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**Category and attribute knowledge deterioration in Alzheimer's
Disease**

Cox, Diane Marie, M.S.

The University of Arizona, 1992

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CATEGORY AND ATTRIBUTE KNOWLEDGE DETERIORATION
IN ALZHEIMER'S DISEASE

by

Diane Marie Cox

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A Thesis Submitted to the Faculty of the
DEPARTMENT OF SPEECH AND HEARING SCIENCES
In Partial Fulfillment of the Requirements
For the Degree of
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In the Graduate College
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1992

STATEMENT BY AUTHOR

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ABSTRACT

Changes associated with Alzheimer's Disease (AD) in the association cortices of temporal, occipital, and parietal lobes of the brain, result in significantly impaired performance of AD subjects on tests of semantic memory. The most prevalent theory regarding the deterioration of semantic memory is that it is a bottom-up process. That is, the knowledge of attributes becomes lost or inaccessible prior to the knowledge of categories. Previous research of this theory has resulted in conflicting results. The purpose of this study was to test further the theory, while taking into account task difficulty. Thirty probable AD and 28 normal elderly subjects were administered tasks of attribute and categorical knowledge. Results revealed significant differences in performance as a result of task difficulty. These results call into question the methodology previously used to assess the bottom-up theory, as well as the ability to use attribute and categorical knowledge separately.

INTRODUCTION

Alzheimer's Disease (AD) is a progressive degenerative disease characterized by changes in the brain's structure and neurochemical make-up. These changes are most prominent in the association cortices of the temporal, parietal, and occipital lobes which are thought to be critical for lexical-semantic memory. Hence, AD patients demonstrate significant impairment on tests of semantic knowledge (Appell, Kertesz, & Fisman, 1982; Emery & Emery, 1983; Murdoch, Chenery, Wilks, & Boyle, 1987; Bayles & Kaszniak, 1987). Semantic memory is the system which stores, processes, and retrieves knowledge of the meaning of concepts, facts, and words (Tulving, 1972). It comprises an individual's knowledge of the world.

A major question for neuropsychologists and neurolinguists is how Alzheimer's disease affects semantic memory. The most prevalent theory regarding the deterioration of semantic memory is that it is a bottom-up process (Warrington, 1975; Schwartz, Marin & Saffran, 1979; Martin & Fedio, 1983; Chertkow et al., 1989; Ober et al., 1986; Martin, 1987). That is, the knowledge of specific attributes of an object are lost, or become inaccessible, prior to the loss of categorical knowledge. Because knowledge of the attributes of an object enables individuals to perceive and distinguish the object from other items within a category, loss of such knowledge can be argued to affect performance on many language tasks, including naming (Kirshner, Webb & Kelty, 1984), comprehension (Bayles & Kaszniak, 1987) and encoding (Wilson et al., 1983).

Warrington (1975) studied three patients with cortical atrophy whose performance on a visual recognition by forced choice task, and a visual recognition by semantic probe task (yes/no response) supported the theory of a bottom-up deterioration of semantic memory. Initially the patients were given a forced choice object recognition task in which they were to determine which of three objects fell into a certain category, such as animal/not animal, or insect/not insect. Attribute knowledge was examined by having the subjects indicate which was the "dangerous" animal, "largest" animal, "foreign" animal, or animal of a certain color. Similar testing was also conducted using pictures of inanimate objects. A second task required a yes/no response to a direct question regarding the picture stimuli, such as "Is it an animal?" (categorical knowledge) and "Is it bigger than a cat?" (attribute knowledge). Subjects in the study had difficulty on the tasks requiring attribute knowledge but performed well on the tests of categorical knowledge.

Schwartz, Marin and Saffran (1979), in a case study of a subject with presenile dementia, attributed the object misnamings of their subject to a loss of knowledge of the semantic attributes of the objects. They presented the subject with a picture and a choice of five names. The choices consisted of the correct name, two unrelated names, a phonologically similar (phonologic distractor) name, and a member of the same semantic category (semantic distractor). Analysis of longitudinal testing data for the subject indicated that when an error was made, the semantic distractor was most likely chosen. The loss of naming ability was characterized by the subject choosing the appropriate label on the initial test, and the semantic distractor on the retest, for several test items. This pattern led Schwartz et al. to agree with

Warrington (1975) and hypothesize that the subject's "lexical loss (was) characterized by the progressive loss of the semantic features which define reference terms; and that, moreover, this loss occurs systematically, with more specific, distinguishing features lost before more general ones" (p. 285).

Martin and Fedio (1983) conducted a study that has been characterized as replicating Warrington's (1975) results. The AD subjects in this study had less difficulty sorting objects into sets, producing appropriate category labels, and answering questions regarding each object's superordinate category, than answering questions regarding specific attributes. Martin and Fedio concluded that mild dementia patients retain sufficient attribute knowledge to categorize related objects but demonstrate a "reduction in the availability of the set of attributes that determine word meanings" (p. 138).

Chertkow et al. (1989) replicated and expanded the Martin and Fedio (1983) study and obtained similar results. Using a larger number of objects, AD subjects were given a forced choice task in which they were to decide the appropriate attribute or function of a given object. Results revealed normal performance of AD patients on questions requiring categorical knowledge but impaired performance on questions requiring attribute knowledge. In addition, AD patients demonstrated increased difficulty answering questions about objects that they could not name, implying specific semantic memory impairment.

The mild AD subjects in the Martin and Fedio (1983) study were also administered a verbal fluency task, the results of which were interpreted as further evidence in support of the theory of a bottom-up deterioration of semantic memory. The subjects were asked to name as many items in a

supermarket as they could in a sixty second time period (Mattis, 1976). As compared to normal control subjects, these mild dementia patients produced disproportionately fewer items from fewer categories, and the ratio of items named (apple, milk, lettuce) to categories named (fruit, dairy, meat) differed. The AD patients produced more category names and fewer items within the categories than did normal controls. Martin and Fedio argued that the reduction in the production of the names of items to categories indicated a loss of attribute knowledge rather than a slower rate of information processing. They speculated that if the AD patients' processing was only slowed, then the ratio of categories to items within a category would be similar in the AD and control subjects. This was not the case, as the AD patients not only exhibited reduced verbal fluency, but produced a disproportionate number of category names.

Ober et al. (1986) replicated and expanded the Martin and Fedio (1983) study to include subjects with moderate-to-severe dementia, as well as mild dementia. Ober et al. found that the moderate-to-severe dementia subjects produced still fewer categories and items per category than the mild dementia subjects, and the moderate-to-severe subjects changed more frequently between categories than did the mild dementia subjects. These data were considered to buttress the case for the bottom-up deterioration of semantic memory.

In a later study, Martin (1987) interpreted the poor performance of 3 AD subjects on the supermarket task (Mattis, 1976) to be the result of a restricted set of the attributes needed to differentiate semantically similar items. The 3 AD subjects, who exhibited "markedly different profiles of impairment and

preserved cognitive ability," all demonstrated reduced verbal fluency characterized by decreased generation of items within the categories produced. One subject produced four category names, and no items within the categories. These findings concur with those in the previous work completed by Martin and Fedio (1983).

Together, the results of the aforementioned studies have been used to make a case for the deterioration of attribute knowledge before categorical knowledge. However, results of other studies (Grober et al, 1985; Nebes & Brady, 1988, 1990; Bayles et al., 1990) challenge the bottom-up theory of semantic memory deterioration in AD.

