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Dysnomia in Alzheimer's Disease: An Evaluation of Neurobehavioral Subtypes

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The relative influence of perceptual and semantic features on naming performance was investigated with reference to the neurobehavioral profiles displayed by patients with Alzheimer's disease (AD). Forty-one patients were classified as manifesting a verbal, visual, or global subtype based upon their pattern of neuropsychological functioning. Perceptual characteristics of to-be-named pictures were varied by manipulating the amount of line detail, whereas semantic qualities were varied by altering word frequency norms. All AD subtypes were less accurate than normal elderly controls in naming low frequency pictures. Patients and controls took longer to name low frequency and high complexity pictures, and this effect was comparable across the AD groups. Patients with predominantly visual deficits were significantly slower in naming than controls, and those with verbal impairments made a higher proportion of semantic naming errors when compared to patients displaying visual or severe global impairments. These results suggest that deficits in semantic processing contribute to naming dysfunction in AD, and they highlight the importance of examining dissociations among neurobehavioral subtypes. © 1992 Academic Press, Inc.

Dysnomia is a common neurobehavioral feature of Alzheimer's disease (AD) and, along with memory disturbance, often occurs as an initial cognitive symptom. It is well known that deficient semantic processing contributes to this naming impairment. Investigators have reported that patients make a large proportion of semantically related errors (e.g., calling a dart an "arrow"), that naming performance correlates with se-

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mantic retrieval involving word list generation, and that accuracy improves with increased frequency of the items' names in the English language (Bayles & Tomoeda, 1983; Bowles, Obler, & Albert, 1987; Huff, Corkin, & Growdon, 1986; Kirshner, Webb, & Kelly, 1984; Martin & Fedio, 1983; Shuttleworth & Huber, 1988). The integrity of perceptual processing, however, also plays a role in successful naming. For example, Kirschner and colleagues (1984) found that naming accuracy was highest when actual objects were shown as opposed to representations of these objects in photographs, plain drawings, or drawings masked by superimposed grids. Shuttleworth and Huber (1988) also observed more accurate and faster naming of real than pictured objects.

The purpose of the current investigation was to evaluate the relative importance of semantic and perceptual features as a function of neurobehavioral subtypes displayed by patients. There is agreement that considerable heterogeneity exists in neuropsychological profiles in AD (Becker, Huff, Nebes, Holland, & Boller, 1988; Martin, 1987; Martin, Brouwers, Lalonde, Cox, Teleska, Fedio, Foster, & Chase, 1986; Teng, Wimer, Roberts, Damasio, Eslinger, Folstein, Tune, Whitehouse, Bardolph, Chui, & Henderson, 1989), with patients exhibiting impairments in both semantic and visuospatial/visuoconstructive abilities or a focal pattern characterized by verbal deficits but relatively preserved visual analytic skills or vice versa. Previous studies have typically not considered individual differences that could contribute to naming performance. Shuttleworth and Huber (1988, 1989) observed variability in the types of naming errors made by their patients, some of whom made primarily semantic errors while others made perceptual errors. They commented, ". . . attempting to average patient scores may tend to confuse rather than to clarify the nature of their naming disorder. In fact, at any given time, there may well be several possible anomic syndromes in DAT, varying over a continuum from mostly aphasic to mostly perceptual" (1988, p. 232).

In our study, patients were classified as manifesting a verbal, visual, or global deficit, and the influence of semantic versus perceptual features on naming performance was examined. Subtype classification was based on neuropsychological procedures that discriminated groups of AD patients in other investigations (Becker et al., 1988; Martin, 1987; Martin et al., 1986; Teng et al., 1989). The word frequency of to-be-named pictures was varied according to norms of their occurrence in the English language (Kucera & Francis, 1967; Thorndike & Lorge, 1944). The perceptual manipulation consisted of varying the visual complexity of the stimuli by altering the amount of line detail present in pictures (Snodgrass & Vanderwart, 1980). This variable was chosen due to clinical descriptions of AD patients emphasizing impaired visual scanning, simultanagnosia, and pull to detail (Fletcher & Sharpe, 1986, 1988; Hof, Bouras, Constantinidis,

& Morrison, 1989; Hutton, Dippel, & Sung, 1987, Hutton, Nagel, & Lowenson, 1984; Shuttleworth & Huber, 1989). Shuttleworth and Huber (1989) in their naming study described a subset of patients who attended to irrelevant parts of drawings (e.g., responding "bowl" to a picture of a pipe). We simultaneously manipulated word frequency (high versus low) and perceptual complexity (high versus low) of pictures to evaluate whether patients with verbal deficits were impaired in naming low-versus high-frequency items (regardless of visual complexity) and whether those with visual deficits were adversely affected in naming high- versus low-complexity pictures (irrespective of frequency).

