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ARTICLES

Verb Naming in Normal Aging

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Few studies have examined verb naming in normal aging, although decline in the ability to name nouns has been well documented. In this study, we examined longitudinal performance on the Action Naming Test (ANT), a confrontation naming test for verbs. The purpose of this study was to confirm the verb naming deficit associated with aging, which was previously seen only in cross-sectional studies, and to provide additional normative data on verb naming ability that may prove useful to studies on verb naming in populations with brain dysfunction. Sixty-six healthy men and women aged 30 to 79 were each tested with the ANT 3 times over a 7-year span. ANT performance showed a significant decline over time for all participants except the youngest group. Longitudinal methodology supports the conclusion that this finding of a decline in verb naming ability arises from true age-related changes and not from cohort differences.

Key words: verb naming, aging, action naming

Elderly people typically complain of difficulty remembering names of people. These personal, anecdotal observations are confirmed by descriptive research studies that demonstrate age-related problems with proper noun naming (G. Cohen, 1990). *Tip-of-the-tongue* (TOT) phenomena, in which one cannot produce the name for a familiar concept but has a sense of the name and can retrieve some information about the name, are more common with increasing age (Burke, Worthley, & Martin, 1988; G. Cohen & Faulkner, 1986). TOTs most often occur with proper names (Burke, MacKay, Worthley, & Wade, 1991; Burke et al., 1988). Research also shows these age-related retrieval deficits extend to common nouns as well (Au et al., 1995; Barresi, 1996; Borod, Goodglass, & Kaplan, 1980; Bowles & Poon, 1985; Nicholas, Obler, Albert, & Goodglass, 1985).

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Although noun naming difficulties in the elderly are well documented, retrieval deficits for other parts of speech have not been as clearly demonstrated. Age-related change in ability to retrieve verbs, for example, has not been well studied. Verbs seem to be especially appropriate for further study not only because they are a major content word class, but also because they can be fairly easily depicted pictorially, which allows study using a traditional confrontation naming paradigm. Differences between noun and verb retrieval abilities have also been studied recently in both normal (Warburton et al., 1996) and aphasic participants (Caramazza & Hillis, 1991; Damasio & Tranel, 1993; Kohn, Lorch, & Pearson, 1989; Miceli, Silveri, Nocentini, & Caramazza, 1988; Miceli, Silveri, Villa, & Caramazza, 1984; Williams & Canter, 1987; Zingeser & Berndt, 1990). These studies have been partly empirical in nature, but they also have helped to delineate theories of semantic memory organization and processing. Because of the importance of verbs to theories of linguistic processing and language breakdown (see, e.g., Grodzhinsky, 1990), it is important to study how retrieval of verbs may be affected by the language changes associated with normal aging.

Existing research on verb naming in healthy adults does not provide a clear picture of how the capacity to name actions changes with age. Results for experimentally induced TOTs show a larger mean proportion of TOTs for adjectives and verbs in older participants than in younger participants (Burke et al., 1988). In contrast, Burke et al. (1988) found different results with naturally occurring TOTs with *abstract words,* which included verbs. (Also included in this category were "non-object nouns, adjectives, ... a few phrases, and one adverb.") They found that these naturally occurring abstract word TOTs account for 35% of all TOTs for young people (mean age 19.4 years), but only 13% for the elderly (mean age 71.0 years). However, there was evidence that formal situations common to the college environment provided more opportunities for abstract TOTs in the younger group. Thus, the results for word finding difficulties with verbs, as studied in TOT phenomena, are somewhat unclear. Furthermore, because verbs were studied in a larger group of different types of words and even some phrases, it is hard to determine from these data how action naming in particular is affected by age.

We have been specifically studying verb naming ability in healthy adults in our laboratory. As part of a large-scale, ongoing longitudinal study on language and aging, we tested healthy participants in four different age groups (30s, 50s, 60s, and 70s) using the Action Naming Test (ANT; Obler & Albert, 1979).[1] This test is a set of 55 line drawings of actions that range from easy to hard to name (see Figure 1). It was designed to be similar in administration and form to the Boston Naming Test (BNT; Kaplan, Goodglass, & Weintraub, 1976). In an earlier report we described results of cross-sectional analyses of ANT performance to determine how verb naming ability changes with age (Nicholas et al., 1985). The results demonstrated a significant age group effect in the ability to give an accurate name to a picture of an activity. Healthy 70-year-olds scored significantly lower than the other three age groups tested (30s, 50s, and 60s).

