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The Naming Deficit in Early Alzheimer's and Vascular Dementia

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Patients with early Alzheimer's disease (AD) were compared to normal controls and patients with early vascular dementia (VaD) on their naming errors using the Boston Naming Test (H. Goodglass & E. Kaplan, 1983). All naming errors were classified into three general error categories: visuoperceptual, semantic, and phonemic. Semantic errors were further classified into coordinate errors (responses that belong to the same semantic category as the target words), superordinate errors (responses that belong to a broader semantic category than the target word), and functional-circumlocutory errors (circumlocutions and responses that functionally describe the target word). The findings indicated that AD participants display more overall naming errors than VaD participants, although the pattern of general errors was similar between the patient groups. However, the qualitative difference between the patient groups was observed within the semantic errors because the AD group made more superordinate errors.

It is now well established that progressive naming difficulties are one of the main characteristics of Alzheimer's disease (AD). However, the underlying functional deficit causing the naming problem is not well understood. Two main hypotheses attempt to explain this deficit, one implicating visuoperceptual channels and the other implicating a loss of semantic knowledge.

Early studies of naming difficulties in AD suggested that AD patients have primarily visuoperceptual deficits, which interfere with naming visually presented items. Support for this hypothesis was provided by studies showing that AD patients have less difficulty naming visually well-defined objects (Rochford, 1971) and objects that they are allowed to handle (Barker & Lawson, 1968), that their naming accuracy varies with the perceptual difficulty of the items (Cormier, Margison, & Fisk, 1991; Goldstein, Green, Presley, & Green, 1992; Kirshner, Webb, & Kelly, 1984), and that their naming improves when they are presented with real objects rather than with drawings (Shuttleworth & Huber, 1988).

However, more recent studies have called into question this perceptual interpretation of the naming deficit in AD. Investigations of the qualitative nature of naming errors have indicated that naming errors are more often related semantically than perceptually to the target words (Bayles & Tomoeda, 1983; Goldstein et al., 1992; Hodges, Salmon, & Butters, 1991; Nebes, 1989). On various naming tasks, AD patients tend to make semantically related errors such as calling an object either by the name of its category (e.g., *animal* instead of *dog*) or by the name of another member of the same category (e.g., *cat* instead of *dog*). These observations led to the alternative hypothesis that semantic knowledge, rather than visual processing, is impaired in AD.

Along these same lines, several authors have suggested that the naming problem in AD is due to a loss or a reduction in the availability of the specific semantic attributes that determine concept meaning (Martin & Fedio, 1983; Monsh et al., 1994; Ober & Shenaut, 1988; Tippett & Farah, 1994). According to this view, the impaired semantic knowledge is central to other language deficits observed in AD, including problems with semantic category fluency (Butters, Granholm, Salmon, Grant, & Wolfe, 1987; Monsh et al., 1994), phonemic category fluency (Monsh et al., 1994), naming to definition (Huff, Corkin, & Growden, 1988), semantic priming (Ober & Shenaut, 1988), and recognition of object names (Flicker, Ferris, Crook, & Bartus, 1987).

It is evident from the aphasia research that detailed analyses of naming errors are of theoretical and clinical importance in studying language deficits (Goodglass et al., 1997; Kohn & Goodglass, 1985; Williams & Cantor, 1982). The importance of studying naming errors has also been shown in AD research (Bayles & Tomoeda, 1983; Cox, Bayles, & Trosset, 1996; Goldstein et al., 1992; Hodges et al., 1991; LaBarge, Balota, Storandt, & Smith, 1992; Nicholas, Obler, Au, & Albert, 1996). With the exception of a few studies (Cormier et al., 1991; Nicholas et al., 1996), the previous naming studies generally provided evidence for impaired semantic knowledge in AD (Bayles & Tomoeda, 1983; Cox et al., 1996; Goldstein et al., 1992; Hodges et al.,

