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Last in, First to Go: Age of Acquisition and Naming in the Elderly

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Twenty-six elderly subjects (ages 71–86) and 10 young adult subjects (ages 22–33) named 206 black-and-white line drawings of objects. Although the two groups did not differ significantly on VIQ, the elderly group named significantly fewer of the objects than the younger group (who were almost at ceiling). A regression analysis of the data from the elderly group found effects of both age of acquisition and name agreement on naming accuracy after 5 and 15 s and an effect of word length after 5 but not 15 s. There were no independent effects of picture complexity, object familiarity, word frequency, or imageability. The majority of the elderly subjects' naming errors were semantic in nature, with circumlocutions, visual errors, and ''don't know'' responses accounting for most of the remaining errors. The implications of the findings for our understanding of word-finding problems in the elderly are discussed.

INTRODUCTION

One of the spontaneous complaints of many older people is of difficulty remembering names, both the proper names of people and places and the common names of objects and things. The complaint is typically that the speaker *knows* the elusive name but that it ''just won't come'' (Cohen & Faulkner, 1986; Reason & Lucas, 1984). Research suggests that word retrieval problems of this sort do not become significant until individuals reach their 70s (Albert, Heller, & Milberg, 1988; Borod, Goodglass, & Kaplan, 1980; Nicholas, Obler, Albert, & Goodglass, 1985), but that after that point problems can be detected in the retrieval of common names (Albert *et al.*, 1988; Au, Joung, Nicholas, Obler, Kass, & Albert, 1995; Borod *et al.*, 1980; Maylor, 1995; Nicholas *et al.*, 1985), proper names (Burke, MacKay,

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Worthley, & Wade, 1991; Cohen & Faulkner, 1986; Maylor, 1990, 1995), and verbs (Nicholas *et al.*, 1985).

In a test which involves naming pictures of objects, an elderly person will succeed in naming some items but struggle to recall the names of others. If there is a degree of consistency in which items older people have difficulty naming and which they find relatively easy, then it is possible to ask whether properties of the objects or their names can be identified which affect the ease or difficulty of naming. If such properties can be identified they should tell us something about the causes of naming problems in the elderly.

Naming, Lexical Properties, and Age

1. Word length. We know of only one previous study that has looked at the effects of properties of objects and/or their names on naming accuracy in the elderly. Le Dorze and Durocher (1992) compared the naming of 120 objects with one-, two-, or three-syllable names in young (25–44 years of age), middle aged (45–64), and elderly (65–85) subjects. There was an effect of age on naming accuracy, with the older subjects recalling fewer names than the younger subjects, and an effect of length, with longer names being less well recalled than shorter names. There was also a significant interaction between age and naming, such that the elderly subjects had particular difficulty with longer names. Unfortunately, the different length names in this study were not matched on other potentially important factors which correlate with length. There is, for example, a well known correlation between length and word frequency, with more common words tending to be shorter than less common words, and word frequency has been proposed as a determinant of naming difficulty in the elderly (see below). Le Dorze and Durocher (1992) reported a correlation of -0.45 between frequency and length for the items in their study, but made no further attempt to discover which (if either) was the operative factor.

2. Word frequency. Other studies have looked at factors affecting naming *latency* rather than accuracy in older subjects. Thomas, Fozard, and Waugh (1977) had five groups of male subjects of ages from 25 to over 65 years name pictured objects. Naming latency showed a significant increase with age. Although the effects of word frequency were not analyzed statistically, a breakdown of the objects according to the frequency of use of their names suggested that latencies were shorter for high than for low frequency names, but that frequency did not interact with participant age; that is, the effect of frequency on naming latency was no greater for older than for younger subjects (see Thomas *et al.*, 1977, Fig. 3). Effects of word frequency on object naming latency in young adults have been reported by Oldfield and Wingfield (1965) and Jescheniak and Levelt (1994) among others.

On the basis of their theoretical model of naming, Burke and Laver (1990) predicted that word frequency would affect naming accuracy in the elderly. The model they proposed has units called nodes that are connected in a network. Activation spreads between nodes along connections. The strength of the connections between nodes determines how much and how well activation is passed from one node to the next. In the model, frequently used connections are stronger than less frequently used ones, so high frequency items are accessed faster (cf. Dell, 1986; Dell & O'Sheaghda, 1992). Burke and Laver (1990) suggested that the efficiency of the connections between nodes declines with age. This means that the amount of activation passed between nodes reduces, so naming latencies are increased. Such a reduction in the flow of activation could have more serious consequences for low frequency words, whose retrieval requires activation to pass along little-used connections, than for high frequency words. In order to test their hypothesis, Burke and Laver collected diary data concerning the number and type of tip-of-the-tongue (ToT) occurrences experienced by three different age groups (young, mid-age, and elderly). After excluding proper names, they showed that the target words which induced ToT's tended to be low frequency words.