METHODS

Subjects. Forty-one patients with probable AD according to NINCDS–ADRDA criteria (McKhann, Drachman, Folstein, Katzman, Price, & Stadlan, 1984) were studied. Patients were referred to the Wesley Woods Memory Assessment Clinic for neuropsychological evaluation as part of their clinical workup or were participants in ongoing pharmacological studies. In the latter cases, patients were tested at baseline prior to drug intervention. All patients had been extensively evaluated for alternative causes of dementia with laboratory procedures including computed tomography or magnetic resonance imaging, electroencephalogram, and blood screens. The average age of the sample was 73.2 years (SD = 6.9) with a mean educational level of 13.1 years (SD = 3.2). Mini-Mental State Examination (MMSE; Folstein, Folstein, & McHugh, 1975) scores were obtained for 27 patients and averaged 21.2 (SD = 3.0) of 30 points. The other participants received the Dementia Rating Scale (DRS; Mattis, 1988) during their neuropsychological examination. The total mean score was 105.3 (SD = 10.6) of 144 points. Both the MMSE and the DRS provide measures of general cognitive functioning and assess common areas including attention, design copying, and memory. In order to examine the extent to which these scores were related, a Pearson product moment correlation coefficient was calculated for nine AD patients who received both the MMSE and the DRS. This correlation was +.57, which approached but missed significance in this small subsample ($r = .67$ needed for $p < .05$).

Fourteen neurologically intact elderly controls (mean age = 71.6, SD = 6.9; mean education = 14.5, SD = 2.0) were recruited from the community. Their MMSE scores averaged 28.7 points (SD = 1.4).

No patient or control was included in this study if there was a premorbid history of significant neurologic illness (e.g., stroke, hypoxia, head injury), drug/alcohol abuse, or psychiatric condition. English was the primary language for participants. Near card binocular acuity (with glasses if used) was 20/50 or better.

Subtypes of AD. Patients received specific tests found in previous studies to differentiate verbal, visual, and global subtypes of AD (Becker et al., 1988; Martin, 1987; Martin et al., 1986; Teng et al., 1988). The Controlled Oral Word Association Test (COWA; Benton & Hamsher, 1989), a measure of verbal fluency, required individuals to generate words beginning with specific letters. The Block Design subtest of the Wechsler Adult Intelligence Scale—Revised (Wechsler, 1981) evaluated visuospatial abilities by having patients configure blocks to match models. Patients were subtyped based on the normative data of 20 elderly controls who were different from the experimental control subjects receiving the naming task. Scores on the COWA and Block Design measures were converted to standard scores by taking each patient's raw score, subtracting it from the normative sample mean, and dividing it by the normative sample's standard deviation. A patient was identified as a *verbal subtype* if the standard score on the COWA was more than 2 *SD*s below control performance and the Block Design score was within 2 *SD*s of controls. A patient was identified as a *visual subtype* on the basis of a Block Design score greater than 2 *SD*s below control performance with relative preservation of word fluency (within 2 *SD*s of the normative sample). Two additional groups were derived consisting of patients with *mild global impairments* (within 2 *SD*s of control performance) or *severe global impairments* (greater than 2 *SD*s below control performance) on both tests.

Table 1 lists the demographic and neuropsychological performances of the four groups of AD patients and the control subjects in this study. One-way analyses of variance (ANOVA) indicated nonsignificant differences in age, $F(4, 50) = .53, p = .71$, and education, $F(4, 50) = .74, p = .57$. The COWA scores for the verbal and severe global patients were significantly impaired when compared to those for the patients with predominantly visual or mild deficits. In contrast, the Block Design scores of the visual and severe global AD patients were significantly worse than those of patients with verbal and mild deficits. Table 1 displays the MMSE scores for the subgroups and controls. There were no significant differences among the subgroups in their MMSE scores. However, they all significantly differed from controls.

Generation of naming stimuli. Creation of the naming stimuli occurred in two phases in order to derive a final set that was equated for age of acquisition, name agreement, and familiarity. These variables can influence the ease of naming apart from frequency or complexity (Carroll & White, 1973b; Feyereisen, Van Der Borght, & Seron, 1988). In the first phase, 159 words were selected from lists provided by Carroll and White (1973a), Snodgrass and Vanderwart (1980), and Gilhooly and Logie (1980) that had low (<5 occurrences/million) or high (>20 occurrences/million) frequency values according to Kucera-Francis (1967) and Thorndike-Lorge (1944) word norms. Age of acquisition ratings were obtained by mailing the list to 18 community-residing elderly individuals who were participants in other ongoing research. Using instructions adapted from normative studies (Carroll & White, 1973a; Gilhooly & Logie, 1980), subjects were asked to rate when they learned the meaning of each word on a 7-point scale (1 = learned between 0 and 2 years of age) with 2-year increments up to a value of 7 (learned at age 13 years or older). Following the compilation of all data, 106 words were selected with age of acquisition norms of 2.5 or higher (corresponding to 5 years or older).

In the second creation phase, line drawings depicting these words were found in the Boston Naming Test (Kaplan, Goodglass, & Weintraub, 1983), the Peabody Picture Vocabulary Test—Revised (Dunn & Dunn, 1981), and Snodgrass and Vanderwart norms (1980). They were photostated to be of equal size. Twelve separate community-residing elderly individuals rated these stimuli along three variables (name of item, complexity, and familiarity). Instructions for each characteristic were from normative studies (Carroll & White, 1973a, Gilhooly & Logie, 1980; Snodgrass & Vanderwart, 1980). First, individuals were instructed to look at each picture and "write only one name, the first name that comes to mind." They were also asked to judge the complexity of each picture ("the amount of detail or intricacy of line in the picture") using a scale from 1 (very simple) to 6 (very complex). Finally, familiarity scores were obtained by having controls rate "the degree to which you come in contact with or think about the concept" from 1 (very unfamiliar) to 6 (very familiar).