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1991). However, the results of previous studies are often confounded by the lack of a comprehensive error classification system that makes the relative magnitude of visuoperceptual, semantic, and phonological factors difficult to interpret. The naming errors produced on visual naming tests are often ambiguous with respect to their nature and can reflect any combination between the visuoperceptual, semantic, and phonological features of the target word (e.g., *otter* for *beaver* can be interpreted as both a visual and a semantic error). Most of the earlier studies used only basic error categories, such as semantic and perceptual errors (Cormier et al., 1991; Goldstein et al., 1992; LaBarge et al., 1992), some focused on semantic errors (Bayles, Tomoeda, & Trosset, 1990; Nicholas et al., 1996), and a few studies used a large number of error categories (Hodges et al., 1991; Kohn & Goodglass, 1985). However, even the studies that conducted a fine-grained error analysis failed to account for some specific types of responses, such as responses that are both semantically and phonologically related (e.g., *elevator for escalator*) or responses that are visually, semantically, and phonologically related (e.g., *pen* for *pencil* or *lattice* for *trellis*).

The goal of the present study was to evaluate the relative contributions of visuoperceptual, semantic, and phonological factors on naming errors made by AD patients on a confrontation naming task. The study was designed to circumvent the aforementioned limitations of the previous studies by providing a more detailed analysis of the confrontation naming errors in AD. This was done by classifying all errors into visuoperceptual, semantic, and phonemic errors and by making these basic categories mutually nonexclusive. Our aim was to analyze the semantic errors in detail; therefore, semantic errors were further studied independently and were classified into coordinate errors, superordinate errors, and functional–circumlocutory errors. This classification of semantic errors was developed with the goal of evaluating recent suggestions that early problems associated with semantic knowledge in AD can be described as a "blurring" of distinctions between closely related exemplars of a given broad semantic category (Chertkow & Bub, 1990; Cox et al., 1996; Hodges et al., 1991). If differentiation of within-category exemplars (which requires detailed knowledge of these exemplars) is impaired in AD, then AD patients would be expected to make more naming errors of superordinate nature (e.g., *bird* for *pelican*) than errors of coordinate nature (e.g., *penguin* for *pelican*).

Additionally, we compared naming errors of early AD patients to errors made by patients with early vascular dementia (VaD). In this study, we focus on a specific subtype of VaD, a cerebrovascular condition related to microvascular ischemic disease and changes in subcortical white matter. This disease often affects frontal functions and functions controlled by subcortical structures (Kertesz & Clydesdale, 1994; Ylikoski et al., 1993). Previous comparisons of language functions in AD and VaD were mainly based on verbal fluency tests, whereas comparisons of naming deficits are rare and provide contradictory results (Loewenstein et al., 1991; Powell, Cummings, Hill, & Benson, 1988; Villardita, 1993). Generally, VaD is a heterogeneous disorder, and lack of clear etiological subtype criteria may be one of the reasons for the contradictory findings. Other methodological issues, such as patient groups not matched for age, education, and dementia severity, may be additional factors contributing to the unreliable comparison findings (Almkvist, Backman, Basun, & Wahlund, 1993; Loewenstein et al., 1991; Powell et al., 1988).

Thus, direct comparisons of AD and VaD patients on their naming abilities are of special interest to studies of language in neurological disease. Both diseases result from a neurodegenerative process associated with aging, but, given neuroanatomical and functional differences in the brain areas involved (cortical vs. subcortical), qualitative and quantitative differences in naming abilities are expected. If cortical areas that subserve the semantic language component are affected in early AD patients, then this should be reflected in the increase of semantic naming errors when compared to VaD patients and controls. Additionally, on the basis of the previous discussion regarding specific changes of semantic knowledge in AD, we expected AD and VaD to differ with respect to quality of semantic errors, with AD showing a tendency to produce more superordinate errors than VaD. In contrast, if semantic knowledge remain preserved in VaD and if only the subcortical neural networks providing connections for this region are disrupted, then any naming problems found in VaD patients would reflect a general information-processing limitation rather than an impairment of semantic knowledge per se. Consequently, we expected to find an even, nonspecific distribution of semantic errors in VaD patients. In sum, in addition to the expected differences in the severity of naming problems between AD and VaD patients, we also hypothesized that the pattern of semantic errors would be syndrome-specific in early AD and not in VaD.