Grober, Buschke, Kawas and Fuld (1985) asked 20 dementia subjects to decide which words, on a list of 18, were important in understanding a stimulus word. The lists consisted of 9 "attributes" of the stimulus item, and 9 foils. "Attributes" were defined as "individual pieces of information in a concept's representation," for example *fly*, *runway* and *pilot* were all related to the item *airplane*. Results revealed that the dementia subjects correctly identified 95% of the words (attributes) associated with the stimulus word. Whereas this finding led Grober et al. to conclude that specific attribute knowledge is retained in tasks of recognition, the 95% level achieved by the dementia subjects was significantly lower than that achieved by the nondemented controls. A forced-choice procedure was then administered in which the subjects had to decide whether a target (an associate of the stimulus item) or a foil (an unrelated item) was related to a stimulus item. Again the demented subjects selected the target words at a much higher than chance level, lending Grober et al. to argue that a disruption occurs in the

organization of semantic memory, in which the importance of attributes is altered, rather than a loss of attributes.

To further examine attribute organization, Grober et al. administered a task in which the subjects were asked to rank order the importance of attributes to the understanding of the test item. Three attributes, varying in degree of importance (essential, nonessential or intermediate) were selected for each test item (e.g. *airplane: fly, radar, luggage*). Results indicated that the demented subjects performed more poorly than nondemented subjects, however, a better than chance level of performance in rank ordering attributes by importance again was apparent in the demented subjects. These results were interpreted as failing to support the theory that semantic memory loss is characterized by a loss of attributes, but rather suggest that the ability to judge the importance of attributes is impaired.

Nebes and Brady (1988) completed a study which supported the findings of Grober et al. (1985). Nebes and Brady presented AD patients with a target concept (a line drawing with its name printed below), followed by a series of ten words. Five of the words were unrelated to the target and the others specified either a physical feature, function, superordinate category, associate, or were the target concept label. The subjects were asked to identify which words in the series were related to the target concept. Results did not show a significant discrepancy in the ability of AD patients to make decisions regarding attributes compared to categories.

In addition, Nebes and Brady (1988) asked subjects to generate features, actions, and associates of the target concepts. Although the dementia subjects had more difficulty generating attributes, they did not demonstrate

impairment specific to any attribute type.

In a more recent study, Nebes and Brady (1990) closely examined the ability of their subjects to determine the importance of attributes to a concept's meaning. The reaction time of subjects for determining whether a word was an attribute of a target was measured. Results showed that the reaction times varied with the importance of the attribute. Less time was needed for the highly important attributes, in both the demented and nondemented subjects. In addition, the AD patients demonstrated a high level of accuracy in determining the attributes, as was reported by Grober et al. (1985) and Nebes and Brady (1988). These data suggest that semantic memory for attributes remains intact in dementia subjects and that the organization of the attributes is by relative importance.

Moreover, Bayles, Tomoeda and Trosset (1990) observed that as dementia severity increased, the ability of 88 AD patients to name objects became less impaired than the ability to recall or recognize categorical information pertaining to the objects. They argued that the opposite should have occurred if attribute knowledge is needed to name and if attribute knowledge deteriorates earlier and greater than category knowledge. In addition, the misnamings produced were more commonly attributes of the objects rather than a superordinate of the object, which was a rare response.

The combined results of these studies indicate that the nature of semantic memory deterioration in AD is an unresolved issue. The methodology employed, and the types of tasks used, influence the performance of dementia patients. For example, when AD subjects were asked direct yes/no or forced choice questions (Warrington, 1975; Martin and

Fedio, 1983) about attributes, they did relatively poorly, but when they were asked to relate an attribute to a concept (Grober et al., 1985, Nebes & Brady, 1988), they did relatively well. The same was true for judging the importance of attributes. Grober et al. (1985) tested knowledge of attribute importance directly and found significant difficulties in the dementia patients; Nebes and Brady (1990) found normal performance when attribute knowledge was tested indirectly.

The inconsistency of results across these studies likely results from several factors, the first being a lack of control of task difficulty when intertask comparisons were made. Only Bayles et al. (1990) controlled for relative task difficulty. Second, several of the tasks were not designed to test category or attribute knowledge, for example the supermarket task which was designed to measure verbal fluency.

The purpose of this study was to test further the theory that the use of attribute knowledge decreases more rapidly than categorical knowledge in AD patients. Subjects in the study were asked to demonstrate knowledge of attributes and categories both explicitly and implicitly. Task influences were controlled by determining the absolute difficulty of the tasks, and comparing the rates at which they deteriorated as a result of increased severity of the disease. Additionally, the same stimulus items were used across tasks making intertask comparisons feasible. It was hypothesized that if attribute knowledge is lost prior to categorical knowledge, then the performance on the attribute task would decline at a faster rate than performance on the category tasks.

METHODS

Subjects

Thirty probable AD and 28 normal elderly control subjects participated in this study. The subjects were also participants in a larger study, at the University of Arizona. Each met the following criteria for inclusion in both studies: they were native speakers of English, were right-handed, had vision sufficient to read, and had normal premorbid intelligence as estimated by a regression equation using demographic information (Wilson, Rosenbaum, & Brown, 1979). (See Appendix A.) The speech discrimination task of the Arizona Battery for Communication Disorders of Dementia (ABCD) (Bayles & Tomoeda, 1991) was administered to exclude hearing difficulty in the test environment. Subjects were required to pass the speech discrimination task with 80% or better accuracy.

Subjects received a complete physical and neurological examination to rule out cardiovascular disease, cerebrovascular accident, alcohol or substance abuse, psychiatric illness, syphilis, brain damage of a known cause, metabolic toxicity, and drug interaction. Subjects were screened for depression using the Hamilton Depression Rating Scale (Hamilton, 1960). Those who scored higher than 12 were excluded from the study. In addition, subjects scoring four or more on the Modified Hachinski Scale (Hachinski et al., 1975; Rosen et al., 1980) were determined to be at risk for vascular dementia, and therefore eliminated from the study. Subject demographic characteristics are presented in Table 1. Although the AD patients were older, they were similar to the normal subjects in years of education and estimated IQ.

Table 1. Demographic Data for Subject Groups. Standard deviations are in parentheses.

	Normal Controls	Alzheimer's Patients
Number of Subjects	28	30
Age	68.80 (8.2)	77.42 (9.7)
Education (in years)	14.70 (2.3)	13.10 (5.0)
Estimated IQ*	112.40 (8.1)	111.97 (14.5)
MMSE	28.20 (1.2)	13.40 (4.6)

Note. * IQ was estimated using a demographic equation developed by Wilson et al. (1978, 1979).

The diagnosis of probable AD was made according to the criteria established by the National Institute of Neurological and Communication Disorders and Stroke and the Alzheimer's Disease and Related Disorders Association (NINCDS-ADRDA) Task Force on Alzheimer's Disease (McKhann et al., 1984). (Appendix B specifies the NINCDS-ADRDA criteria.) Dementia severity was determined by performance on the Mini-Mental State Exam (MMSE) (Folstein et al., 1975). A maximum score of 30 may be achieved on the MMSE.

Tasks

The three tasks used in this study were composed of the same core eighteen stimulus items (See Appendix C).

Attribute Differences (ATTR). This task required the subjects to explain two important differences between items in the same category. Two cards were presented, each with a stimulus item printed in bold lowercase print. Both stimulus items came from the same category (i.e., *mushroom* and *celery*). The subjects were asked to, "Give two important differences between the mushroom and the celery." One point was given for each correctly stated difference. For statistical purposes, items were determined to be correct only if 2 differences were stated. The responses to this task were written by hand and audio-tape recorded. After completion of testing, the audio-tape recordings were transcribed on word processors, from which scoring was completed. Agreement of transcription was calculated to be 98%. (ATTR administration and scoring procedures are presented in Appendix D.)