3. *Name agreement.* Mitchell (1989) studied the naming of pictures with high or low ''codability'' (otherwise known as ''name agreement''). An object which can only be given one plausible name (e.g., a chair) is said to show high name agreement while an object which has more than one possible name (e.g., a sofa, which can also be called a couch or settee) shows low name agreement. Studies using young adult subjects have established that naming is slower for objects with low name agreement (Gilhooly & Gilhooly, 1979; Lachman, Schaffer, & Hennrikus, 1974; Paivio, Clark, Digdon, & Bons, 1989; Vitkovitch & Tyrrell, 1995). That is, the fact that more than one name exists for an object seems to slow down the retrieval and production of any one of them. Mitchell (1989) compared the naming of objects with high and low name agreement in groups of young (19–32) and older (63–80) adults. Naming latencies were generally slower in the older group, and there was an overall effect of name agreement, but the effect was as strong in the younger group as in the older group, and the interaction between age and name agreement did not approach significance.

4. *Object familiarity.* Poon and Fozard (1978) examined naming latency in three groups of male participants ages 18–22, 45–54, and 60–70 years old. Four categories of objects were investigated. The first category comprised ''unique dated exemplars,'' objects which were commonplace when the oldest participants were young but which had since fallen into disuse (e.g., bed pan, wringer). The second category were ''unique contemporary exemplars,'' objects of recent arrival in the 1960s and 1970s (e.g., calculator, hair dryer). The third category were ''common dated exemplars,'' objects which had been in use throughout the century, but presented as they appeared in

the early decades (e.g., an old camera and an old telephone). The fourth category involved ''common contemporary exemplars,'' objects which had also been in use throughout the century, but this time presented in their contemporary guises. The two groups did not differ significantly in their latency of naming the common contemporary exemplars, but the younger subjects were faster to name the unique contemporary exemplars while the oldest group were significantly faster to name both the unique and the common dated exemplars.

5. *Age of acquisition.* Poon and Fozard (1978) interpreted their results in terms of differences in the familiarity of the depicted objects to younger and older adults. It is also possible, though, that these results, and some of those mentioned earlier, reflect differences in the *age of acquisition* of different object names. The older participants in the Poon and Fozard (1978) study will have encountered the dated exemplars when they were young children, whereas the younger participants are likely to have been older when they first saw them (e.g., in a history program on television or in a museum). There is now a substantial body of evidence showing that, all other things being equal, words learned early in life can be retrieved more rapidly than later acquired words in tasks like object naming and reading aloud (Barry, Morrison, & Ellis, 1997; Carroll & White, 1973; Gilhooly & Gilhooly, 1979; Ellis & Morrison, 1998; Morrison & Ellis, 1995; Morrison, Ellis, & Quinlan, 1992; Vitkovitch & Tyrrell, 1995) and that early acquired words may be more resistant to the effects of some forms of brain injury than later acquired words (Ellis, Lum, & Lambon Ralph, 1996; Feyereisen, Van der Borght, & Seron, 1988; Hirsh & Ellis, 1994; Hirsh & Funnell, 1995).

Age of acquisition correlates significantly with both word length and word frequency (early learned words tending to be short and of high frequency; Morrison, Chappell, & Ellis, 1997). It is therefore possible that the effect of word length on naming in the elderly reported by Le Dorze and Durocher (1992) is, in reality, an effect of age of acquisition and possible also that the tendency noted by Burke and Laver (1990) for words which induce ToT's in older people to be of low frequency could, in reality, be a tendency for late-acquired words to provoke word-finding difficulties.