Method

Participants

Three groups of participants participated in this study: 14 AD patients (14 females), 14 VaD patients (8 females and 6 males), and 12 normal control participants (8 females and 4 males). All patients were recruited from neuropsychological services at two general medical hospitals (The Miriam Hospital and Roger Williams Hospital, Providence, RI) and the geriatric unit at a psychiatric hospital (Butler Hospital, Providence, RI). Each patient received a comprehensive medical, neurological, psychiatric, and neuropsychological examination. None of the patients had been previously diagnosed with any major psychiatric disorder, and there was no history of prior neurological disease including major stroke, but some of the VaD patients had history of minor cerebrovascular problems (i.e., transient ischemic attack, lacunar stroke). None of the patients had a history of alcohol or drug abuse or significant visual or auditory limitations.

The AD patients were diagnosed as having probable AD as defined by the National Institute of Neurological and Communicative Disorders and Stroke (NINCDS) criteria. All AD patients had neuroimaging findings negative for cerebrovascular disease and modified Hachinski Ischemia Scale scores (Hachinski et al., 1975) less than 4. VaD patients were diagnosed as having probable VaD on the basis of diagnostic research criteria established by the

National Institute of Neurological Disorders and Stroke and Association Internationale pour la Recherche et l'Enseignement en Neurosciences (NINDS-AIREN). All VaD patients had neuroimaging findings positive for small-vessel ischemic disease but no evidence of major stroke and modified Hachinski Ischemia Scale scores greater than 6. Control participants were patients from the memory clinic who complained of some memory problems, but their memory problems were not documented in their test results and were diagnosed as resulting from normal aging rather than from a dementing process.[1] One advantage of these control participants over the control participants recruited directly from the community is that these participants received a comprehensive medical and neuropsychological work-up that ruled out early dementia. Consequently, we were able to do this study in patients with early symptoms of dementia and to compare them to neurologically intact controls. Demographic characteristics on the three groups are given in Table 1.

As control measures, the groups were compared on demographic characteristics and level of general cognitive functioning as measured by the Mini-Mental State Examination (MMSE; Folstein, Folstein, & McHugh, 1975). The three groups did not differ in age, $F(2, 37) = 1.17$, $p = .32$, but they differed in years of education, $F(2, 37) = 4.89$, $p = .01$, and general level of cognitive functioning, $F(2, 37) = 17.40$, $p < .001$. These differences were attributable to the well-educated and cognitively intact control group, because the two patient groups did not differ on any of the control variables: age, $F(1, 26) = 1.43$, $p = .24$; education, $F(1, 26) = .16$, $p = .70$; MMSE, $F(1, 26) = .48$, $p = .49$.

Materials

All participants were tested with the Boston Naming Test (BNT; Goodglass & Kaplan, 1983). This test consists of 60 line drawings of items ranging from highly frequent items at the beginning of the test (e.g., tree, pencil) to less frequent items at the end of the test (e.g., sphinx, trellis). Participants are asked to name the items. Only the participants' first spontaneous response to each item was scored. The test was administered according to the following protocol: All participants were given items starting from the beginning of the test, and after six consecutive failures administration was discontinued. Consequently, 7 participants did not receive all 60 test items; all of these participants were in the AD group. It should be noted, however, that the majority of these participants was administered at least 50 test items.