Sorting by Category (SCAT). Categorical knowledge was assessed using a sorting task. The subjects were presented a card with a black and white line drawing of the stimulus item. Next they were shown an array of eight black and white line drawings (2 targets, 6 foils). The subjects were instructed to "Look at all of (the) pictures and point to the two pictures that are in the same class or category as this one [the stimulus picture]." For example, first the stimulus picture of a *mushroom*, was presented and followed by pictures of a *caterpillar*, *spoon*, *chair*, *celery*, *rooster*, *onion*, *foot*, and *kettle*. The subject was expected to point to the *celery* and *onion*, because, like *mushroom*, they

are vegetables. The subjects were given two practice items. Subjects received 1 point for choosing a correct item from the array, 2 points for choosing both correct items. Again, for data analysis purposes, and to decrease the influence of chance, responses were scored as correct only if two correct selections were made. (Protocol for administration and scoring of SCAT are presented in Appendix E.)

Superordinate Naming (SUPR). Subjects were shown three black and white line drawings of objects, under which were the names of the items in bold lowercase print. The subjects were asked, "To which category or class of items do these three pictures belong?" If presented with *chair*, *desk*, and *dresser*, the subject would be expected to answer "*furniture*." Two points were given for the production of an appropriate category name. (Protocol for the administration and scoring of SUPR are presented in Appendix F.)

Data Analysis

One strength of the Bayles et al. (1990) study was that it examined the relative difficulty of the tasks under investigation. Bayles et al. (1990) compared the tasks in a pairwise manner, on an item-by-item basis. The subjects were divided into 3 groups (normal, mild AD, and moderate AD). Within each group, and for each pair of tasks, items were simultaneously classified according to the correctness of response on each task. Items for which responses were the same on both tasks (both correct or both incorrect) did not contribute information regarding the relative difficulty of the tasks. Therefore Bayles defined relative task difficulty by, "dividing (a) the number of instances of failure on the category task and success on the naming task by

(b) the number of instances of success on the category task and failure on the naming task" (p. 504). Changes in relative difficulty, with dementia severity, were observed by comparing these ratios for the three subjects groups.

The present study used a somewhat different approach to analyzing task difficulty. First, instead of dividing subjects into mild and moderate dementia groups defined by the Global Deterioration Scale (GDS) (Reisberg et al., 1982), the Mini Mental State Exam (MMSE) was used as a continuous measure of dementia severity. Second, the pairwise item-by-item approach was not adopted. In such an approach, some information is sacrificed that can be used to estimate how each individual task changes with MMSE performance. Therefore, in this study, all the data from each task were used to estimate how performance on the task changed with mental status. The different rates of decrement were then compared to determine which tasks decreased faster or slower.

A logistic regression model (Hosmer & Lemeshow, 1989) was used to relate task performance to dementia severity. Further description of logistic regression may be found in Appendix G. This model assumes that the probability of getting a specific item correct on task t for subject s is a function of the task and the mental status of the subject. That is:

$$\text{Prob \{item is correct on task } t \text{ for subject } s\} = P_t(\text{MMSE}(s))$$

Assuming mutual independence of the individual items, performance on task t is then a binomial random variable with 18 trials, and probability $P_t(\text{MMSE}(s))$ of success on each trial. Of interest is how $P_t(\text{MMSE}(s))$ changes with MMSE.

The usual specification of the functional form of the logistic model is:

$$P_t(\text{MMSE}) = \frac{e^{(a_t + b_t * (\text{MMSE}))}}{1 + e^{(a_t + b_t * (\text{MMSE}))}}$$

where e = the base of the natural log. As scores on the MMSE increase, $P_t(\text{MMSE})$ increases toward 1 (i.e., normals score close to 18); and as scores on the MMSE decrease, $P_t(\text{MMSE})$ decreases toward 0 (i.e., the extremely demented score close to 0). The method of maximum likelihood was used to estimate the a and b coefficients. The magnitude of b reflects the rate of deterioration of the task performance, so that tasks with a large b deteriorate faster than tasks with a small b . The bottom-up theory would predict that attribute tasks have larger b coefficients than category tasks.

The logistic regression model includes as a special case the constant model. The constant model assumes that $b = 0$, and therefore eliminates consideration of changes in mental status. Both the constant and logistic models were used to evaluate subject performance in this study, to determine the significance of accounting for changes in mental status. The relative fit of these two models can only be done within the same task. That is, the constant and logistic regression model likelihood values cannot be compared across tasks, their scales are task specific. However, the absolute difficulties of the tasks (a coefficient), and the rates at which performance on the tasks changes as a function of dementia severity (b coefficient) may be compared across tasks, because each logistic regression model uses the same independent variable (MMSE), and the dependent variables all are on the

same scale.

The logistic regression approach has an interesting relation to the approach used by Bayles et al. (1990); in a certain sense they are equivalent. Suppose that it is desirable to compute the relative difficulty of Task 1 to Task 2, for subjects with MMSE = $\underline{x}$, using the pairwise item-by-item approach. If results exist for a total of $\underline{n}$ items, and the tasks are independent, then one would expect to observe responses as in Table 2, where $\underline{P}_t$ again denotes the probability of a correct response on task t ($t = 1, 2$).

Table 2. Expected observed responses from a two task comparison where $\underline{n}$ = total number of items, $\underline{P}_1$ denotes the probability of a correct response on Task 1, and $\underline{P}_2$ denotes the probability of correct response on Task 2.

		TASK 2	
		Incorrect	Correct
TASK 1	Incorrect	$\underline{n}(1 - \underline{P}_1)(1 - \underline{P}_2)$	$\underline{n}(1 - \underline{P}_1)\underline{P}_2$
	Correct	$\underline{n}\underline{P}_1(1 - \underline{P}_2)$	$\underline{n}\underline{P}_1\underline{P}_2$

Bayles and colleagues (1990) would define relative task difficulty as:

$$\frac{\underline{n}(1 - \underline{P}_1)\underline{P}_2}{\underline{n}\underline{P}_1(1 - \underline{P}_2)} = \frac{(1 - \underline{P}_1) \underline{P}_2}{\underline{P}_1(1 - \underline{P}_2)}$$

If the logistic model expressions are substituted for $\underline{P}_1$ and $\underline{P}_2$, this expression simplifies to:

$$e^{\{(a_2 - a_1) + (b_2 - b_1) * \underline{x}\}}$$

and the coefficients $\underline{b}_1$ and $\underline{b}_2$ are the only parameters that determine the rate with which this relative difficulty measure changes with $\text{MMSE} = \underline{x}$. Thus, in a certain sense, the approach used by Bayles et al. (1990) and the logistic regression model are equivalent.

RESULTS

Both the constant and the logistic regression models were used to compare performance on ATTR, SCAT, and SUPR. Several subjects did not complete all 18 items on the Attribute Differences task, when it was the judgement of the examiner that the subject was unable to comprehend the task and would produce incorrect responses for every item. To avoid introducing bias into the data analysis by removal of the performance of these subjects, it was assumed that these subjects would have scored 0 on all 18 items, and these scores were used in comparing the tasks. Individual subject performance on each task is presented in Appendix H.

Table 3 depicts the mean performance for normal controls on the tasks, as well as the likelihood of the constant and logistic models, for AD subjects. The constant coefficient (a) in the logistic model may be interpreted as the absolute difficulty of the task, and the multiplier of mental status in the logistic model (b) measures how quickly performance changes as mental status changes. Therefore, larger b values express a faster rate of deterioration.

Recall that the likelihood values obtained from the constant and logistic regression models are task specific and may only be compared to each other within the same task. These values (specifically the negative of the log-likelihood) are a measure of how well the model predicts subject performance. The smaller the value, the better the model. The chi-square statistic is a measurement of the size of the difference between the two models, for the specified task. Finally, the significance probability (p - value), determined by referring the chi-square statistic to a chi-square distribution

with one degree of freedom, is the probability that the difference, is due to chance.

Table 3 shows that the constant model consistently produced higher likelihood values than the logistic regression model. Further, the chi-square ratios were all significant ($p < .0001$). These results indicate that the logistic regression model, which takes into account changes in mental status, is a significantly better predictor of subject performance for these tasks. The difference in models is clearly depicted in Figures 1, 2, and 3 where both the curve produced by the logistic regression model and the line produced by the constant model are shown.