The present study is an attempt to disentangle the various factors which have been claimed to cause naming problems in the elderly. We were particularly keen to explore the possibility that early acquired words may be more resistant to the effect of aging than late acquired words. Previous studies of age of acquisition effects in object naming have used adult estimates of when names are learned. There are obvious problems with relying on such estimates. The present study, however, used a measure of real, objective age of acquisition taken from Morrison *et al.* (1997). They showed over 300 object pictures to 280 children ranging in age from 2 years 6 months to 10 years 11 months. Each item was given a score according to how many of the children in an age group named it correctly with or without an initial phoneme cue. When 75% of two successive age groups had named the item correctly, an age of acquisition equivalent to the mean age of the younger group was assigned to the item.

Over 200 object pictures were shown to a group of elderly subjects ages 71 to 86 years and to a group of young adults. The comparison between the two groups was used to establish that the older adults did indeed experience naming problems. Data on the number of older subjects able to name each of the objects was then used as the basis for a multiple regression analysis in which the rated familiarity of the object, its name agreement, age of acquisition, word frequency, and word length were all assessed as predictors of naming success or failure, along with the visual complexity of the object picture and its imageability.

METHOD

Materials

Two hundred and thirty black-and-white line drawings of objects were used in the study. Of these, 170 pictures were taken from the set published by Snodgrass and Vanderwart (1980) and 60, drawn in a similar style, from Morrison *et al.* (1997).[1] Data were available for all the items on visual complexity, object familiarity, imageability, name agreement, age of acquisition, word frequency, and word length.

Visual complexity. Visual complexity is an estimate of the amount of detail in the drawing of an object. The values for this variable were taken from Morrison *et al.* (1997) for all except three of the pictures (kettle, dress, and box) which were taken from Snodgrass and Vanderwart (1980). Raters in both studies were instructed to rate the familiarity of pictured objects on a five-point scale, from 1 = relatively simple to 5 = very complex.

Object familiarity. Familiarity is a measure of how often individuals consider that they come into contact with or think about an object. Values for this variable were obtained form Morrison *et al.* (1997) whose raters were asked to fill in questionnaires using a five-point scale from 1 = very unfamiliar to 5 = very familiar.

Imageability. The measures for this variable were also taken from Morrison *et al.* (1997). Participants were instructed to rate how easily an object name aroused a mental image of the object by circling the a number on a scale from 1 = very hard to mentally image to 7 = very easy to mentally image.

Name agreement. Name agreement is a measure of how well individuals agree on the target name for a given object. All of the pictures used in this study had name agreement values of 85% or higher from Morrison *et al.* (1997); that is, more than 85% of young adults produced the target name as a first response to the picture.

Age of acquisition. This was taken as the 75% measure from Morrison *et al.* (1997). Items that were not named by 75% of the oldest children in that study, but were named by more than 75% of adults ($n = 13$) were assigned values of 140 months, while items that were named by more than 75% of even the youngest group ($n = 51$) were assigned a value of 24 months.

[1] Copies of the additional pictures that were not taken from Snodgrass and Vanderwart (1980) can be found on the World Wide Web at the URL site http://www.cf.ac.uk/uwcc/psych/morrison along with the children's raw data upon which the age of acquisition norms are based.

Word frequency. Frequency counts are measures of how often a given word appears in spoken or written language. Values for this variable were obtained from the Celex Lexical Database. This database was compiled at the Centre for Lexical Information at the University of Nijmegen by sampling from the Cobuild corpora, which were compiled at the University of Birmingham and are based on contemporary British English (Baayen, Piepenbrock, & Van Rijn, 1993; Sinclair, 1987). The present study used the combined written and spoken frequency counts which were transformed using the formula $\log(1 + x)$ in order to reduce skew.

Word length. Word length was defined as the number of phonemes in the standard British pronunciation of each name.

Subjects

There were two groups of subjects in the study. The elderly group consisted of 26 subjects (16 males, 10 females) all over the age of 70 (mean = 75.6; range = 71–86 years). The subjects were all volunteers drawn from mixed urban (York and Newark, England) and rural (farming communities and villages in South Yorkshire and north Nottinghamshire, England) areas which are similar to those used in the Morrison *et al.* (1997) study. All the elderly subjects were living independently in the community and most were active members of at least one local club (which is how they were first contacted). The volunteers were screened for depression using the Geriatric Mood Scale (GMS; Yesavage, Brink, Rose, Lum, Huang, Adey, & Leirer, 1983) and were excluded if they scored above the mild depression range. Verbal IQ scores were obtained using the WAIS-R (mean = 107; range = 92–128). Raven's Coloured Matrices (mean = 28.3; range = 14–35; Raven, Court, & Raven, 1995) and the National Adult Reading Test (NART: mean error score = 15.04; range = 3–34; Nelson, 1982) were also administered.