Error Classification

We developed error categories drawing on the picture naming studies in aphasia (Kohn & Goodglass, 1985). However, because a large number of error categories may produce confounding effects, we initially classified all incorrect responses into four general categories. These error categories were defined as follows: omissions ("don't knows" and responses that did not share any clear visual, semantic, or phonemic characteristic with the target word), visuoperceptual errors (responses that share visual characteristics with the target word), semantic errors (responses that have similar meaning as the target word), and phonemic errors (responses that share at least two phonemes or rhyme with the target word). As discussed earlier, the error responses often meet criteria for more than one error category. For example, semantically related errors may also share visual characteristics with the target word (e.g., escalator–stairs, face–mask, rhinoceros–hippo, etc.), phonological characteristics (e.g., escalator–elevator, stilts–sticks, etc.), or both (e.g., pen–pencil, wheelchair–chair, trellis–lattice, etc.). For these reasons, we decided to make the general error categories mutually nonexclusive.

Semantic errors were further classified into three mutually exclusive categories: coordinate errors (responses that belong to the same semantic category as the target words), superordinate errors (responses that belong to a broader semantic category than the target word), and functional–circumlocutory errors (responses that functionally describe the target word). Subordinate errors (responses that describe only a detail of the target word) were also originally included in the error classification, but because there were only a few such responses this error category was dropped. Examples of each error type are given in Table 2.

The classification of error responses was performed independently by two of the authors. The interrater reliability was satisfactory ($r = .86$), and, because there was no significant difference between the two sets of data ($p > .05$), differences in sets were resolved and only one data set was used for the analysis.

Table 1
Participant Group Characteristics

Characteristic	AD (n = 14) *M*	AD *SD*	VaD (n = 14) *M*	VaD *SD*	Controls (n = 12) *M*	Controls *SD*
Age	79.0	5.88	76.7	4.08	76.2	5.04
Education	10.6	2.68	11.0	2.08	13.6	3.15
MMSE	23.9	3.25	24.7	2.73	29.4	0.79
BNT	30.0	8.81	44.1	5.22	55.2	3.61

Note. AD = Alzheimer's disease; VaD = vascular disease; MMSE = Mini-Mental Status Examination; BNT = Boston Naming Test.

Table 2
Examples of Error Types

Error type	Target word	Responses
Visual	Pretzel	Snake, knot
Phonemic	Igloo	Iglow
Semantic	Globe	Atlas
	Escalator	Elevator,[a] stairs[b]
Subtypes		
Coordinate	Acorn	Peanut
Superordinate	Acorn	Nut
Functional–circumlocutory	Compass	To make circles

[a]This response also meets criteria for a phonemic error. [b]This response also meets criteria for a visual error.

Results

There was a clear separation between the participant groups on overall BNT accuracy. The difference between the groups on overall accuracy was significant between all groups ($p < .01$), with the control group making the least naming errors and the AD group making the most. This finding was expected, given that naming deficits are often

[1]Five control participants were diagnosed with depression, but there were no differences between the depressed and nondepressed control participants on their overall naming accuracy. In addition, the results of previous studies have found no interaction between the confrontation naming task and geriatric depression (Hill et al., 1992; King, Caine, & Cox, 1993). We, therefore, decided to include these participants in the control group.

Table 3
Percentage of Naming Errors by Participant Group and Error Type

Error type	AD (n = 14)		VaD (n = 14)		Controls (n = 12)	
	M	*SD*	*M*	*SD*	*M*	*SD*
Omissions	14.72	10.23	8.68	4.98	3.46	3.30
Visual	10.31	6.05	3.34	1.84	2.50	3.66
Semantic	26.03	10.84	15.24	5.46	8.47	5.88
Phonemic	2.31	2.33	2.38	1.82	1.11	1.48

Note. AD = Alzheimer's disease; VaD = vascular disease.

observed in AD. In this respect, this result supported the group classification, and the overall BNT accuracy across the groups is presented with other group characteristics in Table 1.

Because of the BNT administration protocol, participants differed in the total number of responses. Therefore, to document differences between the three groups in their naming abilities, the initial analysis used error scores calculated as the proportion (percentage) of total number of responses. Because one of the main goals of this study was to compare groups only on their pattern of errors, all later analyses, to control for the severity of the naming impairment, used error scores calculated as the proportion (percentage) of total number of errors. Similarly, the semantic error subtype scores were calculated as a proportion (percentage) of total semantic errors.