Although these results demonstrated verb finding problems with advanced age, the cross-sectional design did not allow specification of the problems as either age-group-related differences (cohort effects) or true age-related changes. Study of these same participants

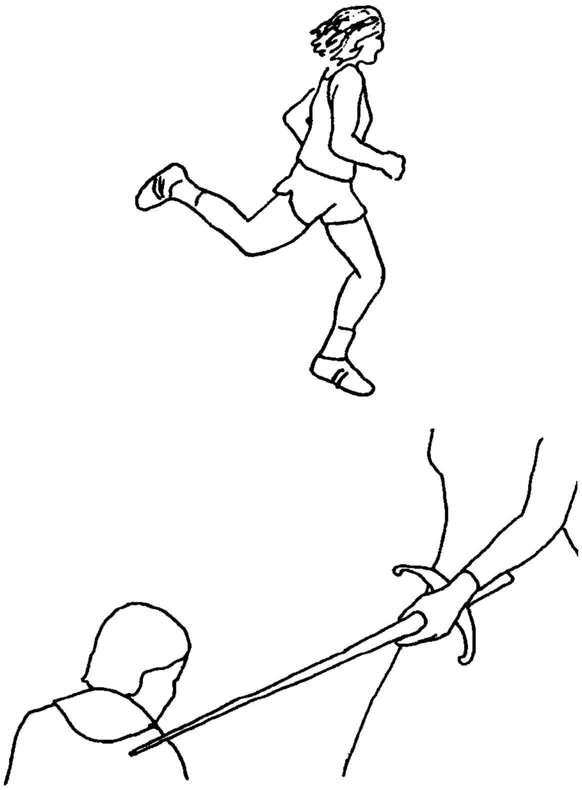

Figure 1. Examples of stimulus pictures from ANT: running (top) and knighting (bottom).

[1]The ANT is not commercially available. Copies are available by request to the Language in the Aging Brain Laboratory at the Boston VA Medical Center by writing to Dr. Lisa Connor or Anna MacKay at Language in the Aging Brain (12A), Boston VA Medical Center, 150 South Huntington Avenue, Boston, MA 02130.

longitudinally can provide data that support one of these conclusions. In this longitudinal study, we analyzed performance on the ANT administered to the same individuals three times over a 7-year span to: (a) determine if the previously reported cross-sectional findings could be attributed to true age-related changes, or conversely whether changes in verb naming were likely due to cohort effects; and (b) collect additional normative data on verb naming abilities with age that could prove useful as comparison data for studies on verb naming in aphasics and other neurologically impaired populations.

Method

Participants

Our participants were 66 men and women, initially aged 30 to 79, taking part in a longitudinal study on language and aging. All participants were screened to include those who were right-handed, had no past or present report of alcohol or drug abuse, and had no history of neurological and psychological illnesses. Before enrollment in the study each candidate underwent visual and audiological screening to eliminate those with poor vision or hearing. All participants were from the Boston, Massachusetts area and were native English speakers. All participants also received the Mini-Mental State Examination (Folstein, Folstein, & McHugh, 1975) at the third test session. No participants failed our screening cutoff level of 27 (out of 30 points) on the Mini-Mental State Examination. Participants were initially grouped into four age ranges: 30 to 39, 50 to 59, 60 to 69, and 70 to 79. All participants were then tested three times, once every 3 years, with an intertest interval ranging from 36 to 42 months. (See Table 1 for participant demographics.)

Participant attrition occurs in any longitudinal study. We report here the results from approximately half (n = 66) of the original participants we were able to test at each of the two subsequent test sessions. Reasons for dropping out of the study were varied and showed no consistent pattern within age groups, other than slightly greater frequency of health-related reasons in the older groups. The rates of return were roughly equivalent in each of the four age groups we report. Reasons for dropping out included loss of contact, not interested in returning, moved away from the area, poor health, and for 7 participants, death. For all age groups, the reasons for attrition in the majority of cases were unknown because we were unable to contact the participants by phone or mail.

Because of the substantial dropout rate, it is important to ensure that the participants who were available for follow-up are still representative of the larger population of aging adults. Analysis of ANT scores (*percentage correct* before cues) at the first test session indicated that the group of 66 participants followed across time had slightly better performance in all age groups than the larger group from whom they were culled (see Table 2). This pattern is not unusual in longitudinal studies (Schaie, 1977). Furthermore, it indicates that declines observed in the longitudinal participants over time cannot be attributed to the fact that these participants were starting off at a lower level to begin with. Based on statistical power of .80 and an alpha level of .05 as suggested by J. Cohen (1992), large-sized effects could be detectable with 18 participants in a study with four groups. Because the number of participants available in the groups in this study was slightly less than that (see Table 1), null results will be interpreted cautiously. If our results indicate lack of significant changes in performance over time, we might be underestimating age-related changes that would be observable in a different or larger sample.

