narrower range of words are judged more accurately than attributes spanning a broad scope of words.
The face validity for this impairment profile can be derived from common clinical observations of AD patients: They tend to perform better in constrained situations where the number of response options is limited, and their pattern of judgments in the present task is correspondingly more accurate for attributes that have relatively privileged relationships with a narrow scope of object names. On sentence comprehension and sentence completion tasks comparing performance on constrained and unconstrained sentences, for example, AD patients were more rapid and more accurate at understanding and completing sentences that contain content words that constrain potential responses (Grossman, Mickanin, Onishi, Hughes, D’Esposito, Ding, Alavi, & Reivich, in press; Nebes, 1994a).

Several hypotheses have been forwarded to account for the semantic memory deficit in AD. Some investigators have argued that there is an undifferentiated degradation or loss of detailed information associated with the mental representation of a concept in semantic memory (Martin, 1992). A variant of this hypothesis is that core or defining information underlying a concept has been degraded (Chertkow & Bub, 1990). The results of the present study do not fully conform to hypotheses such as these since we did not find consistent difficulty judging a specific object name. Other investigators have forwarded the view that information represented in specific object categories may become degraded in AD (Mauri, Daum, Sartori, Riesch, & Birbaumer, 1994; Montanes, Goldblum, & Boller, 1995; Silveri, Daniele, Giustolisi, & Gainotti, 1991). According to this approach, AD patients have greater difficulty naming and understanding natural kinds such as fruits and animals than man-made artifacts such as furniture and clothing. Other studies have not provided support for this approach (Mickanin, Grossman, Onishi, Auriacombe, & Clark, 1994; Tippett, Grossman, & Farah, in press). This category-specific hypothesis was tested in the present study as well, but the findings did not support the claim that natural kinds are more susceptible to degradation in AD. We did observe, however, that subject–predicate statements containing the names of mass substances are relatively difficult to judge for AD patients. This finding is consistent with the results of a sentence comprehension study that probed AD patients’ appreciation of mass and count quantifiers with sentence–picture matching, sentence grammaticality judgment, and sentence completion tasks (Grossman, Mickanin, Onishi, & Hughes, 1995). These studies suggest that the distinction between mass and count is difficult for AD patients to appreciate because of an impairment processing the underlying concepts.

In the present study, we observed a pattern of anomaly judgments that is most consistent with the hypothesis that semantic memory difficulty is determined in part by AD patients’ compromised processing of the relationship between object names and attributes in semantic memory. This parallels the deficit appreciating the relationship between attributes and objects that we observed in a study assessing AD patients’ judgments of anomalous pic-
tues (Grossman et al., 1994). A matrix of semantic relations has been hypothesized to organize information in semantic memory (Miller et al., 1991), and the ability to negotiate this relational network for the purpose of semantic comprehension appears to be compromised in AD. This is analogous to the impairment that follows degradation of the connectivity pattern in a parallel distributed processing semantic network (Small, Hart, Nguyen, & Gordon, 1995; Tippett & Farah, 1994). From this perspective, attributes that interact with a wide range of objects are more likely to be compromised in such a distributed semantic network, as we observed in AD patients’ judgments. Several philosophers and psychologists also have emphasized the importance of relations between the different sorts of information represented in semantic memory (Keil, 1989; Putnam, 1975). Clearly additional studies are needed to investigate semantic memory from this perspective.

There are several alternative explanations for our findings. For example, we assessed semantic memory with an effortful “off-line” measure, and the effortful character of the task may have proven difficult for AD patients rather than the semantic nature of the decision tested in this study (Huff et al., 1986; Nebes, 1994b; Ober & Shenaut, 1994). Priming studies have been administered to AD patients that are “automatic” and therefore avoid this confound since decisions are made on the basis of rapidly presented material (Nebes et al., 1986; Ober et al., 1991). However, several priming studies also have demonstrated abnormal semantic relations in AD (Albert & Milberg, 1989; Chertkow, Bub, Bergman, Brunner, Merling, & Rothfleisch, 1994; Chertkow et al., 1989). AD patients have limited processing resources (Baddeley, Bressi, Della Sella, Logie, & Spinnler, 1991; Baddeley, Logie, Bressi, Della Sala, & Spinnler, 1986; Fisher, Freed, & Corkin, 1990; Morris, 1994) and attention deficits (Kempler, Andersen, & Hender, 1995; Massman, Delis, Filoteo, Butters, Salmon, & Demadura, 1993; Parasuraman, Greenwood, Haxby, & Grady, 1992) that can interfere with the performance of cognitive tasks such as anomaly judgments, even on sentences as brief as ours. However, this kind of account cannot explain the selective impairment for anomalous sentences compared to coherent sentences demonstrated by AD patients. It is possible to argue that the anomalous stimuli were so difficult for AD patients since they were interpreted metaphorically, as can occur when sentences such as “The sauce is sorry” are encountered out of context (Glucksberg, 1995). Metaphoric interpretation is much more complex than literal interpretation, requiring at least analogical reasoning and the appreciation of pragmatic relations in addition to semantic processing (Steinhart, 1995), and this is unlikely to have been recruited by AD patients but not control subjects. Moreover, the use of metaphoric interpretation cannot account for the AD patients’ selectively greater difficulty judging attributes in anomalous sentences with a broader scope of reference. It is clear that much additional work is needed to help interpret the significance of impaired anomaly judgments in AD.
Several caveats must be kept in mind when considering our findings. The AD patients were recruited from a university clinic specializing in the diagnosis and care of patients with cognitive impairments, and there may have been some inadvertent bias in the patients we assessed. Mildly and moderately demented patients were evaluated, so we can generalize our findings only to this segment of the population of AD patients. Our technique avoided the memory and linguistic confounds associated with previous assessments of anomaly in AD, but additional studies probing anomaly in on-line studies are needed to confirm our findings. A wide range of object names and attributes were probed in the present study, but additional investigations are needed to confirm our observations with larger numbers of tokens at each hierarchical level. With these caveats in mind, we conclude that impaired judgments of anomalous subject–predicate statements provide converging evidence to support the claim that AD patients have a semantic memory impairment. The nature of their compromised judgment profile suggests that a limitation processing the matrix of meaning relations in semantic memory contributes to the semantic deficit in AD.

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