Table 3 displays the mean percent of general errors (from the total number of responses) by participant group. The general error scores were analyzed by an analysis of variance (ANOVA) that compared groups (AD, VaD, control) and error types (omissions, visuoperceptual, semantic, phonemic). Both main effects were significant: group, $F(2, 37) = 36.71$, $p < .001$, and error type, $F(3, 111) = 45.63$, $p < .001$). The interaction between group and error type was also significant, $F(6, 111) = 4.82$, $p < .001$. Simple effect analysis indicated that groups differed on frequency of omissions ($p < .001$) and semantic ($p < .001$) and visuoperceptual errors ($p < .001$) but not on frequency of phonemic errors ($p = .76$). A post hoc Tukey test ($p = .01$) that provided pairwise comparisons of the participant groups indicated that each participant group was significantly different from the other groups, with the normal control group exhibiting the fewest errors and the AD group exhibiting the most. However, it should be noted that rank order of the error-type frequency was similar in all three groups, with the semantic errors being the most frequent and the phonemic errors being the least.

A second ANOVA used error scores calculated as a percentage of the total number of errors and compared groups (AD, VaD, control) and error types (omissions, visuoperceptual, semantic, phonemic). Neither the group nor interaction effect was significant, and only the effect of error type was significant, $F(3, 111) = 79.85$, $p < .001$. A post hoc Tukey test ($p = .05$) indicated that each error type differed from the others; semantic errors were the most frequent and phonemic errors were the least. The mean percent error (from total errors) per error type for the three groups of participants is displayed in Figure 1.

To evaluate if the mutually nonexclusive error coding of visuoperceptual, semantic, and phonemic errors affected the participant groups differently, an ANOVA was conducted to compare groups (AD, VaD, control) and error coding type (single-, double-, or triple-coded errors). This analysis

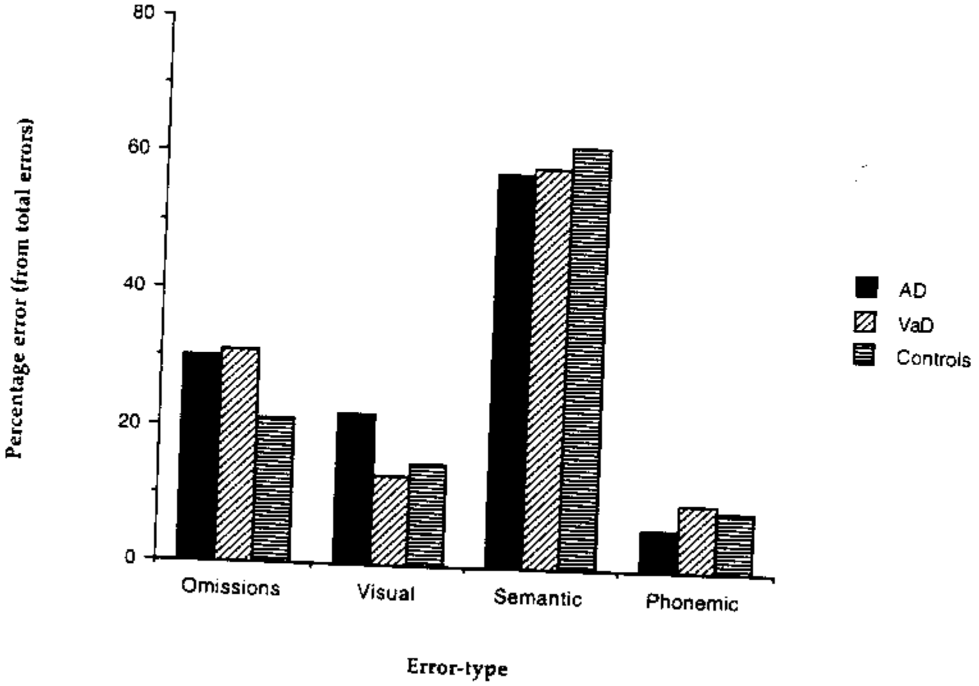

Figure 1. Groups by general error types (based on percentage error from total errors). AD = Alzheimer's disease; VaD = vascular disease.