Procedures

Each participant was administered the ANT, which consists of 55 line drawings of common (e.g., *running*)

Table 1. *Participants' Ages and Education Level*

Age Group	Men (n)	Women (n)	Age at First Testing Session		Years of Education	
			M	SD	M	SD
30s	4	11	33.9	3.0	15.5	1.8
50s	8	7	53.7	2.8	13.4	2.5
60s	10	11	65.2	3.1	13.2	2.3
70s	8	7	72.5	2.5	14.1	3.9

Table 2. *Percentage Correct on the Action Naming Test (ANT) at the First Test Session for the Original Group of Participants and the Group of Longitudinal Participants Seen at All Three Test Sessions*

	Percentage Correct Scores on ANT	
Age Group	Large Group[a] (*n*)	Longitudinal Group[b] (*n*)
30s	98.2 (33)	98.9 (15)
50s	97.8 (31)	98.7 (15)
60s	96.4 (38)	97.8 (21)
70s	95.0 (42)	97.4 (15)

[a]$N = 144$. [b]$N = 66$.

and less common (e.g., *knighting*) actions. Participants were shown each picture and were asked to "tell what's going on in the picture," with instructions that a one-word answer would be sufficient. If a participant's response indicated a misperception (e.g., "lying on the sand" for *floating*), the examiner gave a specified semantic cue (e.g., "he's on the water"). If participants responded with a semantically related name (e.g., "directing" for *conducting*), the examiner prompted them to give another response. This type of prompt, called an eliciting cue, had the form of "what's another word for that?" If they responded with any other incorrect response or no response, the examiner gave a phonemic cue (the first sounds of the word, e.g., *op-* for *operating*). All responses were tape-recorded and transcribed for later analyses.

Scoring

Tests were scored for the number of items correct before and after cues. All incorrect responses were qualitatively categorized into 12 error types as described in the following. These error categories are an expansion of a system originally developed by Kohn and Goodglass (1985) for a picture-naming task.

1. Comment: a response in which no attempt to name is made (e.g., "I don't know what that is called").
2. Semantically related: a word that is in the same or superordinate semantic class (e.g., "crocheting" for *knitting*).
3. Phonologically related: a real word that sounds like the target word (e.g., "knotting" for *knitting*).
4. Circumlocution: a response consisting of several words that describes or defines the target word (e.g., "musician leading a band" for *conducting*).
5. Perceptually related: a word that reflects a misperception or misunderstanding of the drawing (e.g., "tracing" for *operating*).
6. Part–whole: a word or description for only part of the target action or picture; can be a noun as well as a verb (e.g., "baton" for *conducting* or "smiling" for *winking*).
7. Negation: a response containing a negating adverb (e.g., "not skiing").
8. Quasi-word: a response that is not a real word (e.g., "acrobating" for *gymnastics*).
9. Unrelated: a response that has nothing to do with target word or picture (e.g., "walking" for *proposing*).
10. Fragment: part of a word (usually participant is self-correcting; e.g., "swi-" for *diving*).
11. Perseveration: a response given previously (e.g., "running" for *winning* after it had been given for *running*).
12. Noun–verb: a semantically related noun is given for the target word (e.g., "surgeon" for *operating*).

All the error responses were scored only once into their primary category (no double coding was used for error responses); therefore, a detailed scoring protocol was developed to ensure consistent coding because some responses could fit into more than one category. However, participants could make more than one error per item if more than one response to the item was given.

A few responses were judged to be correct but were qualitatively different from the expected response in the *-ing* form of the word, (e.g., instead of saying *winning*, a participant may say "he won a race"). These types of responses were divided into four categories:

1. Augmented correct: contains target word plus extra (modifying) words ("he's conducting the orchestra" for *conducting*).
2. Infinitive: the infinitive version of the verb is given before the desired *-ing* version (e.g., "drip ... dripping" for *dripping*).
3. Truncation: only the infinitive version of the verb is given; the *-ing* version is never said (e.g., "juggle" for *juggling*).
4. Tense: the target verb is given in a different form than the desired *-ing* version or the infinitive version, commonly the past tense (e.g., "knighted" for *knighting*).

To determine if this type of modified correct responding varied with age or time, these responses were doubly coded (i.e., "he won a race" for *winning* would be scored as augmented correct and tense). Two raters scored all tests, with an interrater reliability of 86.7% for all scoring decisions.

Some participants' responses had to be eliminated from analyses due to tester error. Items in which an incorrect response was not properly cued were discarded from analyses. Of the 10,890 items (for all participants over the three testing sessions), 256 items (2.4%) were discarded. Because of the discarded items, all analyses were conducted on scores relative to the number of items included. This percentage correct score was then converted for statistical analyses using an arcsin transformation {2*arcsin[square root(# correct/# of questions)]}.