Performance of the normal control subjects (Table 3) suggests that ATTR is a more difficult task than SCAT and SUPR. The estimated $\underline{a}$ values from the dementia patients scores confirm this difference. That is, as difficulty increases, the numerical size of $\underline{a}$ decreases. Measures of change in performance ($\underline{b}$) on SCAT and SUPR with changes in mental status, were not significantly different. However, comparisons of ATTR to both SCAT and SUPR with changes in mental status, were significant. Specifically, Attribute Differences deteriorated at a significantly faster rate than the category tasks. Task comparisons, with significance values, are shown in Table 4.

Table 3. Change of Difficulty in Attribute Differences (ATTR), Sorting by Category (SCAT), and Superordinate Naming (SUPR), with Changes in MMSE performance.

	TASK		
	ATTR	SCAT	SUPR
Mean # of correct responses by normals	12.75	16.54	17.04
Mean # of correct responses by ADs	1.50	7.50	7.63
Constant Model	79.47	147.10	145.08
Logistic Model	35.65	104.46	97.43
Chi-Square	87.64	85.28	95.30
Significance Probability	.0000	.0000	.0000
Estimated <u>a</u>	-8.1012	-3.0204	-3.1728
Estimated <u>b</u>	.3486	.1971	.2113
Standard Error of Estimated <u>b</u>	.0458	.0238	.0245

Note. Constant Model = -log likelihood of the constant model for AD.

Logistic Model = -log likelihood of the logistic regression model for AD.

Chi-square = measure of the difference between the constant model and the logistic regression model.

Significance Probability (*p* - value) = probability that chi-square ratio is due to chance.

a = constant coefficient in logistic regression model, a measure of absolute difficulty.

b = multiplier of mental status in logistic regression model, a measure of how quickly performance changes as a function of mental status.

Figure 1. Logistic regression and constant model curves of predicted performance on Attribute Differences (predicted values presented in Appendix I).

Figure 2. Logistic regression and constant model curves of predicted performance on Sorting by Category (predicted values presented in Appendix I).

Figure 3. Logistic regression and constant model curves of predicted performance on Superordinate Naming (predicted values presented in Appendix I).

Table 4. Significance testing of comparisons of Attribute Differences (ATTR), Sorting by Category (SCAT), and Superordinate Naming (SUPR) to the .05 level.

TASK 1	TASK 2	z -- value	Significant at the .05 level (z >1.96)
ATTR	SCAT	2.9352	yes
ATTR	SUPR	2.6434	yes
SCAT	SUPR	0.4157	no

DISCUSSION

The purpose of this study was to investigate the bottom-up theory of semantic memory deterioration in AD, in which attribute knowledge is thought to become more compromised than categorical knowledge, as dementia severity increases. If correct, performance on tests of attribute knowledge should decline more rapidly than on tests of categorical knowledge, as dementia severity increases. The theory is based partially on performance of AD patients on confrontation naming tasks (Flicker et al., 1985; Warrington, 1975), because naming has been argued to be an ability that is dependent on attribute knowledge. The theory, and the use of performance of AD patients on a confrontation naming task to substantiate it, have been challenged by Bayles et al. (1990). Therefore, in this study the integrity of attribute and categorical knowledge was investigated with tasks other than confrontation naming.

The fact that performance on the Attribute Differences task declined more rapidly than performance on the category tasks (SCAT and SUPR) would appear to be consistent with the theory of a bottom-up deterioration of semantic memory. However, this interpretation assumes that ATTR tests only attribute knowledge and that SCAT and SUPR test only categorical knowledge. In fact, other differences exist between the tasks which may account for the greater decline of AD subjects on ATTR. Consider that ATTR not only required subjects to generate attributes of the stimuli, but also to organize them in such a way as to specify distinct differences. For example, a subject would receive credit for "celery is green and mushrooms are brown"

but would not receive credit for "celery is crunchy and mushrooms are round," although each are true attributes of the stimuli. Also, consider that in order to generate appropriate differences between items, the subjects must have had an appreciation for what made them similar. Furthermore, the cognitive demands on attention and organization processes in the attribute task undoubtedly affected subject performance. In fact, the markedly low performance of the normal control subjects, on Attribute Differences, supports this assumption. A comparison of performance, by normal control subjects on ATTR and the category tasks (SCAT and SUPR), indicates that the cognitive demands placed on SCAT and SUPR were less than those required to complete ATTR. These differences in cognitive demand, which resulted in significantly different task difficulties, made it impossible to conclude that a decline in performance on Attribute Differences indicates a deterioration of attribute knowledge.

An easier task of attribute knowledge would be helpful in providing the additional information essential to making a decision about category and attribute knowledge deterioration in AD. Because these subjects were also participants in a larger study, at the University of Arizona, consideration was given to what additional data were available to help clarify the performances exhibited on Attribute Differences. As part of the larger study, these subjects also had been administered confrontation naming and concept definition tasks, and decision was made to add these performances to the analysis.

SUPPLEMENTARY ANALYSES

Confrontation naming data were introduced, because they are, in part, what the bottom-up theory is based on (Flicker et al., 1985, Warrington, 1975). The argument has been made that naming is a computational procedure. That is, one must appreciate a certain number of attributes of an object before it is possible to recognize the object and retrieve its name. Bayles and colleagues (1990) found that naming became progressively easier, or deteriorated more slowly, in relation to two category tasks after controlling for task difficulty, however, the performance of subjects in that study could have been due to some artifact of the testing. If their finding could be replicated it would give more credibility to the view that knowledge of attributes does not decrease significantly faster than categorical knowledge, if Confrontation Naming is a test of attribute knowledge.

Defining a concept entails specifying the category to which it belongs, and/or the attributes which it possesses. If subjects produced a superordinate category in their definitions of the stimulus concepts, but not attributes, this would provide additional support for the bottom-up theory. Also, based on the performance of normal subjects, Concept Definition was thought to be less difficult than ATTR because subjects were asked to describe a single object, rather than distinguish between a pair of objects. Accordingly, transcripts of responses to the definition task were re-scored and it was determined whether the subject produced a superordinate (DEFC), or attribute (DEFA) of the object, and if so, how many.

In the Confrontation Naming (CNAM) task subjects were shown black and white line drawings of the eighteen stimulus items and asked to name them. One point was awarded for each correct response. (CNAM administration and scoring procedures are presented in Appendix J.)

In the Concept Definition (DEFC/DEFA) task, subjects were shown cards on which the names of the eighteen stimulus items were presented in bold lowercase print and were asked to give a definition of each stimulus item. One point was awarded for production of an appropriate superordinate, or category (DEFC). One point was awarded for each of the appropriate attributes (DEFA) produced, up to 3. No points were awarded for inappropriate or false responses. The examiner wrote down, and audio-taped, the responses of the subjects. Upon completion of testing, the audio-tapes were transcribed to word processors, from which scoring was completed. (Concept Definition administration and scoring procedures are presented in Appendix K).

Supplemental Data Analysis

Both CNAM and the category portion of the definitions task (DEFC) were scored on a correct/incorrect basis. Then the logistic regression model was applied.

Two procedures were used to analyze the attribute portion of the definitions task (DEFA). First, the DEFA variable (scored by the number of attributes produced: 1, 2, or 3) was used to investigate how the number of attributes produced by the subjects declined as a function of mental status. Second, use of the logistic regression model was necessary for comparisons of

absolute task difficulty (a coefficient) and rates of change of performance on the tasks as a function of mental status (b coefficient), across tasks. However, the logistic regression model requires dichotomous scoring. Therefore, the DEFA variable was re-scored so that all correct responses (1, 2, or 3 attributes) were scored as correct, receiving 1 point.