The young adult group consisted of 10 subjects (5 males, 5 females) with a mean age of 27.5 years (range = 22–33). This group was also given the WAIS-R verbal tests (VIQ mean = 104; range = 94–119). The two groups did not differ significantly on VIQ scores ($t(23.71) = .78$, $p = .44$). The younger group was given the Standard Progressive Matrices (mean = 49.1; range = 31–57; Raven, Court, & Raven, 1988). Different versions of the Progressive Matrices were used for the two groups because there are no norms available for the Standard Progressive Matrices for older subjects while the Coloured Matrices are too easy for young subjects. Conversion tables are, however, provided for the two tests: on the converted scores the older group performed significantly less well than the young adult group ($t(34) = -4.3$, $p < .01$).

Procedure

The elderly subjects were seen on two occasions. On the first day the verbal subtests of the WAIS-R and the NART were administered. The second testing session, which usually took place 1 week later, consisted of Raven's Coloured Matrices, followed by naming the 230 drawings and finally the Geriatric Mood Scale. The younger subjects completed all the testing in 1 day, apart from one subject who finished in 2 days.

For the object naming, the 230 pictures were divided into four notebooks which were randomly ordered for each subject. The order of the pictures within each notebook was also changed approximately once every five subjects. There was only one item to be named per page. Subjects were instructed to say the first name that came to mind and to try to give a one-word response to each item. They turned the pages themselves and went through each book at their own pace. As they named an item, the subject's response was recorded on an answer sheet. Subjects were placed under no time pressure, but if a subject was unable to name an item within 15 s, the target word was provided by the experimenter and the next

TABLE 1
Mean Number and Percentage of Correct Responses within Different Time Intervals for the Young Adult and Elderly Groups

Group	Time: 0–5 s	5–10 s	10–15 s	Total correct by 15 s
Elderly				
Mean	184.38	2.73	0.50	187.6
%	98.28	1.46	0.26	
Young adults				
Mean	197.10	0.30	0.00	197.4
%	99.85	0.15	0.00	

item was attempted. All responses were recorded on the response sheets along with a note as to whether the item was named within 5, 10, or 15 s. The time taken to complete all four books varied from 15 to 30 min for the elderly subjects and 10 to 20 min for the younger subjects. Subjects who needed glasses were required to wear them during the naming task.

RESULTS

Twenty-four pictures were eliminated from the analysis. Nine were removed because of doubts about the appropriateness of their age of acquisition values for the elderly population. These were items which fell into the Poon and Fozard (1978) category of ‘‘unique contemporary exemplars’’ (e.g., a microwave oven). Thirteen pictures were excluded because some of the elderly subjects provided alternative, yet correct, names for the items (e.g., revolver for gun, hatchet for axe). It was thought that these may be items whose dominant names have changed down the generations. Two further pictures were removed due to subjects having difficulty recognizing what they were depicting. There were therefore 206 pictures included in the final analyses.

Naming accuracy in the elderly and young groups. The mean number of items named correctly out of a maximum of 206 was 187.6 (91.1%) for the elderly group (range = 178–201) and 197.4 (96.0%) for the younger group (range = 191–204). This difference was significant ($t(34) = -4.00$, $p < .001$), confirming the existence of naming problems in the elderly group.

Latency of responding. As mentioned earlier, subjects were allowed 15 s to name each item, but a note was made of whether the response was made within 5, 10, or 15 s. Table 1 shows the mean number of correct responses made within each time period. A repeated measures ANOVA was performed on the number of correct responses at each response deadline. There were significant effects of age ($F(1, 34) = 16.0$, $p < .001$) and time ($F(2, 68) =$

13765.6, $p < .001$) and a significant age by time interaction ($F(2, 68) = 17.6$, $p < .001$). *T* tests indicated that the younger adults made significantly more correct responses in the 0- to 5-s time period ($t(34) = -4.286$, $p < .001$) and significantly fewer correct responses in the 5- to 10-s time period ($t(34) = 2.491$, $p < .05$). Thus, the elderly group named fewer items correctly and tended to take longer to produce the correct responses that were made.