revealed significant coding-type effect, $F(2, 72) = 245.82$, $p < .001$, but no group effect, $F(2, 36) = .88$, $p = .42$, or interaction effect, $F(4, 72) = .87$, $p = .49$. Single-coded errors were the most frequent type of errors in all three participant groups, whereas the triple-coded errors were the least frequent. Table 4 displays mean percent of error coding type (from the total number of visuoperceptual, semantic, and phonemic errors) by participant group.

The next analysis compared the patient groups on their subtypes of semantically related errors. Because the control group made a small number of semantic errors (8.5%), and these were primarily limited to the last items of the test, the control group was excluded from the following analysis.[2] An ANOVA was conducted to compare groups (AD, VaD) and semantic error subtypes (coordinate, superordinate, functional–circumlocutory). Neither main effect was significant: group, $F(1, 26) = .08$, $p = .78$; semantic error subtype, $F(2, 52) = 1.65$, $p = .20$. However, the interaction between group and semantic error subtype was significant, $F(2, 52) = 5.56$, $p = .006$. Simple effect analysis indicated that, as compared to the VaD group, the AD group made significantly more superordinate errors ($p = .002$), somewhat fewer coordinate errors ($p = .06$), and a similar percentage of functional–circumlocution errors ($p = .22$). Additionally, the AD group made significantly more superordinate than coordinate errors ($p = .024$), whereas the VaD group displayed a nearly significant tendency to make coordinate errors more often than superordinate errors ($p = .056$). The mean percent error per semantic error subtype for the patient groups is displayed in Figure 2.

Discussion

Our purpose was to investigate contributions of visuoperceptual, semantic, and phonological factors to the naming deficit in early AD. Furthermore, our aim was to analyze semantic errors in detail to better understand deficits associated with semantic knowledge in AD. Specifically, we studied types of naming errors produced by early AD patients on a naming test and compared their error types to those produced by patients with early VaD associated with microvascular ischemic disease and normal controls.

Consistent with our expectations, the results showed that AD patients made more overall naming errors than both VaD patients and elderly controls. The AD group made significantly more errors than the VaD group, across most error types (i.e., semantic and visuoperceptual). However, the pattern of general errors was similar between the two patient groups and the control group, with semantic errors being the most frequent and phonemic errors being the least. When groups were compared only across the pattern of their errors and not across the severity of their naming impairment, all group differences disappeared. This finding of only quantitative, rather than qualitative, differences between the three groups may be interpreted as evidence that, when only general error categories are applied (visuoperceptual, semantic, phonemic), the naming problem in AD appears to be syndrome nonspecific. The relative contributions of visuoperceptual and semantic factors appear similar in all three groups, although they are magnified in the AD group as a result of the general severity of the naming deficit. On the basis of only these results, the naming deficit in AD could be interpreted as being a nonspecific deterioration of both visual and semantic processes involved in naming.

However, qualitative differences between the two patient groups were observed within the subtypes of semantic errors. AD patients showed a significant tendency to name a broader (i.e., superordinate) category instead of the target word (e.g., *animal* instead of *beaver*) compared to the VaD patients. VaD patients, contrary to AD patients, showed a nearly significant ($p = .056$) tendency to name a coordinate category member instead of the target word (e.g., *rat* instead of *beaver*). The two patient groups did not differ on their tendency to make functional–circumlocutory errors. These results cannot be explained as merely reflecting group differences in severity of the naming impairment but rather as evidence that the pattern of the semantic naming errors in AD is syndrome specific. These findings support and further extend some earlier suggestions that, in AD, differentiation of within-category exemplars is impaired whereas knowledge of broad semantic categories is preserved (Chertkow & Bub, 1990; Cox et al., 1996; Hodges et al., 1991; Johnson, Bonilla, & Hermann, 1997). Compared to the other naming studies, which used different error classifications and were not able to show any specific deficits of semantic knowledge in AD (Cormier et al., 1991; Nicholas et al., 1996), these results show the importance of a detailed analysis of semantic errors.