RESULTS

The constant and logistic regression models were used to compare Confrontation Naming and Concept Definition, both to each other, and to Attribute Differences, Sorting by Category and Superordinate Naming. Figures 4, 5, and 6 depict the predicted test performance of subjects using both the logistic regression and constant models. Again, results indicate the the logistic regression model, witch takes into account mental status, is a significantly better predictor of subject performance on these tasks. Table 5 depicts the mean performance for normal and AD subjects on all of the tasks, as well as the absolute difficulty of these tasks, (the constant coefficient a on the logistic model) and the degree of performance decrement associated with changes in mental status (coefficient b , the multiplier of mental status on the logistic model). Individual subject performance on each task is presented in Appendix H.

Figures 4, 5, and 6 about here

Table 5 about here

Comparison of Confrontation Naming (CNAM) to SCAT, SUPR, and ATTR.

CNAM had a smaller b coefficient than both of the category tasks, SCAT and SUPR. Therefore, as dementia severity increased, SCAT and SUPR

(both category tasks) became progressively harder than CNAM (a putative attribute task). The difference in rate of change of performance between Confrontation Naming and Superordinate Naming was significant, but the difference in rate of change of performance on Confrontation Naming and Sorting by Category was not significant. Note too, that the subjects' performances on the category tasks did not differ significantly, thus the differences demonstrated when compared to Confrontation Naming is not decisive. Task comparisons, with significance values, are presented in Table 6.

Table 6 about here

Comparison of Concept Definition to CNAM, SCAT, SUPR, and ATTR.

Recall that providing a definition of an object entails specifying attribute knowledge (DEFA), categorical knowledge (DEFC), or both. Using the logistic regression model, a comparison between the definition variables (DEFA and DEFC), measured under identical conditions, showed that demented subjects' performance on DEFA did not decrease at a significantly faster rate than performance on DEFC. When a comparison was made of the attribute portion of the concept definition task (DEFA) to ATTR, ATTR had a significantly higher absolute difficulty (a coefficient), and rate of decrement (b coefficient), than DEFA.

A comparison also was made of the relation of the number of attributes

generated in the attribute portion of the definition task to mental status. Results revealed that whereas the number of attributes generated decreased, the subjects ability to produce at least one attribute was retained (Figure 7).

Figure 4. Logistic regression and constant model curves of predicted performance on Confrontation Naming (predicted values presented in Appendix J).

Figure 5. Logistic regression and constant model curves of predicted performance on the attribute portion of Concept Definition (predicted values presented in Appendix J).

Figure 6. Logistic regression and constant model curves of predicted performance on the category portion of Concept Definition (predicted values presented in Appendix J).

Table 5. Change of Difficulty in Confrontation Naming (CNAM), the Attribute Portion of Definitions (DEFA), the Superordinate Portion of Definitions (DEFC), as well as ATTR, SCAT, and SUPR, with Changes in MMSE Performance.

	TASK					
	ATTR	CNAM	DEFA*	DEFC	SCAT	SUPR
Mean # of correct responses by normals	12.75	17.46	13.73	18.00	16.54	17.04
Mean # of correct responses by ADs	1.50	9.33	13.13	6.46	7.50	7.63
Constant Model	79.47	161.68	89.15	105.96	147.10	145.08
Logistic Model	35.65	138.90	72.10	79.85	104.46	97.43
Chi-square	87.64	45.56	34.10	52.22	85.28	95.30
Significance Probability	.0000	.0000	.0000	.0000	.0000	.0000
Estimated <u>a</u>	-8.1012	-1.7510	-2.3564	-1.2586	-3.0204	-3.1728
Estimated <u>b</u>	.3486	.1370	.1177	.1640	.1971	.2113
Standard Error of Estimated <u>b</u>	.0458	.0217	.0212	.0246	.0238	.0245

Note. DEFA* = scored on a correct/incorrect basis.

Constant Model = -log likelihood of the constant model for AD.

Logistic Model = -log likelihood of the logistic regression model for AD.

Chi-square = measure of the difference between the Constant Model and the Logistic Regression Model.

Significance Probability (*p* - value) = probability that chi-square ratio is due to chance.

a = constant coefficient in logistic regression model, a measure of absolute difficulty.

b = multiplier of mental status in logistic regression model, a measure of how quickly performance changes as a function of mental status.

Table 6. Significance testing of task comparisons to the .05 level.

TASK 1	TASK 2	z -- value	Significant at the .05 level (z >1.96)
ATTR	SCAT	2.9352	yes
ATTR	SUPR	2.6434	yes
SCAT	SUPR	0.4157	no
ATTR	CNAM	4.1751	yes
ATTR	DEFC	3.5508	yes
ATTR	DEFA	5.6875	yes
SCAT	CNAM	1.8660	no
SCAT	DEFC	0.9670	no
SCAT	DEFA	2.4911	yes
SUPR	CNAM	2.2702	yes
SUPR	DEFC	1.3624	no
SUPR	DEFA	2.8890	yes
CNAM	DEFC	0.8231	no
CNAM	DEFA	0.6362	no
DEFC	DEFA	1.4257	no

Figure 7. Number of attributes, given by AD subjects, on DEFA, as a function of mental status.

SUMMARY and CONCLUSIONS

This study originated in an attempt to investigate the bottom-up theory of semantic memory deterioration in Alzheimer's Disease. Three tasks were used to assess categorical and attribute knowledge of 28 normal and 30 AD subjects. Categorical knowledge was assessed using a Sorting by Category task, and a Superordinate Naming task. Attribute knowledge was assessed using an Attribute Differences task. Intertask comparisons revealed that attribute knowledge decreased at a faster rate than categorical knowledge, as a function of dementia severity, a finding consistent with the bottom-up theory. However, the attribute task was significantly harder than the category tasks, and faster deterioration of subject performance on it may have reflected a deterioration of a variety of cognitive processes, and not only a deterioration of attribute knowledge.

In an attempt to clarify the effects of Alzheimer's Disease on attribute and categorical knowledge, the study was expanded to examine existing data on Confrontation Naming (presumably a measure of attribute knowledge, and an easier task than ATTR), and Concept Definition. If performance on Confrontation Naming also deteriorated faster than performance on the category tasks, then that would be additional evidence in support of the bottom-up theory of semantic memory deterioration. That support would be strengthened further if subjects also produced significantly fewer attributes, than categories, on the definition task.

Results of these additional analyses of Confrontation Naming and Concept Definition did not provide evidence to strengthen the case for the

bottom-up theory. Specifically, Confrontation Naming did not deteriorate faster than the category tasks with increases in dementia severity. In fact, it decreased more slowly, as reported previously by Bayles et al. (1990). This finding clearly demonstrates that CNAM and ATTR measure different abilities and increases doubt that CNAM is a test of attribute knowledge. If the same abilities were being assessed, then subject performance certainly would have been expected to change in the same direction. Therefore, it is inappropriate to use either CNAM or ATTR to draw a definitive conclusion regarding attribute knowledge deterioration in AD. Also, subjects' production of attributes on the definition task did not deteriorate significantly faster than did production of superordinates on the definition task. Thus, a convincing pattern of findings failed to emerge, and one can only speculate about the mixed results. At least two explanations seem plausible.

First, it may be that both attribute and categorical knowledge are being assessed by these tasks. An argument could be made that in order to specify any category to which several items belong, there must be an appreciation of their similarities, or attributes, and in order to specify attributes of a category, knowledge of the category must exist. Moreover, when specifying attributes it is apparent that they also form categories. For example, if asked to specify members of the category "transportation," one may respond, "car, plane, bus." Whereas "car" is an attribute of the category "transportation," it also may be considered a category itself, encompassing "Ford, and Oldsmobile." Further, "Ford" and "Oldsmobile" may be categories encompassing "Escort, Ranger" and "Calais, Ciera" respectively. As can be seen by this example, what are considered attributes in one instance can be considered categories in another,

and what are considered categories in one instance can be considered attributes in another. This relationship of attributes and categories calls into question the nature of the assumed hierarchical organization of categories and attributes, and may in part explain the varied reports regarding attribute knowledge deterioration.