Results

The study design used age group cells called *30s, 50s, 60s,* and *70s*, reflecting the participants' ages at first testing. Age groups were not significantly different for education level or gender. When it was necessary to analyze scores relative to the number of items included, analyses were conducted on arcsin transformed proportion scores.

Correctness

Age Group (four different groups) × Time (three different test sessions) repeated measures analyses of variance (ANOVAs) for the number of items spontaneously correct in one attempt showed significant effects for age, $F(3, 62) = 4.68$, $p < .01$, and time, $F(2, 124) = 34.29$, $p < .001$, with the number of items spontaneously correct decreasing across the age groups and across the test times (see Figure 2). The number of items correct before cues, including self-corrected items in which participants made errors but corrected themselves, also showed a significant age group effect, $F(3, 62) = 3.50$, $p < .05$, and time effect, $F(2, 124) = 52.19$, $p < .001$. There was also a significant Age × Time interaction, $F(6, 124) = 2.62$, $p < .05$, for scores before cues. Post hoc t tests showed that performance of all groups except 30-year-olds decreased significantly over the 7-year test interval (the first testing session to the third; $p < .05$ for 50s and 60s; $p < .01$ for 70s). Post hoc analyses also showed significant differences among the age groups only at Time 3; at this time, the 30-year-olds were significantly better than the 70-year-olds ($p < .05$; see Figure 3). It is notable that analyses of number correct after cues showed no significant age group or time effects. Table 3 gives the percentage of spontaneously correct responses, correct responses before cues, and correct responses after cues for each of the four age groups at each of the three time sessions.

Effect of Education

Because of the role that education may play in naming performance (Welch, Doineau, Johnson, & King, 1996), we investigated the effect of education level on our results, even though education level was not significantly different among the four age groups. To ensure that education differences were not accounting for or significantly contributing to our apparent aging effect, we used bivariate regression analyses to determine edu-

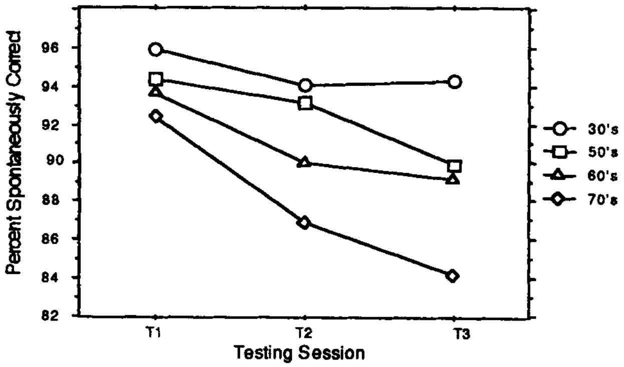

Figure 2. Mean percentage of items spontaneously correct in one attempt by time and age group.

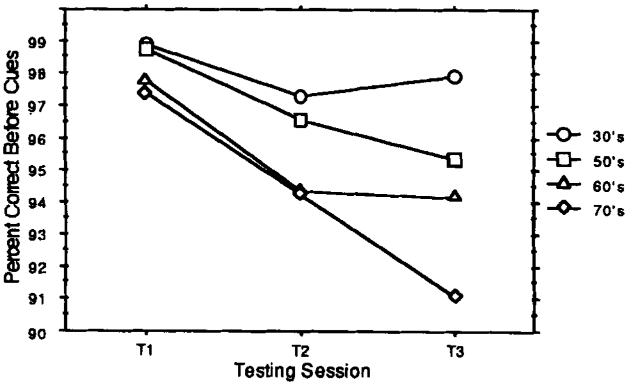

Figure 3. Mean percentage correct before cues by time and age group.

Table 3. *Percentage Correct Scores on the Action Naming Test and Standard Deviations for the Four Age Groups at the Three Testing Sessions*

	30s		50s		60s		70s	
	% Correct	*SD*	% Correct	*SD*	% Correct	*SD*	% Correct	*SD*
Spontaneously correct in one attempt								
Test 1	95.9	.04	94.3	.06	93.6	.07	92.3	.06
Test 2	94.0	.02	93.2	.04	90.0	.06	86.9	.07
Test 3	94.3	.03	89.9	.05	89.1	.07	84.1	.06
Correct before cues								
Test 1	98.9	.02	98.7	.02	97.8	.03	97.4	.03
Test 2	97.3	.03	96.6	.03	94.3	.05	94.2	.06
Test 3	97.9	.02	95.4	.03	94.2	.05	91.1	.04
Correct after cues								
Test 1	99.9	.01	100.0	.00	99.9	.00	99.9	.01
Test 2	99.8	.01	99.8	.01	99.8	.01	99.6	.01
Test 3	99.9	.01	99.9	.01	99.7	.01	99.1	.02