Regression analysis of elderly data. Each pictured object was given two scores depending upon the number of elderly subjects who named it correctly by 5 s (range = 5–26) or 15 s (range = 8–26). The correlations of the 7 predictor variables (visual complexity, object familiarity, imageability, name agreement, age of acquisition, word frequency, and word length) with each other and with naming accuracy at 5 and 15 s are shown in Table 2.[2] We note that all of the predictor variables showed significant correlations with naming accuracy in the elderly group. This does not mean, however, that all of the variables genuinely influence naming accuracy: when the predictors are themselves intercorrelated, as they are here, significant raw correlations of some factors with naming accuracy may simply be reflections of their correlations with other factors which have a real influence on naming.

In order to distinguish which variables make a genuine contribution to predicting naming accuracy in the elderly a multiple regression analysis was carried out using the scores for each item at 5 and 15 s as the dependent measures. The results are shown in Table 3. The combinations of predictor variables showed a significant ability to predict naming success and failure at both response deadlines (5 s, multiple $R = .586$, $F = 14.8$, $p < .001$; 15 s, multiple $R = .552$, $F = 12.4$, $p < .001$).

For correct names produced within 5 s, age of acquisition had the highest raw correlation with naming accuracy and emerged from the regression analysis as a highly significant independent predictor (pictures with late-acquired names being less likely to be named within 5 s). There were also significant independent contributions of name agreement (items with lower name agreement being named less accurately) and word length (longer items being named less accurately).

The results were similar for items named within 15 s. Again, age of acquisition had the highest raw correlation with naming accuracy and was a highly significant independent predictor in the regression analysis. The independent contribution of name agreement was also significant, but word length did not make a significant independent contribution to predicting naming accuracy at this longer time interval ($t = -1.08$, $p = .281$). The number of elderly sub-

[2] Analyses of items named correctly by 10 s produced the same results a for 15 s, so we will focus on the results for the 5- and 15-s response deadlines.

TABLE 2
Correlation Matrix for Naming Accuracy (by 5 and 15 s) in the Elderly Group and the Seven Predictor Variables

	1a,b	2	3	4	5	6	7	8
1a. Naming accuracy at 5 s	1	−.151*	.306**	.130*	.292**	−.538**	.318**	−.293**
1b. Naming accuracy at 15 s	1	−.131*	.281**	.118*	.287**	−.511**	.301**	−.237**
2. Visual complexity		1	−.247**	−.127*	.073	.168*	−.157*	.045
3. Object familiarity			1	.121*	.090	−.498**	.651**	−.396**
4. Imageability				1	.119*	−.391**	.163*	−.006
5. Name agreement					1	−.292**	.128*	−.064
6. Age of acquisition						1	−.456**	.291**
7. Word frequency							1	−.482**
8. Word length								1

* $p < .05$.
** $p < .001$.

TABLE 3
Results of the Regression Analysis on the Elderly Naming Data

	Correct by 5 s				Correct by 15 s			
Variable	B	SE B	β	*t*	B	SE B	β	*t*
Visual complexity	−.405	.269	−.091	−1.51	−.298	.248	−.075	−1.20
Object familiarity	−.139	.360	−.032	−0.39	−.159	.332	−.040	−0.48
Imageability	−.798	.589	−.086	−1.36	−.793	.543	−.096	−1.46
Name agreement	.165	.062	.162	2.66*	.147	.057	.161	2.57*
Age of acquisition	.057	.009	−.467	−6.14**	−.049	.009	−.456	−5.83**
Word frequency	.238	.527	.038	0.47	.384	.486	.066	0.79
Word length	−.342	.168	−.137	−2.04*	−.167	.155	−.074	−1.08

* $p < .05$.
** $p < .001$.

jects naming each of the 206 items included in the analysis by the 15-s deadline is shown in the Appendix.[3]

Word length exerted a significant effect on naming accuracy at 5 s but not at 15 s. A post hoc analysis examined the characteristics of the object names which the elderly subjects tended to recall between 5 and 15 s. There were 52 names that were produced between 5 and 15 s by at least one elderly subject. Thirty-five (67.3%) of these were two or more syllables in length. That compares with 63 of the 154 words never produced between 5 and 15 s (40.9%). Thus, longer object names were overrepresented in the sample of names which elderly subjects recalled between 5 and 15 s. Inspection of their age of acquisition values showed that they did not differ significantly from those of longer words recalled within 5 s: it was their length that seemed to hinder rapid retrieval (but not eventual retrieval given more time). In contrast, the 17 one-syllable names that were produced between 5 and 15 s by at least one elderly subject *were* significantly biassed toward later ages of acquisition than one-syllable words that were never produced later ($t(123) = -2.59$, $p = .01$).