Second, what may be decreasing is the subjects' generative ability, that is the ability to produce multiple attributes. Results revealed that the number of attributes produced dramatically declined in AD (Figure 7), even though moderate and severe AD patients continued to produce at least one attribute. For example, a very mild AD defined "kangaroo" as, "an animal that has two main legs and hops on them, and has two small upper legs it uses like arms, and it has a huge tail. It is an Australian animal. It has even been taught to box. Carries its young in a pouch." A moderate AD defined "kangaroo" as, "an animal that has a pouch in which it carries it's young. It jumps." A more severe AD defined "kangaroo" as, " animal, native to Australia." Thus, although the number of attributes generated declined, the tendency to generate at least one attribute remained. This finding may be interpreted two ways. The degeneration in the number of attributes may be interpreted as support for the bottom-up theory of semantic memory deterioration, or it may be that the subjects' ability to produce multiple attributes is declining, rather than attribute knowledge itself. The observed decline in the production of multiple attributes may be a function of decreased episodic memory, a hallmark characteristic of dementia of the Alzheimer type. The same may have been true for the Attribute Differences task that the subjects simply may have forgotten the task prior to completing the stimulus item.

Hence the decline in the number of attributes that demented subjects generated in this study may not be clearly indicative of a deterioration of attribute knowledge.

In conclusion, the results of this study do not resolve the issue of semantic memory deterioration in Alzheimer's Disease. In fact, these results raise questions regarding the theory and the methodology that has been used to test it, even further. Attribute knowledge was observed to deteriorate both more slowly and more quickly than categorical knowledge, as a function of task requirements. Prior to the present study, only Bayles et al. (1990) controlled for task difficulty, which clearly was essential in differentiating the performance of the AD subjects. Moreover, the differences in performance across tasks in this study demonstrate how easy it is to obtain different results as a function of task difficulty.

Further research is needed that controls for task difficulty and considers the possibility that to demonstrate knowledge of attributes requires an appreciation of categories, and to demonstrate knowledge of categories requires an appreciation of attributes. Only through careful consideration of the processes and abilities required to perform the tasks used to examine attribute knowledge, will the bottom-up theory be definitively confirmed or denied. Additional research, then, will not only help refine the bottom-up theory but will help clarify the results of this, and previous research, of semantic memory deterioration in Alzheimer's Disease.

APPENDICES

APPENDIX A

An Index of Premorbid Intelligence*

$$\begin{aligned} \text{Estimated Full Scale IQ} = & .17 (\text{age}) - 1.53 (\text{sex}) - 11.33 (\text{race}) + 2.4354 (\text{education}) \\ & + 1.01 (\text{occupation}) + 74.05 \end{aligned}$$

AGE: in years

SEX: male = 1
female = 2

RACE: white = 1
nonwhite = 2

EDUCATION: in years

OCCUPATION: scores from Weschler's (1955, page 7)
13 occupational categories:

Professional and Technical = 5
Farmers and Farm Managers = 1
Managers, Officials, and Proprietors = 7
Clerical and Sales = 7
Craftsman and Foremen = 6
Operatives = 3
Private household workers = 3
Service workers = 5
Farm Laborers = 0
Laborers = 1
Keeping House = 4
Students = 10
Others (disabled, unemployed, retired, etc.) = 0

*from Wilson et al. (1978), Wilson et al. (1979)

APPENDIX B

Subject Selection Criteria

ALL SUBJECTS:

Native speaker of English
 Right-handed
 See well enough to read
 Hear well enough to pass a speech discrimination task with 80% accuracy
 Normal or above normal premorbid intelligence as calculated by demographic equation (see Appendix A)
 Physical and neurological examination to rule out the following:
     myocardial infarction or chronic cardiovascular disease
     cerebrovascular accident
     alcohol or substance abuse
     chronic psychiatric illness or long-term neuroleptic history
     syphilis
     brain damage sustained earlier from known cause e.g., hypoxia
     primary disorders (other primary systemic disorders), metabolic toxicity, drug interaction

AD SUBJECTS: (as specified by the NINCDS-ADRDA task force)

Diagnosis of probable AD:
     Medical history
     Physical examination
     Neurological examination
     Laboratory tests within the last 6 months:
         1) clinical chemistries, SMA 20
             a. serum folic acid
             b. serum thyroid function tests
         2) hematology
         3) urinalysis
         4) serology
         5) chest x-ray
         6) CT scan

Must have gradual progressive onset/course

Impairment of at least two of the following (as measured by the MMSE)

- 1) learning
- 2) attention
- 3) memory
- 4) orientation

Impairment in calculation, abstraction, or judgement

Problems in ability to work, relate to family or peers, or function socially

An ischemic score of 4 or less to deselect multi-infarct dementia patients

Determination of presence of extrapyramidal signs

APPENDIX C

Core Stimulus Items

Kangaroo
Fly
Owl
Barrel
Axe
Sailboat
Basket
Helicopter
Peacock

Mushroom
Accordion
Saw
Whistle
Spider
Bear
Pineapple
Harp
Kite

APPENDIX D

Protocol for Attribute Differences Task

INSTRUCTIONS: Turn on tape recorder and write down responses.
 Lay out the two practice item words.
"Tell me two important difference between _____ and _____."

Feedback on trial items:

If subject responds correctly, acknowledge so,
 If subject gives only one difference, say, **"Good, now tell me another difference between these two things."**

If subject responds incorrectly, explain what and go to the next item.

If after 15 seconds the subjects says nothing, model a correct answer, **"You must state the difference so I can recognize it. I think it may help you to say, 'the difference between _____ and _____ is _____'",** and proceed to the next item.

Instructions may be repeated at any point in test.

SCORING: Points = 0 if subject specifies 0 or 1 correct differences, or no response.

Points = 1 if subject specifies two correct differences.

SCORING CRITERION: The differences specified must be: function, size, color, taste, smell, etc. This includes any idea that may be construed as a true attribute of the stimulus item.

Responses may receive credit in two ways:

1. Both attributes may be given for each stimulus item separately:
"A duck has webbed feet and is a daytime bird. An owl has claws and is a night-time bird."
2. One attribute difference may be given for each stimulus item, followed by another attribute difference for each stimulus item.
"A duck has webbed feet and an owl has claws. A duck is a daytime bird and an owl is a night-time bird."

Specific Scoring Guidelines:

1. Information provided must be true.
"Bananas are pink and pineapples are not." (No points awarded)
2. If the wrong stimulus item is stated in a response, no points are awarded. If for example, the stimulus items were owl and duck:
"A camel sits in a tree and is nocturnal." (No points awarded)
3. Attributes stated must be contrasting differences.
"A barrel is built to ship material and goods in, is rotund. A suitcase is a small crate made of different materials." (No points awarded, differences were not contrasted, rotund is "shape", small is "size").
4. Read carefully for specific attribute differences in rambling sentences.
"Oh yeah I love owls, they are so wise and have such sharp claws. I hate ducks, they can be so dumb. Did you know that? But ducks swim you know because they have webbed feet."
One point awarded for owl has claws and duck has webbed feet.

APPENDIX E

Protocol for Sorting by Category Task

INSTRUCTIONS: Begin with the first practice item.
Place the target card on the stand and say the word.
Present the first word/picture foil pages.
Say, **"Look at all of these pictures and point to the two pictures that are in the same class or category as this one."**
Prompt may be repeated if subject selects only one item.
Feedback on trial items:
    If subject responds correctly, acknowledge so.
    If subject responds incorrectly, explain why and proceed to the next item.
    If the subject says nothing, repeat the instructions and explain the appropriate choices.

SCORING: Points = 0 if subject provides an incorrect response, or no response.
Points = 1 if subject provides both correct responses.