cation-corrected scores on the before cues measure. Education level was correlated with the number of items correct before cuing for each time and within each age group. These correlations were then used to predict the number of items correct before cues from the educational level for each participant. Each participant received a score that was corrected for education level with respect to age group. On the analysis of the number correct before cues adjusted for education, a repeated measures ANOVA still showed significant effects for age, $F(3, 62) = 20.39$, $p < .001$, and time, $F(2, 124) = 402.03)$, $p < .001$, as well as an interaction, $F(6, 124) = 20.17$, $p < .001$. Post hoc *t* tests showed that all age groups' performance declined significantly from the first testing session to the second ($p < .01$ for all age groups) and from the first testing session to the third ($p < .01$ for all age groups except 30-year-olds, $p < .05$). The 70-year-olds' performance also declined significantly from the second testing session to the third ($p < .01$). At the third testing session, the 60- and 70-year-olds' performance was significantly worse than that of the 30-year-olds ($p < .01$, 30s vs. 70s; $p < .05$, 30s vs. 60s), and the 70-year-olds' performance was significantly worse than that of the 50-year-olds ($p < .05$).

We were especially interested in the effect of education on correctness scores for 70-year-olds because only in that age group did education correlate with the measure of percentage correct before cues. It therefore seemed that education might be affecting this measure for the 70-year-olds across time. To further understand these findings, we conducted a median split of education level (*Mdn* = 12 years) for the 70-year-olds and performed a repeated measures ANOVA on Level of

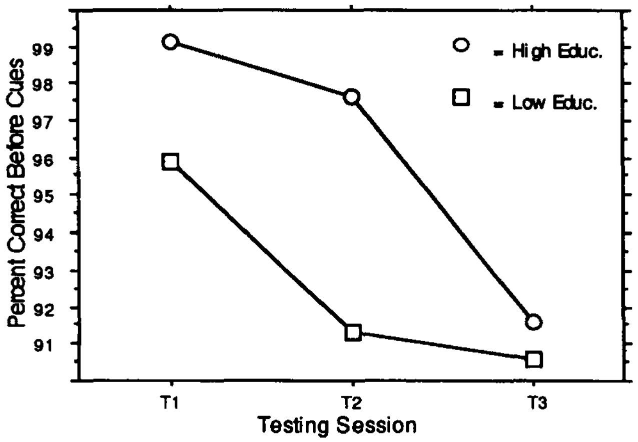

Figure 4. **Mean percentage correct before cues for 70s age group by time and education level.**

Education × Time for the percentage of items correct before cues. Results showed a significant effect for education, $F(1, 13) = 8.18$, $p < .05$, and time, $F(2, 26) = 22.70$, $p < .001$, as well as the interaction, $F(2, 26) = 3.83$, $p < .05$, such that the more highly educated 70-year-olds' performance declined significantly from the first and second testing sessions to the third. Scores of less highly educated 70-year-olds showed only a trend toward a significant change across the three testing sessions (see Figure 4). It should be noted that this effect could be confounded by gender differences because nearly all the women fell into the less highly educated group, whereas almost all the men were in the more highly educated group. Interestingly, we found that men performed significantly better than women in both the 50- and 60-year-old groups as well ($p < .05$ for

50s and $p < .01$ for 60s), but this gender effect disappeared when education-corrected scores were used. Therefore, it is unlikely that gender effects were masquerading as education effects in the 70s group.

Error Analyses

Although quantitative analyses showed that elderly people named fewer items before cues than younger participants, these results do not give information about the incorrect responses. When attempting to name pictures, participants commonly try several times. Sometimes participants make an error on an item they eventually produce correctly on their own (if they self-correct), and sometimes they produce more than one error per item. Therefore, the number of errors does not always equal the number of incorrect items. That is, a participant may make several different types of errors for a given item, but the item would only be counted wrong once. Because the number and style of errors could contribute additional information about the nature of naming difficulties in normal aging, we conducted qualitative analyses on the errors made by each participant.

Number of Errors

We examined the total number of errors made to determine if older participants made more errors in addition to getting fewer items correct. Results of a repeated measures ANOVA showed a significant effect of age, $F(3, 62) = 4.09, p = .01$, and time, $F(2, 124) = 23.62, p < .001$, but no Age × Time interaction (see Figure 5 and Table 4).

Because we found an increase in the total number of errors with increasing age, we wanted to determine if there were some error types that showed greater changes with age, or if some error types did not change at all with age. Many of our error categories, such as phonemically related errors, circumlocutions, and comments, did not show a significant increase with either age or time. Table 4 shows the number of errors for the four age groups at each of the three time sessions for the error types for which we did find significant differences. ANOVAs comparing the age groups on individual error types indicated a significant age group effect for perceptually related responses, $F(3, 62) = 4.54, p < .01$; nouns-for-verbs, $F(3, 62) = 3.30, p < .05$; perseverations, $F(3, 62) = 4.11, p = .01$; and fragments, $F(3, 62) = 2.86, p < .05$, with the number of errors of each type being higher in the older age groups.