Error classification. An analysis of the errors made by the elderly group was carried out using the first naming response made by the elderly participants. Following Mitchum, Ritgert, Sandson, and Berndt (1990), all incorrect responses were divided into seven main categories: (1) visual errors in which the picture resembled the object named in error but there was no semantic relationship between the two; (2) phonological errors—real word and nonword errors in which the response had at least 50% of its phonemes in com-

[3] The same analyses were repeated using adult ratings of age of acquisition taken from Morrison *et al.* (1997). The outcome was the same as that obtained with the objective age of acquisition norms except for the fact that there was no independent effect of length at the shortest time interval. Age of acquisition and name agreement remained the only two variables that exerted independent effects on naming accuracy at both time intervals.

TABLE 4
Classification of Errors Made by the Elderly Group

Error type	Example target → response	% of Total errors
Visual	Mountain → ''Tree root''	9.62
Phonological	Butterfly → ''Flutterby''	2.51
Neologisms	Sandwich → Sango	0.21
Unrelated Word	Plug → Camera box	0.84
No response/Don't know		5.44
Circumlocution/Definition	Stethoscope → Doctors use to listen to your heart	9.00
Semantic		72.38
		% of Semantic
Coordinate/Associate	Horse → Pony	80.35
Super-/Subordinate	Beetle → Insect	13.01
Semantic rejection	Fox → Not a wolf	4.62
Incorrect rejection	Sea horse → Not a sea horse	2.02

mon with the target; (3) neologisms—nonword errors that had less that 50% of phonemes in common with the target; (4) unrelated words that had no apparent visual, phonological, or semantic relationship to the target; (5) no response or ''don't know'' errors; (6) circumlocutions or definitions; and (7) semantic errors in which the target and the error were related in meaning (either categorically or associatively).

The proportions of each error type are shown in Table 4 along with examples of each. Just over 70% of the errors made by the elderly subjects were semantic in nature. The next most common error types were visual errors, followed closely by circumlocutions/definitions. Phonological errors, neologisms, and unrelated word errors were rare.

Semantic errors were subdivided into coordinate or associate errors (40% of which were also considered to be visually similar to the target), superordinate or subordinate errors, semantic rejections (errors where a word semantically related to the target was rejected by the subject), and incorrect rejections (correct responses falsely rejected by the subject). The majority of semantic errors were associate/coordinate errors. Table 4 is based on the first response to each item, but we note that some of these errors (19.7%) were spontaneously corrected by the elderly subjects. The majority of the errors that were spontaneously corrected were semantic. Often the individual would produce a word and then quickly say ''No, can I change that?'' or would produce the target immediately after their incorrect response without stating they were incorrect first.

DISCUSSION

The elderly group named fewer pictures correctly than did the young adult group and were slower to produce the names they were able to retrieve. This confirms the existence of significant naming problems in normal people over the age of 70.

Age of acquisition and name agreement emerged from the regression analyses as independent predictors of name accuracy in the elderly group for both the 5- and 15-s response deadlines, with the older people being better able to retrieve early- than late-acquired object names, and better able to retrieve the names of objects which have only one plausible name than objects that have more than one possible name. Word length exerted an independent effect of naming accuracy at the 5-s deadline, when naming accuracy was better for items with short than long names, but that effect had disappeared by the 15-s deadline. We note that Le Dorze and Durocher (1992) used a 5-s time limit when collecting their naming data, but we also note that differences in word length were almost certainly confounded in that study with differences in other factors which correlate with length, such as age of acquisition.

Several other predictor variables showed significant raw correlations with naming accuracy in the older group, but such raw correlations can be misleading when the predictors are themselves intercorrelated, as they are here. Thus, although frequency correlated significantly with naming accuracy in the elderly group, it did not come close to making a significant independent contribution to predicting naming accuracy in either of the multiple regression analyses. The lack of an independent effect of word frequency on naming accuracy fails to support the Burke and Laver (1990) conjecture that words used less frequently in adulthood will be more susceptible to the effects of aging than words used more often. There was also no independent effect of object familiarity on naming accuracy for a set which excluded items from Poon and Fozard's (1978) categories of 'unique dated exemplars' or 'unique contemporary exemplars'.