One possible criticism of using the BNT to study naming errors is that the test items are not equally indicative of the semantic category to which they belong. Items earlier in the test tend to be more easily assigned to a category (e.g., *beaver*), whereas later items tend to be more difficult to place into a specific category (e.g., *protractor*). Additionally, the greater semantic transparency of the items earlier in the test is associated with a richer coordinate category membership, making these items similarly prone to either coordinate or superordinate errors and later items more prone to functional–circumlocutory errors. For example, AD patients

Table 4
Percentage of Error Coding Type by Participant Groups

	AD (n = 14)		VaD (n = 14)		Controls (n = 12)	
Coding type	*M*	*SD*	*M*	*SD*	*M*	*SD*
Single coded	77.35	15.78	84.73	10.15	80.51	20.76
Double coded	20.02	16.75	10.75	11.93	14.63	17.37
Triple coded	2.85	5.12	4.50	5.80	4.85	11.19

Note. AD = Alzheimer's disease; VaD = vascular disease.

[2]Within the small number of semantic errors made by the control group, functional–circumlocutory errors occurred most often while similar numbers of coordinate and superordinate errors were observed. However, because most of these semantic errors occurred on the last items of the BNT (which have a reduced category salience as compared to the earlier items), the observed pattern of semantic errors in the controls was likely biased by the item order.

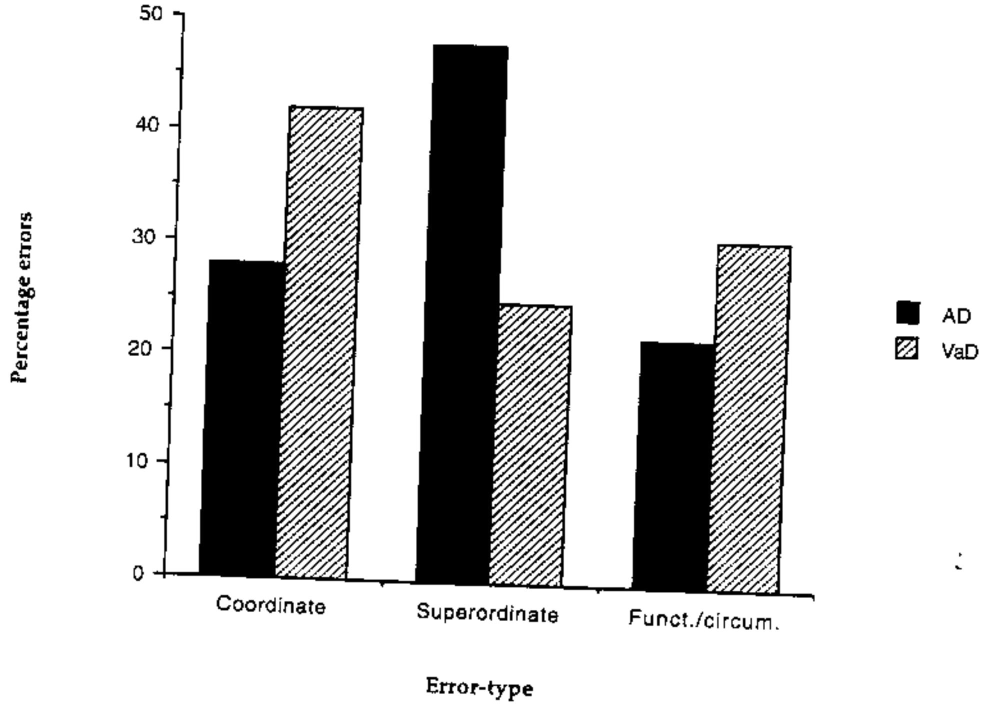

Figure 2. Groups by semantic error subtypes. AD = Alzheimer's disease; VaD = vascular disease; Funct./circum. = functional–circumlocutory.