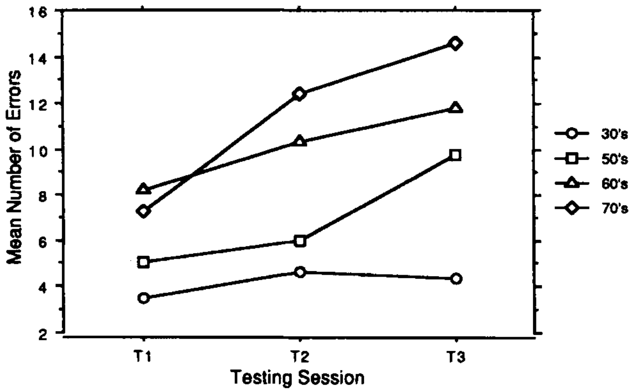

Figure 5. Mean number of errors by time and age group.

Table 4. *Number of Total Errors and Error Subtypes for the Four Age Groups at the Three Testing Sessions*

Errors	30s	50s	60s	70s
Total errors				
Test 1	3.5	5.1	8.2	7.3
Test 2	4.7	6.0	10.3	12.4
Test 3	4.4	9.8	11.8	14.6
Perceptual				
Test 1	0.1	0.3	0.2	0.3
Test 2	0.1	0.0	0.3	0.7
Test 3	0.2	0.1	0.4	0.7
Noun for verb				
Test 1	0.4	0.9	1.0	0.6
Test 2	0.4	1.2	1.7	2.1
Test 3	0.4	0.7	1.7	1.3
Perseveration				
Test 1	0.7	0.5	1.2	0.8
Test 2	0.9	1.4	2.1	2.2
Test 3	1.1	2.5	2.2	3.6
Fragment				
Test 1	0.2	0.2	0.5	0.3
Test 2	0.1	0.3	0.8	0.7
Test 3	0.3	0.3	0.6	0.5
Semantic				
Test 1	1.0	0.7	0.8	1.1
Test 2	1.6	1.1	1.9	1.8
Test 3	1.2	2.7	2.5	3.2
Augmented				
Test 1	1.3	1.6	1.8	2.5
Test 2	0.5	1.5	2.0	1.7
Test 3	0.5	0.3	1.6	0.9

The repeated measures ANOVA comparing across time indicated that the number of nouns-for-verbs, $F(2, 124) = 6.81, p < .01$, and perseverations, $F(2, 124) =$

23.53, $p < .001$, also increased significantly with time, as did the number of semantically related responses, $F(2, 124) = 24.40$, $p < .001$. Augmented correct responses decreased significantly with time as well, $F(2, 124) = 4.45$, $p = .01$. Finally, there were significant Age × Time interactions for both semantically related responses, $F(6, 124) = 2.80$, $p = .01$, and perseverations, $F(6, 124) = 3.06$, $p < .01$; 30-year-olds had significantly fewer errors of both types than 70-year-olds at the third testing session ($p < .05$). All age groups except 30-year-olds significantly increased in the number of semantic errors from the first to third testing session. Fifty-year-olds also showed a significant increase in semantic errors from the second testing session to the third. The 50-year-olds and 70-year-olds significantly increased in the number of perseverations from the first to third testing session.

Proportions of Error Types

Although these analyses demonstrate the differences in number of errors of each type across the four age groups, they do not provide information about the pattern of errors. We were also interested in the dynamic interplay among error types as the discrete changes occur. Therefore we performed an additional set of analyses on the proportion of each error type. We looked at the percentage of the total errors that each error type constituted.

Analyses of the proportion distribution of errors revealed slightly different results from those found with number of errors. The proportion of semantic errors showed a significant age group effect, $F(3, 49) = 3.01$, $p < .05$, with proportion of semantic errors being lower in older age groups, whereas the proportion of perceptual errors was significantly higher in the older age groups, $F(3, 49) = 3.12$, $p < .05$. The error type that constituted a considerably larger percentage of the total errors with time was perseverations, $F(2, 98) = 3.81$, $p < .05$. Quasi-words had a significantly higher percentage at the second testing session compared to the first and third testing sessions, $F(2, 98) = 3.25$, $p < .05$. The proportion of quasi-words also showed a significant interaction, $F(6, 98) = 2.53$, $p < .05$, with the 50-year-olds having a significantly higher percentage of quasi-words than all other age groups at the second testing session; however, quasi-words are very infrequent types of responses.