Neither age of acquisition nor name agreement affected naming accuracy in the young adult group whose performance was close to ceiling. Age of acquisition and name agreement are, however, factors which consistently emerge as significant predictors of the *speed* with which young adults can name pictures of objects (Barry *et al.*, 1997; Carroll & White, 1973; Ellis & Morrison, 1998; Gilhooly & Gilhooly, 1979; Lachman *et al.*, 1974; Mitchell, 1989; Morrison *et al.*, 1992; Paivio *et al.*, 1989; Vitkovitch & Tyrrell, 1995). Hence it appears that the properties of names which cause young adults to produce them more slowly are the same properties which make those names difficult for elderly people to retrieve at all. We would suggest that naming latency and naming accuracy might be thought of as operating on a continuum for older adults. Older people often report remembering an elusive word several hours or even days after a failed attempt at word finding. Should a name remembered a day later be classed as a ''no response'' error or as a correct response made with a reaction time of 24 h? From this perspective, many apparent failures in name retrieval can be seen as responses whose reaction times exceed any reasonable experimental limits.

Theoretical accounts of effects of age of acquisition and name agreement tend to ''locate'' the influence of both those variables in the process of name retrieval (Barry *et al.,* 1997; Brown & Watson, 1987; Ellis & Morrison, 1998; Gilhooly & Watson, 1981; Vitkovitch & Tyrrell, 1995). We will discuss such accounts below, but would note at this point that assigning age of acquisition and name agreement effects to the process of lexical retrieval does not mean that the effects of aging are confined to that stage. Maylor (1997) cites evidence from a number of different sources in support of the assertion that the efficiency of *all* stages of object recognition and naming declines with age. We note that almost 10% of the errors made by the elderly group in the present study were visual errors in which they misidentified a picture as representing a different object. The young adult group did not make errors of that nature to the same items. Visual errors suggest problems in the processes whereby perceptual descriptions of visual stimuli are created or access the stored representations of familiar objects. Many of the errors classified as semantic involved confusions between objects that are pictorially as well as conceptually similar, so it may be that the rate of (nonsemantic) visual errors underestimated the degree of perceptual difficulty experienced by older people.

Semantic errors accounted for a high proportion of the elderly naming errors, an observation which is in line with previous reports by Albert *et al.* (1988), Au *et al.* (1995), and Maylor (1995) among others. Some of the semantic errors may be due to perceptual problems, others central, semantic problems, while others again may be a reflection of word retrieval problems. Caramazza and Hillis (1990) have shown that semantic errors can arise as a result of impairments at the semantic level or at word retrieval, which means that they are relatively unhelpful guides to the locus of an impairment. However, if semantic errors can arise because of perceptual, semantic, or word-finding problems, and if problems of all three types occur in older people, that may explain why semantic errors are the dominant form of error in elderly subjects whose cognitive efficiency is declining at all stages of processing.

Naming an object requires the successful operation of perceptual, semantic, and phonological processes (Ellis & Young, 1988; Riddoch & Humphreys, 1987), and a failure of any of those processes will result in inability to retrieve and produce the required name. This dependence of naming on several different cognitive systems may explain why naming problems are such a salient and noticeable accompaniment of aging (Cohen & Faulkner, 1986; Reason & Lucas, 1984). Burke and Laver (1990) suggested that part of the reduced efficiency of the elderly cognitive system may be due to diminished flow of activation between different representational domains. We would suggest that effects of both name agreement and age of acquisition on elderly naming accuracy may reflect in particular a reduction in the amounts of activation reaching the speech output lexicon from semantic representations. Thus, if an object has more than one plausible name (i.e., low name agreement), then activation reaching the lexicon from semantics may be divided between those alternatives, meaning that more is required to access any one of them (Vitkovitch & Tyrrell, 1995). A reduction in the amounts of activation reaching the lexicon from semantics could therefore differentially impair retrieval of the names of object with multiple names. Brown and Watson (1987) suggested that the phonological representations of late-acquired words may be more fragmented than the representations of early-acquired words (see also Barry *et al.*, 1997, and Ellis & Morrison, 1998). If this is the case, then more activation may be required to access the representation of late than early acquired words. A general reduction in flow of activation in the elderly would hinder the retrieval of late acquired names more than early acquired ones. Finally, in a ''distributed memory'' model of word retrieval, a long name will be a phonological pattern that involves more elements than a short name. Complex word forms may require more activation than simpler ones, so reduced input from semantics may again affect the retrieval of long names more than short ones. This particular effect is, however, only short-lived: the elderly subjects in the present study experienced difficulty with longer names at the 5-s deadline but by the 15-s dealine those difficulties had been overcome (presumably because more activation has reached the phonological representations by then).