From this set, 40 pictures were selected with 10 in each group representing the factorial combinations of low–high complexity (rankings of <2.5 or >3.5) and low–high frequency (<5 occurrences/million or >20 occurrences/million). The rankings of the stimuli are provided in Table 2. One-way ANOVAs indicated that the sets differed significantly ($p < .001$) in terms of high versus low frequency and high versus low complexity but not according to age of acquisition, percentage of name agreement, or familiarity. Examples of the stimuli are displayed in Fig. 1

Procedure. Subjects were individually tested. They were instructed that they would see pictures projected on the wall and should provide the name of each picture. They were

TABLE 1

MEANS (AND STANDARD DEVIATIONS) OF DEMOGRAPHIC CHARACTERISTICS AND NEUROPSYCHOLOGICAL TEST SCORES OF AD SUBGROUPS AND NORMAL CONTROLS[a]

Type of impairment	Age	Education	COWA[b]	Block design[b]	MMSE[c]
Verbal (N = 7)	75.3 (3.9)	13.6 (2.0)	7.1 (3.7)^{a,b}	10.1 (2.6)^{e,f,g}	19.8 (4.6)
Visual (N = 11)	71.5 (9.3)	13.5 (2.9)	19.5 (7.1)^{a,c}	2.8 (2.8)^{e,h}	20.7 (2.6)
Mild global (N = 10)	72.4 (5.2)	12.6 (3.0)	18.7 (7.0)^{b,d}	14.8 (5.5)^{g,h,i}	22.8 (2.1)
Severe global (N = 13)	74.1 (7.3)	12.9 (4.2)	7.4 (1.9)^{c,d}	1.3 (1.7)^{f,i}	20.8 (3.0)
Normal controls (N = 14)	71.6 (6.9)	14.5 (2.0)	24.6 (5.2)*	26.6 (11.0)*	28.7 (1.4)*

[a] A common superscript letter indicates a significant difference ($p < .05$) between groups.

[b] Raw scores for Controlled Oral Word Association (two letters) and WAIS-R Block Design.

[c] N: Verbal = 4, Visual = 7, Mild = 8, Severe = 8, Controls = 13.

* Significantly different from all AD subgroups.

TABLE 2

MEANS (AND STANDARD DEVIATIONS) OF RATINGS OF PICTURE DIMENSIONS IN THE FOUR NAMING CONDITIONS[a]

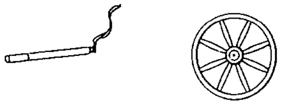
	Frequency	Complexity	Age of acquisition	Percentage of name agreement	Familiarity
High Complexity–High Frequency	39.5 (13.5)^{a,b}	4.6 (.56)^{e,f}	3.0 (.63)	97.6 (3.9)	4.9 (1.1)
High Complexity–Low Frequency	2.8 (1.7)^{a,c}	4.8 (.65)^{g,h}	3.5 (.86)	95.4 (7.2)	4.0 (.90)
Low Complexity–High Frequency	35.0 (17.1)^{c,d}	2.4 (.37)^{e,g}	3.2 (.64)	96.7 (5.9)	5.1 (.98)
Low Complexity–Low Frequency	2.0 (1.2)^{b,d}	2.7 (.28)^{f,h}	3.8 (.93)	95.0 (9.0)	4.8 (1.2)

[a] A common superscript letter indicates a significant difference ($p < .05$) between groups.

High Complexity - High Frequency

High Complexity - Low Frequency

Low Complexity - High Frequency



Low Complexity - Low Frequency

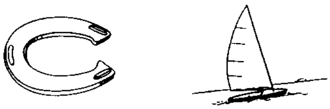


FIG. 1. Examples of pictures representing the combinations of High–Low Frequency and High–Low Complexity.

encouraged to say just the names and not to preface their responses with extraneous words. If a subject engaged in such behavior, s/he was reminded of this rule prior to each trial.

The stimuli were projected via a Kodak (Model 5200) slide projector attached to a light-sensitive recording mechanism which began timing (in milliseconds) when the stimulus appeared. The examiner held a response key which was pressed as soon as a correct response was provided. This manual method, while less accurate than a voice-activated timer, was chosen due to the fact that initial errors or circumlocutory responses by AD patients would prematurely stop the timer. Shuttleworth and Huber (1988), using a hand-held stopwatch, found that this manual method was sensitive to frequency effects on naming performance in both AD patients and elderly normal controls.

Subjects were allowed up to 30 sec to name the stimulus before the timer automatically stopped. They were not instructed to respond quickly nor were they aware that they were being timed. Naming responses and latencies to provide correct names were recorded. Four random orders of stimuli presentation were constructed with the restriction that no more than two pictures from the same condition occurred contiguously. Different examiners administered the naming task and neuropsychological measures in order to avoid any biases based on knowledge of the pattern of performance.