To further understand the change in error pattern with age, we asked the following question: Are elderly participants just increasing their number of errors of each type, or is the diversity of the errors increasing with age? To answer, we looked at the number of types of errors made for each participant (e.g., a total of three semantically related errors and four fragments on all items would be two types of errors for that participant). Using an Age × Time repeated measures ANOVA, this measure was found to show both significant age group, $F(3, 62) = 3.78$, $p = .01$, and time effects, $F(2, 124) = 15.20$, $p < .001$, with more types of errors being made with older age and with increasing time. The Age × Time interaction was not significant.

Discussion

We found a decline in the ability to retrieve verbs with age. Elderly participants named significantly fewer pictured actions before cues than did younger participants. Moreover, this pattern of decline was demonstrated for participants over 50 years old within only a 7-year time span. Thus, when we consider the ability to name verbs prior to a cue, our results indicate that verb naming decline begins certainly by the sixth decade and continues with advancing age. When we consider a more stringent criterion, the ability to spontaneously produce the verb name in a single response (not including self-corrected responses), our results indicate that verb naming difficulties may actually begin as early as the fourth decade. It is only by the sixth decade, however, that problems cannot be readily self-corrected.

It should be noted that although difficulties in spontaneous naming were seen, our older participants were still able to achieve greater than 90% correct before cues on the ANT. Thus, the normal changes in action naming with age are not likely to have a significant impact on word finding ability in daily functioning. Nonetheless, older adults do experience discomfort around problems with word finding. Also it is important to consider these changes when assessing older patients for language difficulties. Our results offer normative data against which action naming problems can be compared in clinical settings.

Our longitudinal analyses detect a subtle decline with age in action naming ability that was not evident with a cross-sectional design (Nicholas et al., 1985). Because elderly and young participants are able to name actions equally well after cues, it appears that the nature of the naming problem with age is a retrieval deficit for specific lexical labels, as has been reported for nouns (Bowles & Poon, 1985; Nicholas et al., 1985). The information needed to retrieve the name of a pictured action is available at all ages; but, beginning with the sixth decade of life, problems occur with the immediate retrieval of some of this information. At that time, neural mechanisms necessary for lexical retrieval no longer fully support the naming of actions, as they no longer fully support the naming of objects. Cues become necessary for the accurate retrieval of verbs from the lexicon, just as they are for nouns.

Three error types—perseveration, noun-for-verb substitutions, and semantically related responses—yield particularly interesting changes with age. As did Salmon and Butters (1987), we found more perseveration with age. Although perseveration has previously been described as an underlying deficit affecting language processing in aphasia (Albert & Sandson, 1986), the significant finding of increased perseveration with age and time in this study indicates that perseveration may also be a factor contributing to or reflecting impaired lexical retrieval in normal aging. As Sandson (1986) pointed out, recurrent perseveration may be a reflection of memory dysfunction. Thus, the memory impairment of normal aging may yield perseveration, which either contributes to or is otherwise associated with lexical retrieval deficits.

The design of the ANT itself, it must be noted, may foster the production of perseverative errors. Several pictures with related target word answers are included (such as *running* and *racing*, *kneeling* and *proposing*, *pouring* and *drinking*). In general, perseverative responses for all ages were highly semantically related to their targets. Perseveration therefore may have occurred because these semantically related responses were "primed" by being elicited previously. When confronted with word finding difficulties, older participants in particular may tend to answer with previously given responses, especially if they also share semantic features with the target response. Additional studies on perseveration in normal aging will help to clarify this issue.

Noun-for-verb responses increased significantly with age and also increased from Time 1 to Times 2 and 3, particularly for 60- and 70-year-olds. Other researchers have similarly found that people sometimes respond with nouns when asked to name verbs (Berndt, Mitchum, Haendiges, & Sandson, 1997). The conceptual relevance of this finding is unclear, but may indicate weakening in form class distinctions across the ages. Older participants may not be as aware that the task is a verb naming task (because the examiners never explicitly say it is). Elderly participants may respond with nouns because they more easily lose set, or it may be a more common or familiar task to label a picture as a noun; thus, when confronted with word finding difficulties, they are apt to answer with related nouns, often naming other aspects of the stimulus picture.[2]