with impaired naming show a tendency to make naming errors early in the test. Thus, if the performance of AD patients was induced exclusively by the BNT's item characteristics, AD patients would be expected to make a similar number of superordinate and coordinate errors, whereas VaD patients would be expected to make the functional–circumlocutory errors most often. However, a pattern of errors that indicates dissociation of coordinate and superordinate errors in AD (and possibly in VaD) was observed, and these results cannot be explained on the basis of the item characteristics.

Recent theoretical models view semantic knowledge as a systematically organized network of interrelated concepts and representations (Collins & Loftus, 1975; Lukatela, Lukatela, Carello, & Turvey, 1993; Rumelhart & McClelland, 1986). These semantic units are presumably stored in a hierarchically distributed fashion in the association cortices (Marshall, 1988; McCarthy & Warrington, 1990). There is still a considerable controversy regarding the nature of naming retrieval processes (serial vs. parallel) within the semantic network (Goodglass et al., 1997; Kohn & Goodglass, 1985; Martin, Weisberg, & Saffran, 1989). As the association cortices gradually deteriorate, as in AD, either the storage organization of semantic memory or retrieval processes along the network may become disrupted and result in a naming dysfunction.

The present results support the findings that in early AD the semantic system is damaged and that availability of the lower and more detailed nodes of this system is grossly reduced, whereas the availability of the higher (superordinate) level concepts appears preserved. The source of this deficit may reflect structural changes in the organization of semantic knowledge or limited retrieval (processing) capacities. The present findings are based on an explicit (i.e., attentionally controlled) semantic memory task and do not allow conclusions in this respect. Studies of semantic priming, as measured by on-line reaction time on lexical decision tasks (not controlled attentionally), are better suited to answer this question. However, in AD, these studies have produced inconsistent results with priming effects ranging from subnormal to supernormal (Chertkow & Bub, 1990; Ober & Shenaut, 1988; for a review, see Ober & Shenaut, 1995). On the basis of this study, we would expect that semantic priming effects in AD would depend on the quality of the prime target relation, with the priming of superordinate concepts being superior to the priming of coordinate concepts. We are currently testing this hypothesis.

We turn now to the comparison of VaD patients and elderly controls. The results show that VaD patients have naming problems because they produce more naming errors compared to the healthy controls, with an increase in visuoperceptual and semantic errors but not in phonemic errors. As stated previously, semantic errors were the most frequent error type in both VaD and controls. This finding is consistent with earlier characterizations of naming in healthy elderly participants (Albert, Heller, & Milberg, 1988) and in neurologically impaired groups, such as those with Huntington's disease and different types of aphasia (Hodges et al., 1991; Kohn & Goodglass, 1985). Thus, this tendency to make semantic errors seems common across different neurological populations and healthy elderly. This similarity implies that the complex naming process, especially at the semantic level, is vulnerable to a wide range of neurological changes, including the ones associated with normal aging, and cannot be ascribed to a single lesion site (Benson, 1979). The unexpected observation that the VaD group showed a nearly significant tendency to make coordinate errors more often than superordinate or circumlocutory errors needs further exploration.

In conclusion, we showed that AD patients demonstrate a very similar pattern of general naming errors (i.e., visuoperceptual, semantic, and phonemic) when compared to VaD patients and healthy, elderly control participants. In addition, we showed that the pattern of subtypes of semantic naming errors seen in AD patients is distinct from that seen in VaD patients. This indicates that the tendency to make superordinate errors rather than any other type of semantic errors is specific to early AD.

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