RESULTS

Naming accuracy. The number of correct responses (10 possible per condition) was analyzed in a 5 (Group) by 2 (High versus Low Frequency) by 2 (High versus Low Complexity) repeated measures ANOVA with

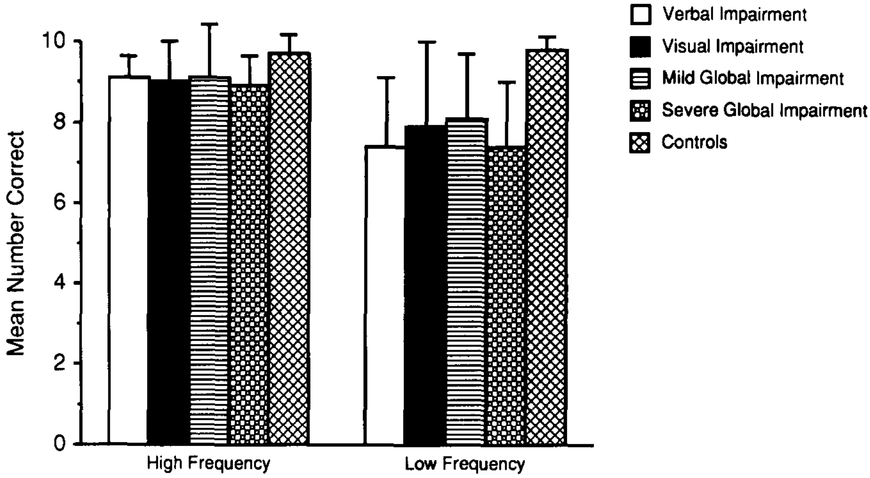


FIG. 2. Mean number of correct responses as a function of Subject Group and Frequency. The error bars represent standard deviations.

Group as the between-subjects factor and Frequency and Complexity as within-subjects factors. This analysis indicated significant ($p < .01$) main effects of Group, $F(4, 50) = 4.68$, and Frequency, $F(1, 50) = 37.65$, as well as an interaction between these two variables, $F(4, 50) = 4.02$. The nature of this interaction is displayed in Fig. 2. Analysis of the simple main effects revealed no disparities among groups in the number of correct responses for high-frequency items, $F(4, 50) = 1.77$, $p = .15$, but a significant difference among the groups in naming low frequency items, $F(4, 50) = 5.39$, $p < .01$. Posthoc Newman–Keuls analysis of the cell means (Keppel, 1973; Myers, 1966) demonstrated that normal controls were significantly ($p < .05$) more accurate in naming low frequency pictures than all AD groups. While inspection of the figure reveals a trend for naming of low frequency items to be poorer in patients with verbal and severe global impairments, their accuracy was in fact comparable to that of the other patient groups.

The above analysis also indicated a significant main effect of Complexity, $F(1, 50) = 9.53$, $p < .01$, and no interaction of this variable with Group, F (4, 50) $= .68$, $p = .61$ (Fig. 3). Overall naming accuracy was higher for low complexity (mean = 8.79, $SD = .91$) than for high complexity pictures (mean = 8.45, $SD = 1.26$), and this effect was consistent for all patients and controls.

Naming latency. Median (Med) latencies to name the pictures were examined. This analysis incorporated correct responses only and excluded those that exceeded the maximum time allotment of 30 sec. A 5 (Group) by 2 (High versus Low Frequency) by 2 (High versus Low Complexity)

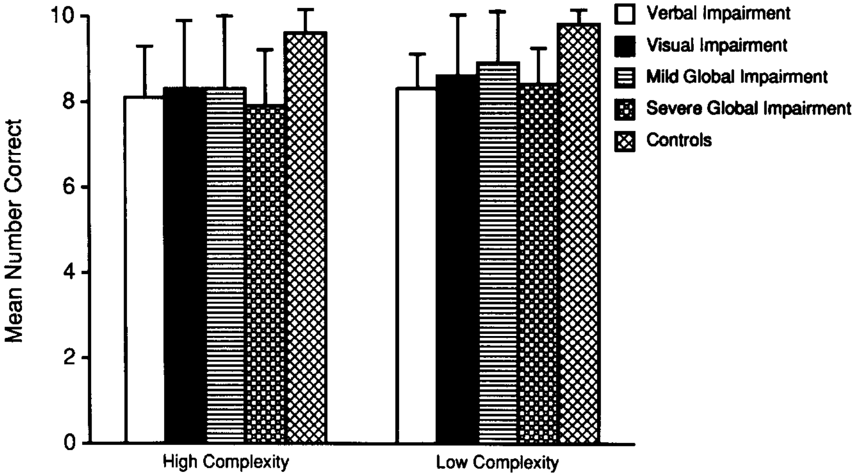


FIG. 3. Mean number of correct responses as a function of Subject Group and Complexity. The error bars represent standard deviations.

repeated measures ANOVA indicated a significant main effect of Group, $F(4, 50) = 3.01, p < .05$. Posthoc Newman–Keuls analysis revealed that patients with visual impairments (Med = 2.57 sec., *SD* = 1.56) were significantly slower than control subjects (Med = 1.45 sec., *SD* = .27). The performance of patients with verbal (Med = 2.17 sec., *SD* = .36), mild global (Med = 2.43 sec., *SD* = 1.18), and severe global (Med = 2.39 sec., *SD* = .59) deficits, while also slower, did not differ significantly from that of controls. The AD groups' latencies were comparable to each other.