The explanations offered for why naming accuracy in the elderly may be affected by age of acquisition, name agreement, and length all propose that the words which elderly subjects fail to retrieve nevertheless remain within their mental lexicons. That is, the problem is one of access rather than storage. This proposal is supported at an anecdotal level by the frequent reports of elderly people that elusive names will occur to them several hours or even days later, and by the fact that when words are provided for elderly people in vocabulary tests they can be as good as younger people at saying what those words mean (Rabbitt, 1993).

In summary, we have confirmed that elderly people have a significant object naming deficit compared to younger individuals. Elderly subjects named fewer items correctly than younger subjects and were prone to both visual and semantic errors. The probability of successful name retrieval in the elderly was influenced by age of acquisition and name agreement at all response deadlines and by word length at the shortest deadline (5 s). We suggest that all of these effects may be explained as being due to a general reduction in flow of activation between pictorial, semantic, and phonological representations in the elderly brain.

APPENDIX

Alphabetical Listing of the Items Used in the Study, Showing the Number of Elderly Subjects ($n = 26$) Who Named Each Item Correctly by the 15-s Response Deadline

Item	Total	Item	Total	Item	Total	Item	Total
anchor	26	crab	26	ladder	26	skunk	10
apple	25	crown	26	ladybird	20	slide	25
arm	24	cup	26	lamp	26	snail	25
armadillo	19	cymbals	21	leaf	26	snake	26
arrow	25	dentist	21	leg	22	snowman	25
ashtray	26	desk	24	lemon	26	sock	26
ball	26	doctor	25	lion	25	soldier	26
balloon	24	dog	24	lobster	18	spanner	25
banana	26	donkey	19	medal	25	spider	23
barrel	24	door	26	mermaid	26	spoon	25
basket	26	dragon	24	microscope	17	squirrel	26
bath	26	dress	25	moon	26	star	26
bed	26	drum	26	mountain	23	stethoscope	23
beetle	18	ear	26	nail	26	stool	26
bell	26	elephant	24	nose	24	strawberry	26
bellows	23	envelope	22	nun	22	submarine	23
belt	25	eye	25	nurse	26	sun	26
biscuit	19	fairy	20	onion	26	swan	26
blouse	15	fence	22	orange	23	swing	25
book	25	finger	25	owl	26	sword	22
boot	25	fish	25	pan	26	table	24
bottle	26	flag	25	peacock	23	telescope	22
bowl	19	flower	24	pear	26	tent	26
box	26	flute	14	pen	26	thimble	19
boy	20	fly	20	pencil	26	thumb	26
bread	22	foot	23	penguin	26	tie	26
bullet	19	fork	26	pepper	13	tiger	25
butterfly	25	fox	23	piano	26	tomato	20
button	20	frog	25	pig	25	tortoise	25
cactus	26	genie	22	pipe	26	towel	26
cake	23	giraffe	24	plug	25	tractor	25
camel	24	glove	25	pond	24	tree	26
candle	26	goat	26	porter	16	trumpet	21
cannon	19	grapes	25	pumpkin	16	typewriter	23
cap	26	guitar	15	purse	22	umbrella	26
carrot	26	hammer	26	queen	24	van	24
castle	23	hand	26	rabbit	26	vase	26
cat	26	harp	26	raccoon	9	violin	22
caterpillar	20	heart	26	ring	26	volcano	11
celery	24	horse	26	sandwich	24	waistcoat	26
chain	26	house	26	saw	26	watch	25
chair	26	iron	26	scarecrow	22	well	26
cheese	25	jelly	21	scissors	25	whale	17
cherry	17	jigsaw	25	screw	25	whistle	26
church	26	judge	17	screwdriver	26	windmill	26
cigar	24	jug	26	seahorse	16	window	25
clock	26	kangaroo	26	shawl	21	witch	25
clown	26	kettle	26	sheep	25	wizard	8
coat	23	key	26	shell	25	yo-yo	24
comb	26	king	26	shirt	21	zebra	25
cow	26	kite	26	shoe	26		
cowboy	22	knife	26	skirt	25		

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