APPENDIX F

Protocol for Superordinate Naming Task

INSTRUCTIONS: Begin with the first practice item.
Present the three related picture/words cards and say the name of each.
Say, **"To which category or class of items do these three pictures belong?"**
Feedback for practice items:
If subject responds correctly, acknowledge so.
If subject responds incorrectly, explain why and proceed to the next practice item, and repeat above prompt.
Prompt is repeated with each presentation of stimulus items.

SCORING: Points = 0 if subject provides an incorrect response, or says, "I don't know".
Points = 2 if subject provides correct response.
Points = 5 if no response.

APPENDIX G

Logistic Regression

A popular and useful model for predicting dichotomous variables from a continuous variable is the logistic regression model. That is, the model relates the probability of success ($P(x)$), against a regressor variable, in this case, performance on the MMSE. Each task in this study was scored dichotomously. Therefore, each response was coded as either 1 or 0, for correct and incorrect responses respectively. Items that may be coded in this manner are referred to as Bernoulli trials, and may be thought of as coin toss experiments.

Logistic regression was used to determine the probability of a success ($y = 1$), and how that probability changes as a function of mental status (simply, $P = F(u(x))$). That is, this model assumes that the probability of getting a specific item correct on task t for subject s is a function of the task and the mental status of the subject. Therefore:

$$\text{Prob (item is correct on task } t \text{ for subject } s) = P_t(\text{MMSE}(s))$$

Assuming mutual independence of the individual items, performance on task t is then a binomial random variable with 18 trials, and probability $P_t(\text{MMSE}(s))$ of success on each trial. The logistic regression model adopted in this study assumes that the functional form of the relation between MMSE and the probability of a correct response is:

$$P_t(\text{MMSE}) = \frac{e^{(a_t + b_t * (\text{MMSE}))}}{1 + e^{(a_t + b_t * (\text{MMSE}))}}$$

where e = the base of the natural log, $\underline{a}$ = the intrinsic difficulty of task $\underline{t}$, and $\underline{b}$ = the rate of deterioration of performance on task $\underline{t}$. The method of maximum likelihood was used to estimate the $\underline{a}$ and $\underline{b}$ coefficients. As scores on the MMSE increase, $\underline{P}_{\underline{t}}(\text{MMSE})$ increases toward 1 (i.e., normals score close to 18); and as scores on the MMSE decrease, $\underline{P}_{\underline{t}}(\text{MMSE})$ decreases toward 0 (i.e., the extremely demented score close to 0). The parameters obtained from this model are beneficial because they can be computed with easily, and the results are easily interpretable.

APPENDIX H

Individual Subject Performance on all TasksTable H-1. Individual performance of normal subjects on all tasks.

Subject	MMSE	CNAM		SCAT		SUPR		ATTR		DEFN	
		+	admin	+	admin	+	admin	+	admin	Cat.	Attr.
1201	28	15	18	17	18	17	18	15	18	13	18
1202	28	18	18	17	18	18	18	14	18	14	18
1203	29	18	18	16	18	18	18	07	18	14	18
1204	28	18	18	18	18	18	18	14	18	15	18
1205	28	18	18	16	18	14	18	17	18	08	18
1207	29	17	18	15	18	16	18	16	18	12	18
1208	30	18	18	18	18	18	18	16	17	16	18
1209	26	18	18	17	18	18	18	07	17	11	18
1210	29	18	18	18	18	17	18	11	18	12	18
1211	30	17	18	17	18	18	18	10	18	15	18
1212	27	18	18	16	18	18	18	15	18	13	18
1213	30	18	18	17	18	18	18	16	18	15	18
1214	28	18	18	16	18	18	18	11	18	14	18
1215	29	18	18	18	18	18	18	14	18	14	18
1216	27	18	18	16	18	16	18	00	00	11	18
1217	27	18	18	15	18	17	18	17	18	17	18
1218	28	18	18	17	18	15	18	08	18	17	18
1219	28	17	18	17	18	18	18	17	18	17	18
1220	25	18	18	17	18	16	18	03	18	10	18
1221	29	18	18	18	18	18	18	17	18	18	18
1222	29	16	18	15	18	17	18	14	18		
1223	29	18	18	17	18	17	18	15	18	18	18
1224	29	17	18	16	18	17	18	12	18	08	18
1225	26	18	18	16	18	18	18	09	18	14	18
1226	29	17	18	17	18	17	18	17	18	13	18
1227	29	16	18	16	18	14	18	14	18		
1229	28	15	18	13	18	16	18	05	18	13	18
1231	29	18	18	17	18	17	18	12	18	15	18

Note. + = number of items correct.

admin = number of items (out of 18) that were administered.

DEFN*: Cat. = number of items correct when category portion of
Concept Definition task was scored on 0, 1 basis.

Attr. = number of items correct when attribute portion of
Concept Definition task was scored on 0, 1 basis.

Table H-2. Individual performance of Alzheimer's Disease subjects on all tasks.

Subject	MMSE	CNAM		SCAT		SUPR		ATTR		DEFN*	
		+	admin	+	admin	+	admin	+	admin	Cat.	Attr.
3201	12	13	18	09	18	06	18	00	18	01	15
3202	20	18	18	14	18	16	18	05	18	11	18
3203	10	13	18	00	05	09	18	00	18	10	15
3204	17	12	18	13	18	14	18	00	06	11	13
3205	05	11	18	01	18	00	05	00	18	02	16
3208	16	10	18	13	18	15	18	02	18	14	15
3210	20	14	18	12	18	13	18	09	18	08	18
3211	15	10	18	11	18	12	18	03	18	07	16
3212	20	16	18	15	18	13	18	00	17	12	17
3213	07	03	18	09	18	08	18	00	05	04	05
3214	15	01	18	06	18	03	18	01	18	03	12
3215	10	05	18	03	18	07	18	00	18	06	13
3219	12	15	18	02	18	00	05	00	06		
3220	11	13	18	08	18	06	18	00	05		
3222	17	07	18	05	18	07	18	00	00	07	11
3224	15	17	18	13	18	12	18	00	00	03	14
3225	12	04	18	04	18	02	18	00	07	02	11
3226	09	01	18	04	18	04	18	00	00		
3228	12	08	18	04	18	05	18	00	08	07	12
3229	11	00	18	04	18	02	18	00	05		
3230	18	06	18	10	18	10	18	05	18	09	12
3232	12	00	10	00	06	00	18	00	05	00	01
3233	26	17	18	17	18	17	18	12	18	07	18
3234										09	15
3235	07	02	18	01	18	03	18	00	06	00	02
3236	11	05	18	04	18	02	18	00	18		
3238	12	06	18	13	18	03	18	00	18		
3239	11	12	18	13	18	14	18	02	18		
3240	08	15	18	04	18	05	18	00	05	06	11
3245	16	11	18	00	05	12	18	03	00	03	17
3257	16	15	18	13	18	09	18	00	18	13	18

Note. + = number of items correct.

admin = number of items (out of 18) that were administered.

DEFN*: Cat. = number of items correct when category portion of Concept Definition task was scored on 0, 1 basis.

Attr. = number of items correct when attribute portion of Concept Definition task was scored on 0, 1 basis.

APPENDIX I

Predicted Test Performance Values from the Logistic Regression
and Constant Models

Table I-1. Predicted test performance, as a function of mental status, using the logistic regression model.