There were also significant main effects of Frequency, $F(1, 50) = 9.61$, $p < .01$, and Complexity, $F(1, 50) = 4.59$, $p < .05$. Performance of patients and controls as a function of these variables is displayed in Figs. 4 and 5. High frequency pictures (Med = 1.87, *SD* = .43) were named more rapidly than low frequency pictures (Med = 2.54, *SD* = 1.54). In addition, latencies to name low complexity pictures (Med = 2.03, *SD* = .55) were faster than those for high complexity stimuli (Med = 2.38, *SD* = 1.42) There was no significant interaction of Group with either Frequency, $F(4, 50) = 1.09, p = .37$, or Complexity, $F(4, 50) = .52, p = .72$, indicating that patients and controls maintained a similar pattern across manipulations.

Types of naming errors. Using a previously developed coding scheme (Bayles & Tomoeda, 1983), naming errors were classified into four types: no response (no name provided), unrelated error (saying "rocket" for glove), visually related error (saying "bamboo" for asparagus, "piano key" for comb), and semantically related error (saying "peach" for pear,

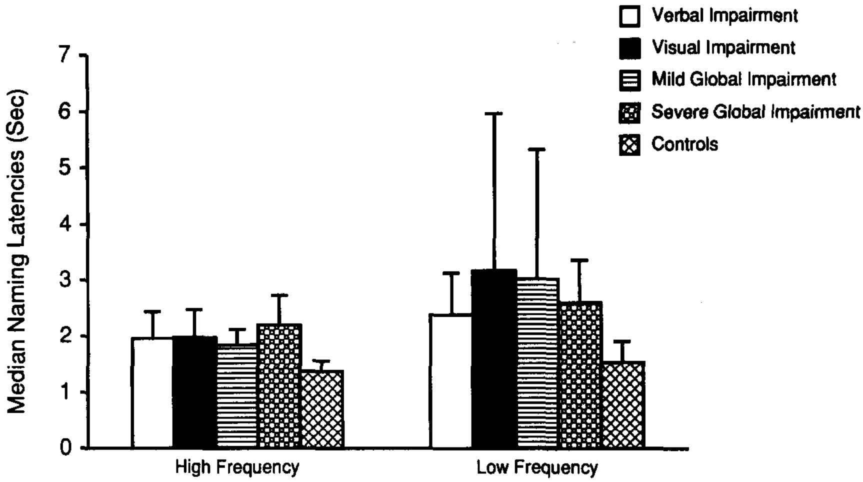


FIG. 4. Median naming latencies as a function of Subject Group and Frequency. The error bars represent standard deviations.

"sweeping" for broom, "bird" for owl). The proportion of each type of error committed by each subject was calculated by taking the number of errors for a particular type and dividing by the total errors. Two AD patients (one visual and one mild) and eight controls were excluded from this analysis since they did not make any errors. Table 3 displays the data for the five subject groups. Separate one-way ANOVAs indicated that the groups did not differ significantly in the proportion of errors consisting

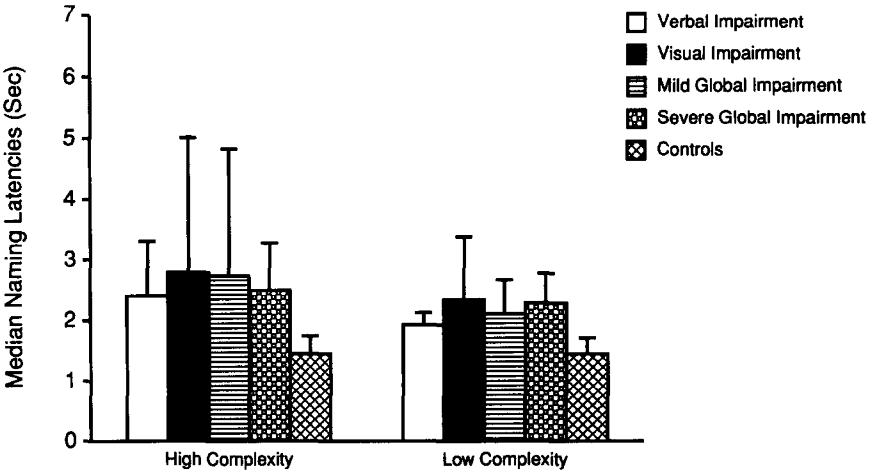


FIG. 5. Median naming latencies as a function of Subject Group and Complexity. The error bars represent standard deviations.

TABLE 3
MEAN PROPORTIONS (AND STANDARD DEVIATIONS) OF TYPES OF NAMING ERRORS[a]

	Error type			
Type of impairment	No response	Unrelated	Visual	Semantic
Verbal ($N = 7$)	.10 (.17)	.03 (.08)	.13 (.12)	.75 (.16)^{a,b}
Visual ($N = 10$)	.13 (.17)	.11 (.17)	.16 (.19)	.61 (.24)^{a}
Mild global ($N = 9$)	.12 (.14)	.01 (.04)	.19 (.32)	.67 (.28)
Severe global ($N = 13$)	.18 (.15)	.04 (.09)	.22 (.16)	.56 (.16)^{b}
Normal controls ($N = 6$)	.17 (.41)	.00 (.00)	.57 (.46)*	.26 (.39)*

[a] A common superscript letter indicates a significant difference ($p < .05$) between groups.
* Significantly different from all AD subgroups.

of no responses, $F(4, 40) = .26$, $p = .90$, or unrelated responses, $F(4, 40) = 1.50$, $p = .22$. However, there were significant group differences for both visual errors, $F(4, 40) = 3.18$, $p < .05$, and semantic errors, $F(4, 40) = 3.73$, $p < .05$. As seen in Table 3 and confirmed by posthoc Newman–Keuls analysis of the means, normal controls were more likely ($p < .05$) to make visually related errors than all the patient subtypes. The opposite pattern was observed for semantic responses in which patients were more likely to commit semantic errors relative to controls. In addition, patients with predominantly verbal deficits had a significantly higher proportion of semantic errors than those with visual and severe global impairments.