The relevance of semantic errors in naming has been an important area of debate, particularly regarding the issue of semantic system deterioration in normal aging and dementia (Bayles, Tomoeda, & Trosset, 1990; Hodges, Salmon, & Butters, 1991; Nicholas, Obler, Au, & Albert, 1996). In this study, we found that semantically related errors were one of the most common error types made in naming verbs, just as they had been in naming objects on an object naming task (see Au et al., 1995, for BNT results). Furthermore, all age groups except the 30s showed significant increases in the number of semantic errors on the ANT from the first test session to the third test session. This was different from the pattern observed for semantic errors on the BNT, which did not show an Age Group × Time interaction. However, we also found that older participants made proportionally fewer semantically related errors on the ANT than the group of older participants made on the BNT. A direct comparison across the two tests is problematic because participants of all ages perform at higher levels on the ANT than they do on the BNT. Thus, the fact that the ANT and the BNT are not equally difficult makes it hard to compare error pattern profiles across the two tests. Compounding this difficulty are the varied interpretations of the meaning of semantic errors (see Nicholas et al., 1996, for a discussion of this issue). Thus, whether or not changes in the absolute number or the proportion of semantically related errors seen with age on the ANT or the BNT reflect important changes in semantic memory functioning is far from certain at this time.

The role of education in naming performance with aging has been another area of interest. Other investigators have shown that education contributes to naming ability for nouns, but cannot entirely account for the decline in noun naming ability seen with age (LaBarge, Edwards, & Knesevich, 1986; Van Gorp, Satz, Kiersch, & Henry, 1986; Welch et al., 1996). Our findings of significant age, time, and interaction effects with education-corrected analyses support the conclusion of a verb naming ability decline with age, unrelated to educational level. Indeed, because the age-related results

[2]Another explanation for the increase in noun-for-verb responses observed across time is that, at the first test time, the participants were first tested with the ANT and then the BNT; whereas at the second and third test sessions, the order was reversed—participants were first tested with the BNT and then with the ANT.

of our education-adjusted scores were significant and pointed to significant changes even within our youngest age group, our findings do not support those of investigators who argue that education effects contribute to the naming decline found with aging (LaBarge et al., 1986; Van Gorp et al., 1986; Welch et al., 1996). We also found that a correlation between educational level and the measure of correct naming before cues was significant only for the 70-year-olds at the first and second testing times. This further supports our conclusion that education does not play a major role in action naming ability for most participants.

However, because the 70-year-olds with higher educational levels did score better than 70-year-olds with lower educational levels at both the first and second testing times and only the more highly educated 70-year-olds' performance changed significantly with time, it seems that education may be acting as a "buffer" against further naming decline. The less highly educated group has already declined by their eighth decade, whereas the more highly educated group is only beginning to decline at this time. The difference is seen only in 70-year-olds because that is the group in which naming decline is most advanced in our study, and it is only with this level of decline that the educational effect is seen. Because the high and low education level 70-year-olds did not perform significantly differently at the third testing session, the buffering effect of education may be limited; even high education cannot prevent naming decline after a certain point.

Our results on an action naming task in healthy adults will be useful as normative data. Verb naming abilities have been tested in healthy elderly participants serving as control participants in studies of naming in aphasia. However, the literature on aphasia describing difficulties with verb naming and production typically describes a small number of age- and education-matched normal participants (e.g., Kohn et al., 1984; Miceli et al., 1984), and there is generally greater variability with elderly participants than younger participants in cognitive studies (Nelson & Dannefer, 1992). Therefore, the findings of verb naming abilities for healthy elderly individuals generated from these other studies may not accurately reflect the normal differences between age groups or the variability within age groups. Neuropsychological studies assessing verb naming in aphasics, patients with head injuries, and other clinical populations can use our findings from healthy participants for comparative purposes.

Furthermore, our normative findings on changes in verb retrieval with age make possible the comparison of noun and verb naming abilities, which may provide further evidence for a dissociation in noun and verb naming ability. Several recent studies in aphasia look at differences between noun and verb production and comprehension (Kohn et al., 1989; Miceli et al., 1988; Miceli et al., 1984; Williams & Canter, 1987; Zingeser & Berndt, 1990). The double dissociation these studies found in the abilities to name nouns and verbs has recently received anatomical support in case reports of brain-damaged participants (Damasio & Tranel, 1993). Whether a similar dissociation exists for noun and verb naming in normal elderly populations is an important area of further research.

As we mentioned earlier in the discussion of semantically related errors, our longitudinal participants were given the BNT as well as the ANT. We have data on both noun and verb naming abilities over 7 years from the same participants (see Au et al., 1995, for BNT results). Briefly, we found that for both the ANT and the BNT, naming declines were seen over the 7-year period of testing for all except the youngest age group (30s). However, there were some indications of differences between noun and verb naming from the qualitative error analyses. BNT results tended to show significant changes in a greater number of error categories with age. The data point to possible differences in the strategies used to retrieve nouns and verbs in older participants that are worthy of additional study.

Our findings of ANT performance changes with age provide evidence of a decline in verb naming ability with healthy aging. Longitudinal methodology supports the conclusion that these findings are due to true age-related changes rather than cohort differences.

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