MMSE	ATTR	SCAT	SUPR	CNAM	DEFA	DEFC
1	.0077	1.0094	.8855	2.9887	1.7339	4.5136
2	.0109	1.2145	1.0814	3.3459	1.9273	5.0905
3	.0155	1.4576	1.3172	3.7352	2.1394	5.7099
4	.0220	1.7444	1.5995	4.1570	2.3714	6.3675
5	.0311	2.0806	1.9354	4.6110	2.6245	7.0573
6	.0441	2.4716	2.3318	5.0963	2.8995	7.7720
7	.0624	2.9227	2.7952	5.6113	3.1973	8.5028
8	.0883	3.4378	3.3312	6.1535	3.5186	9.2402
9	.1249	4.0195	3.9432	6.7198	3.8638	9.9745
10	.1765	4.6681	4.6323	7.3059	4.2329	10.6958
11	.2490	5.3811	5.3955	7.9074	4.6257	11.3952
12	.3509	6.1527	6.2258	8.5190	5.0417	12.0648
13	.4932	6.9739	7.1119	9.1350	5.4797	12.6981
14	.6910	7.8321	8.0380	9.7498	5.9383	13.2903
15	.9638	8.7125	8.9852	10.3576	6.4157	13.8379
16	1.3360	9.5985	9.9326	10.9530	6.9095	14.3394
17	1.8363	10.4730	10.8597	11.5309	7.4169	14.7945
18	2.4960	11.3198	11.7473	12.0871	7.9349	15.2041
19	3.3437	12.1247	12.5796	12.6178	8.4602	15.5699
20	4.3976	12.8766	13.3450	13.1200	8.9892	15.8945
21	5.6554	13.5675	14.0364	13.5918	9.5183	16.1808
22	7.0857	14.1927	14.6509	14.0318	10.0438	16.4320
23	8.6249	14.7508	15.1892	14.4393	10.5622	16.6514
24	10.1865	15.2431	15.6548	14.8145	11.0701	16.8422
25	11.6785	15.6725	16.0532	15.1580	11.5645	17.0077
26	13.0248	16.0436	16.3908	15.4707	12.0425	17.1507
27	14.1782	16.3617	16.6748	15.7541	12.5020	17.2739
28	15.1233	16.6325	16.9119	16.0099	12.9409	17.3800
29	15.8698	16.8617	17.1089	16.2397	13.3578	17.4710
30	16.4425	17.0546	17.2718	16.4456	13.7516	17.5490

Table I-2. Predicted mean test performance for each task using the constant model.

TASK	Predicted Mean Test Performance
Attribute Differences	1.4994
Sorting by category	7.5006
Superordinate Naming	7.6338
Confrontation Naming	9.3330
Concept Definition - Attribute	13.1256
Concept Definition - Category	6.4584

APPENDIX J

Protocol for Confrontation Naming Task

INSTRUCTIONS: Say, "I am going to show you a picture, and I would like you to tell me what it is."

Present each picture one at a time.

If the subject does not respond after ten seconds, proceed to the next item.

Start with the practice item.

Say, "What is this one?" This prompt may be used at anytime during the test.

Feedback for practice items:

If subject responds correctly, acknowledge so.

If the subject responds incorrectly, tell them, and give the correct answer.

If the subject does not respond after ten seconds, give the correct answer and proceed to the next item.

SCORING: Points = 0 if the subject responds incorrectly or no response.
Points = 1 if the subject responds correctly.

APPENDIX K

Protocol for Concept Definitions Task

INSTRUCTIONS: Turn on the tape recorder, and write down the responses. Begin with the first practice item.

Say, "I want you to define the following words. For example, you could define the word 'rolling pin' as 'a kitchen utensil that is used to roll out dough. It is long and cylindrical.'"

Say, "Now define the word _____."

Feedback on trial items.

If subject correctly defines second trial item, acknowledge so.

If subject incorrectly defines the item, or does not give a complete definition, give the correct definition, and an explanation.

If the subject fails to respond, prompt: "Now define the word _____."

If after 15 seconds and repeated prompts the subject fails to respond, go to the first test item.

SCORING: Responses are to be transcribed verbatim, and scored from the transcription.

Scoring is to be completed twice.

First, score for the production of an appropriate superordinate (as specified below)

Points = 0 if subject not not produce an appropriate superordinate, or no response.

Points = 1 if subject produces an appropriate superordinate.

Second, score for the production of an appropriate attribute.

Points = 0 if subject does not produce any true attributes, or no response.

Points = 1, 2, or 3 awarded for the number of true attributes produced, up to a maximum of 3.

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MAY 1991

HUMAN SUBJECTS COMMITTEE
Periodic Review

KATHRYN BAYLES/A87.70/SP & HEARING SCI/COMMUNICATION AND NEUROPSYCHIATRIC
STATUS IN DEMENTIA

(Title of Proposal)

1. What is the present state of this project:

- ☒ Continuing   ☐ Closed to New Subjects   ☐ Concluded
☐ Not Begun   ☐ Not Funded
☐ Other*

*(Please specify whether or not the project should be withdrawn permanently from our active files)

2. Is the consent form as approved by the Human Subjects Committee still being used?
(If not, please explain.) ☒ Yes   ☐ No

3. Where are the signed consent forms presently being filed? Room # Circumplex Hotel Room
(If necessary check with your Department Office to ascertain filing place.) 314

4. Have any problems arisen in regard to the participation and safety of the people used as subjects in this project? ☐ Yes   ☒ No

5. Has there been any psychological or physical injury to any subject? ☐ Yes   ☒ No

6. Have any protocol changes been made that have not been approved by the Human Subjects Committee? (If yes, please submit a copy of the changes.) ☐ Yes   ☒ No

This periodic review is required by Department of Health and Human Services regulations. Both the investigator's signature and that of the Chairman of the Departmental Review Committee is required. (The Departmental Review Committee is responsible to the Department Head for the surveillance of the ongoing project.)

Kathryn A. Bayles
Signature of Investigator

4-23-91
Date

Kathryn A. Bayles
Signature of the Departmental Review Committee Chairman

4-23-91
Date

Please return to: University of Arizona
Human Subjects Committee
1696 N. Warren (Bldg. 526B)
Tucson, Arizona 85724

Thank you for verifying that the procedures in the above named project have not changed since last approval and that no physical or psychological harm has come to any participating subjects. This project is reapproved as of the date stamped below for a period of one year. Reapproval is granted with the understanding that no changes will be made to the project's procedures or consent form(s) without the knowledge and approval of this Committee and the College or Departmental Review Committee. Any physical or psychological harm to any subject must also be reported to each committee.

MAY 22 1991

William F. Denny
William F. Denny, M.D. (Chairman)

REAPPROVAL DATE:

Human Subject Committee

THE UNIVERSITY OF
ARIZONA
HEALTH SCIENCES CENTER

1690 N. Warren (Bldg. 526B)
Tucson, Arizona 85724
(602) 626-6721 or 626-7575

April 10, 1992

Kathryn Bayles, Ph.D.
Department of Speech & Hearing Sciences
Speech Building
Main Campus

RE: **HSC A87.70 COMMUNICATION AND NEUROPSYCHIATRIC STATUS IN
DEMENTIA**

Dear Dr. Bayles:

We received your 4 April 1992 letter and accompanying sample questionnaire and 7 April 1992 consent form for your above referenced project. Change involves inclusion of a questionnaire to be completed by 150 caregivers [signed consent will be obtained from this new subject population]. Approval for this change is granted effective 10 April 1992.

The Human Subjects Committee (Institutional Review Board) of the University of Arizona has a current assurance of compliance, number M-1233, which is on file with the Department of Health and Human Services and covers this activity.

Approval is granted with the understanding that no further changes or additions will be made either to the procedures followed or to the consent form(s) used (copies of which we have on file) without the knowledge and approval of the Human Subjects Committee and your College or Departmental Review Committee. Any research related physical or psychological harm to any subject must also be reported to each committee.

A university policy requires that all signed subject consent forms be kept in a permanent file in an area designated for that purpose by the Department Head or comparable authority. This will assure their accessibility in the event that university officials require the information and the principal investigator is unavailable for some reason.

Sincerely yours,

William F. Denny

William F. Denny, M.D.
Chairman
Human Subjects Committee

WFD:rs

cc: Departmental/College Review Committee