Performance on other neuropsychological measures. Neuropsychological test data were available for a number of patients and controls on additional measures hypothesized to be sensitive to the neurobehavioral subtypes as defined in this study (Martin, 1987; Martin et al., 1986; Teng et al., 1989). Two measures tapped verbal functions including the ability to infer the conceptual relationships between stated items (WAIS-R Similarities; Wechsler, 1981) and to comprehend increasingly complex oral commands (Token Test; Benton & Hamsher, 1989). The other two instruments assessed visuomotor processing involving the ability to copy a complex design (Rey–Osterrieth Complex Figure; Lezak, 1983) and to transcribe numbers/symbols under timed conditions (WAIS-R Digit Symbol; Wechsler, 1981). Performance of the groups on these tests is displayed in Table 4.

One-way ANOVAS indicated significant ($p < .05$) group differences on these four measures. Posthoc Newman–Keuls analyses revealed that the performance of control subjects was significantly better than that of all of the patient groups. In addition, dissociations were observed among the patients for each dependent measure. The ability to infer conceptual

TABLE 4
Neuropsychological Test Performance[a]

Type of *impairment*	*Similarities*	*Token test*	*Rey–Osterreith*	*Digit symbol*
Verbal	7.5 (5.5)^{a}	16.5 (4.2)^{b,c,d}	21.6 (12.1)^{e,f,g}	27.8 (11.0)^{k,l}
(*N*)	(4)	(6)	(6)	(4)
Visual	12.2 (4.5)^{a}	18.9 (2.9)^{b}	16.8 (9.7)^{e,h,j}	17.9 (9.0)^{k,m,o}
(*N*)	(10)	(9)	(11)	(8)
Mild global	9.8 (5.8)	19.4 (1.6)^{c}	28.8 (5.1)^{g,h,i}	27.1 (7.3)^{m,n}
(*N*)	(9)	(8)	(10)	(7)
Severe global	9.6 (7.5)	18.5 (2.6)^{d}	12.7 (9.9)^{f,i,j}	6.9 (4.8)^{l,n,o}
(*N*)	(11)	(12)	(13)	(9)
Normal controls	22.5 (4.6)*	21.3 (.78)*	32.8 (4.1)*	52.5 (6.8)*
(*N*)	(13)	(12)	(14)	(8)

[a] Raw scores are reported. Maximum scores possible are 28 points (Similarities), 22 points (Token Test), 36 points (Rey–Osterreith), 93 points (Digit Symbol). A common superscript letter indicates a significant difference ($p < .05$) between groups.

* Significantly different from all AD subgroups.

relations was poorer in the verbal than in the visual subgroup. Patients with predominantly verbal difficulties also had deficient comprehension of commands relative to those with visual, mild global, and severe global impairments. On design copying, the visual subgroup performed significantly worse than patients with verbal and mild global deficits but better than patients with severe global impairments. The functioning of the severe global group was impaired relative to that of the mild global group. Finally, on speeded transcription of numbers/symbols, the visual subgroup was again impaired relative to the verbal and mild groups but was less deficient than the severe global patients. Patients with mild global problems were intact relative to the visual and severe global groups.

DISCUSSION

The results of this study address two general issues relevant to elucidating the naming disorder associated with Alzheimer's disease. The first issue focuses on whether neurobehaviorally distinct subgroups of patients display differences in naming as a function of semantic and perceptual features of stimuli. The second point addresses whether dysnomia in AD primarily reflects word search/retrieval difficulties or impaired visual recognition mechanisms.

With respect to the first issue, it was predicted that patients with verbal deficits but relatively spared visuospatial processing would be selectively impaired in naming low as opposed to high frequency pictures. In contrast, patients with deficient visual analytic skills but relatively preserved verbal functioning were hypothesized to be disproportionately affected when pictures contained high versus low complexity features. The analyses for accuracy and latency did not indicate that particular subgroups were differentially affected by the frequency or complexity manipulations. Word frequency of the stimuli influenced the naming performance of all AD subtypes, with low frequency names being less accurate and slower to retrieve than high frequency names. Although the complexity of the stimuli was also important, there was again a similar effect observed across all AD groups such that stimuli containing a high degree of line detail or complexity were named less accurately and slower than drawings with less details. While these findings suggest that the naming performance among the subgroups was comparable, there were some overall indications for differences in functioning. Specifically, patients with visual impairments were slower in naming pictures than the control subjects. Although all AD groups made a large proportion of semantic errors relative to controls, individuals with predominantly verbal deficits had a relatively higher proportion compared to those with visual and severe global impairments. This latter finding in particular gives support to the observations of Shuttleworth and Huber (1988, 1989) that there is variability in the types of naming errors made by patients and that averaging scores across all groups may obscure these differences.

It might be argued that the AD subtypes as defined in this study were actually not neurobehaviorally distinct, and therefore dissociations as a function of frequency and complexity were unobserved. Our subtypes were defined based upon the research of other investigators (Becker et al., 1988; Martin, 1987; Martin et al., 1986; Teng et al., 1989) who found that performance on tests of word list generation and block construction served to distinguish patient groups. The results of the additional neuropsychological measures administered to subjects appear to support neurobehavioral heterogeneity. Specifically, measures of verbal conceptual reasoning and language comprehension were selectively deficient in patients defined as displaying a verbal subtype relative to a visual pattern. On the other hand, design copying and transcription of number/symbols were poorer in patients with a visual deficit than in patients with a verbal impairment. Our groups obtained *relatively* preserved (within 2 *SD*s) or impaired (greater than 2 *SD*s) scores on the COWA and Block Design tests. However, compared to the elderly control subjects in this study, the AD patients were significantly deficient on these measures, indicating that they were outside the "normal" range. Neurobehavioral distinctions among subtypes may be best appreciated earlier in the disease process, when patients actually perform within normal limits on some tests but not on others.

A second issue raised by the current study addresses whether naming dysfunction primarily reflects impaired semantic access/retrieval or perception. Overall, the current findings suggest that naming performance in AD is strongly influenced by semantic features, a conclusion consistent with the research findings of other investigators (Bayles & Tomoeda, 1983; Huff et al., 1986; Martin & Fedio, 1983). Compared to normal controls, AD patients were disproportionately impaired when they tried to identify items with low frequency names, whereas the performance of the groups did not differ significantly for high frequency pictures. While the complexity of the stimuli also influenced naming, there was no interaction of this variable with subject group, indicating that patients were affected by the amount of line detail to the same extent as controls. We chose to manipulate visual complexity due to reports in the literature of perceptual processing deficits in AD such as poor visual scanning and attending to irrelevant aspects of to-be-named stimuli (Fletcher & Sharpe, 1986, 1988; Hof et al., 1989; Shuttleworth and Huber, 1988, 1989). Complexity was expected to place patients at a disadvantage by increasing their tendency to attend to details. Another line of evidence for semantic processing difficulties concerns the types of naming errors made by subjects. AD patients as a group made a greater proportion of semantic relative to perceptual naming errors, replicating the findings of other investigations (Bayles & Tomoeda, 1983; Huff et al., 1986; Martin & Fedio, 1983). Interestingly, when normal controls made errors, they were more likely to commit perceptual than semantic distortions, a finding which is similar to the results of Kirshner and colleagues (1984).

A number of investigators (Connine, Mullennix, Shernoff, & Yelen, 1990; Feyereisen et al., 1988) have argued that word frequency may influence semantic access due to the fact that words or pictures with high frequency values are also more *familiar.* Familiarity refers to the extent to which individuals come in contact with or think about a particular item in daily functioning. A picture of a wheel (high frequency) may be easily accessed and named as opposed to a picture of a horseshoe (low frequency) because one encounters the former item in daily experience. Rather than exerting a direct influence on the semantic lexicon, high frequency items which are also more familiar may evoke additional senses including visual, auditory, and tactile associations so that they are easier to name. Investigators have expressed disatisfaction with the method of choosing low versus high frequency words published in normative textbooks (Kucera & Francis, 1967, or Thorndike & Lorge, 1944) precisely because these values do not take into account the familiarity of the words. For example, one may encounter two low frequency words (penguin and mushroom) which differ greatly in familiarity. In the present study, we attempted to match the familiarity of pictures across the high and low frequency manipulations in order to avoid this confound. Future studies should examine the relative contributions of frequency and familiarity on naming in AD to more clearly separate their influences on semantic access and perceptual recognition.

REFERENCES

Bayles, K. A., & Tomoeda, C. K. 1983. Confrontation naming impairment in dementia. *Brain and Language,* **19,** 98–114.

Becker, J. T., Huff, F. J., Nebes, R. D., Holland, A., & Boller, F. 1988. Neuropsychological function in Alzheimer's disease. *Archives of Neurology,* **45,** 263–268.

Benton, A. L., & Hamsher, K. deS. 1989. *Multilingual aphasia examination.* Iowa City: AJA Associates. Second ed.

Bowles, N. L., Obler, L. K., & Albert, M. L. 1987. Naming errors in healthy aging and dementia of the Alzheimer type. *Cortex,* **23,** 519–524.

Carroll, J. B., & White, M. N. 1973a. Age-of-acquisition norms for 220 picturable nouns. *Journal of Verbal Learning and Verbal Behavior,* **12,** 563–576.

Carroll, J. B., & White, M. N. 1973b. Word frequency and age of acquisition as determiners of picture-naming latency. *Quarterly Journal of Experimental Psychology,* **25,** 85–95.

Connine, C. M., Mullennix, J., Shernoff, E., & Yelen, J. 1990. Word familiarity and frequency in visual and auditory word recognition. *Journal of Experimental Psychology: Learning, Memory, and Cognition,* **16,** 1084–1096.

Dunn, L. M., & Dunn, L. M. 1981. *Peabody Picture Vocabulary Test—Revised.* Circle Pines, MN: American Guidance Service.

Feyereisen, P., Van Der Borght, F., & Seron, X. 1988. The operativity effect in naming: A reanalysis. *Neuropsychologia,* **26,** 401–415.

Fletcher, W. A., & Sharpe, J. A. 1986. Saccadic eye movement dysfunction in Alzheimer's disease. *Annals of Neurology,* **20,** 464–471.

Fletcher, W. A., & Sharpe, J. A. 1988. Smooth pursuit dysfunction in Alzheimer's disease. *Neurology,* **38,** 272–277.

Folstein, M. F., Folstein, S. E., & McHugh, P. R. 1975. "Mini-Mental State:" A practical method for grading the cognitive state of patients for the clinician. *Journal of Psychiatric Research,* **12,** 189–198.

Gilhooly, K. J., & Logie, R. H. 1980. Age-of-acquisition, imagery, concreteness, familiarity, and ambiguity measures for 1,944 words. *Behavior Research Methods & Instrumentation,* **12,** 395–427.

Hof, P. R., Bouras, C., Constantinidis, J., & Morrison, J. H. 1989. Balint's syndrome in Alzheimer's disease: Specific disruption of the occipito-parietal visual pathway. *Brain Research,* **493,** 368–375.

Huff, F. J., Corkin, S., & Growdon, J. H. 1986. Semantic impairment and anomia in Alzheimer's disease. *Brain and Language,* **28,** 235–249.

Hutton, J. T., Dippel, R. I., & Sung, J. H. 1987. Eye tracking in Pick disease as contrasted to Alzheimer disease. *Neurophthalmology,* **7,** 159–164.

Hutton, J. T., Nagel, J. A., & Loewenson, R. B. 1984. Eye tracking dysfunction in Alzheimer-type dementia. *Neurology,* **34,** 99–102.

Kaplan, E., Goodglass, H., & Weintraub, S. 1983. *Boston naming test.* Philadelphia: Lea & Febiger.

Keppel, G. 1973. *Design and analysis: A researcher's handbook.* Englewood Cliffs, NJ: Prentice-Hall.

Kirshner, H. S., Webb, W. G., & Kelly, M. P. 1984. The naming disorder of dementia. *Neuropsychologia,* **22,** 23–30.

Kucera, M., & Francis, W. N. 1967. *Computational analysis of present-day American English.* Providence, RI: Brown Univ. Press.

Lezak, M. D. 1983. *Neuropsychological assessment.* New York: Oxford Univ. Press.

Martin, A. 1987. Representation of semantic and spatial knowledge in Alzheimer's patients: Implications for models of preserved learning in amnesia. *Journal of Clinical and Experimental Neuropsychology,* **9,** 191–224.

Martin, A., Brouwers, P., Lalonde, F., Cox, C., Teleska, P., Fedio, P., Foster, N. L., & Chase, T. N. 1986. Towards a behavioral typology of Alzheimer's patients. *Journal of Clinical and Experimental Neuropsychology,* **8,** 594–610.

Martin, A., & Fedio, P. 1983. Word production and comprehension in Alzheimer's disease: The breakdown of semantic knowledge. *Brain and Language,* **19,** 124–141.

Mattis, S. 1988. *Dementia Rating Scale.* Odessa, FL: Psychological Assessment Resources.

McKhann, G., Drachman, D., Folstein, M. F., Katzman, R., Price, D., & Stadlan, E. M. 1984. Clinical diagnosis of Alzheimer's disease: Report of the NINCDS–ADRDA Work Group under the auspices of Department of Health and Human Services Task Force on Alzheimer's disease. *Neurology,* **34,** 939–944.

Myers, J. L. 1966. *Fundamentals of experimental design.* Boston: Allyn & Bacon.

Shuttleworth, E. C., & Huber, S. J. 1989. A longitudinal study of the naming disorder of dementia of the Alzheimer type. Neuropsychiatry, Neuropsychology, and Behavioral Neurology, **1,** 267–282.

Shuttleworth, E. C., & Huber, S. J. 1988. The naming disorder of dementia of Alzheimer type. *Brain and Language,* **39,** 222–234.

Snodgrass, J. G., & Vanderwart, M. 1980. A standardized set of 260 pictures: Norms for name agreement, image agreement, familiarity, and visual complexity. *Journal of Experimental Psychology: Human Learning and Memory,* **6,** 174–215.

Teng, E. L., Wimer, C., Roberts, E., Damasio, A. R., Eslinger, P. J., Folstein, M. F., Tune, L. E., Whitehouse, P. J., Bardolph, E. L., Chui, H. C., & Henderson, V. W. 1989. Alzheimer's dementia: Performance on parallel forms of the dementia assessment battery. *Journal of Clinical and Experimental Neuropsychology,* **11,** 899–912.

Thorndike, E. L., & Lorge, I. 1944. *The teacher's word book of 30,000 words.* New York: Bureau of Publications, Teachers College, Columbia Univ.

Wechsler, D. 1981. *Wechsler adult intelligence scale—Revised.* New York: The Psychological Corp.