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Factors Influencing Word Naming in Younger and Older Adults

Daniel H. Spieler
Stanford University

David A. Balota
Washington University

The present study examined age differences in the influence of 3 factors that previous research has shown to influence word-naming performance. The influence of word frequency, orthographic length, and orthographic neighborhood measures was examined using large-scale regression analyses on the naming latencies for 2,820 words. Thirty-one younger adults and 29 older adults named all of these words, and age differences in the influence of these factors were examined. The results revealed that all 3 factors predicted reliable amounts of variance in word-naming latencies for both groups. However, older adults showed a larger influence of word frequency and reduced influences of orthographic length and orthographic neighborhood density compared with younger adults. Overall, these results suggest that lexical level factors increase in influence in older adults whereas sublexical factors decrease in influence.

Although the change of linguistic knowledge and skills early in the life span is well documented, the change in language processes later in life has not been a central focus in developmental psycholinguistics. Of course, the change in language processing from middle to late adulthood occurs at a much slower rate and appears to be considerably less profound than that found in children. Nonetheless, the continued use of the language and the gradual accrual of additional linguistic knowledge may exert an influence on the system that results in subtle changes in language processing. Moreover, if such changes do occur, then these changes will have theoretical import for how one conceptualizes language processing and what one expects models of language processing to account for.

In the present article, we examine data that bear on the question of age-related changes in word processing. The task we examine is simple speeded word naming. This task is well suited to addressing the question of age-related changes because several recent studies have taken the approach of examining the relative influence of specific factors on word-naming performance in younger adults. The specific questions are narrowly focused on three targeted factors that influence word-naming performance, although age-related changes in word processing have import for both one's understanding of age-related changes in language processing and for extant models of visual word recognition. We first turn to a brief discussion of the specific factors that we examine in this article and then discuss possible mechanisms for age-related change or stability in the influence of these factors.

Daniel H. Spieler, Department of Psychology, Stanford University; David A. Balota, Department of Psychology, Washington University.

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Correspondence concerning this article should be addressed to Daniel H. Spieler, Department of Psychology, Jordan Hall, Building 420, Stanford University, Stanford, California 94305–2130. Electronic mail may be sent to spieler@psych.stanford.edu.

Factors Influencing Word Naming

In simple word-naming tasks such as the one used in the present article, individuals are visually presented with single isolated words on a computer screen and are asked to simply name each word aloud as quickly and as accurately as possible. As one would expect, adult English language speakers are generally over 95% accurate even for fairly low frequency words. Thus, the primary dependent measure is the time that elapses from the onset of the word to the onset of the participant's naming response. The interest is in how characteristics of the words influence the speed of naming the word aloud. In studies of this kind, a number of factors have been identified that influence the speed of the naming response.

For quite some time, researchers (e.g., Huey, 1908/1968) have known that the frequency at which a word occurs in the language exerts a powerful influence on naming latency. The more frequently a word occurs, the faster individuals are to name the word. Frequency of occurrence appears to influence several stages in the process of translating the visual features of a word into the phonological output needed for the naming response. Although a large portion of the frequency effects probably arise from the computation of phonology, it is also likely that there is some influence of frequency in accessing semantic information and in the initiation and execution of the articulatory program necessary to output the verbal response (Balota & Abrams, 1995; Balota & Chumbley, 1985). Thus, in most models of visual word recognition, word frequency plays a prominent role.

Far less prominently featured in most word recognition models but still exerting a strong influence on naming performance is simple orthographic length (e.g., Spieler & Balota, 1997; Weekes, 1997). Indeed, in younger adults, length appears to account for a similar amount of variance in naming performance as in word frequency (Spieler & Balota, 1997). The increased naming latency for longer words than for shorter words is likely to arise at several processing stages. For example, pattern recognition processes are likely to be more difficult for words with more letters, and the computation and programming of articulatory commands may also be more difficult for words that contain more phonemes.

The third and final factor that we examine in the present article is the similarity of the target word to other words in the language. *Lexical neighborhoods* are groupings of words that have a high degree of overlap in spelling patterns (e.g., *mint*, *tint*, *mine*, *tent*, etc.). One measure of neighborhood density is Coltheart's *N* (Coltheart, Davelaar, Jonasson, & Besner, 1977), which is defined as the number of words of the same length as the target word that can be formed by changing one letter in the target word. Thus, *lint* has neighbors of *mint*, *tint*, *line*, *lent*, and so on. Generally, naming time is shorter for words from dense neighborhoods than for words from sparse neighborhoods (Andrews, 1989, 1992). We should note, however, that the picture appears to be somewhat more complicated than this straightforward result. Several studies show that aspects of neighborhoods—apart from just density—may influence performance (Carreiras, Perea, & Grainger, 1997; Peereman & Content, 1997; see Andrews, 1997, for a review). However, neighborhood measures such as Coltheart's *N* provide a rough measure of similarity that does appear to map onto the speed with which a word is processed.

The question addressed in the present study is whether the factors that have been identified as influencing word-naming performance exhibit stability across the life span or whether the influence of these factors changes over the life span. At present, there is reason to expect either stability or, at least, two different patterns of change as individuals age. In what follows, we briefly discuss each of these possibilities.

Age-Related Changes in Naming Performance

First, there is reason to expect stability over the life span. Certainly, by the time an individual reaches 20 years of age, the most dramatic changes in processing arising from language acquisition are long over. Until age-related neurological disorders start to affect a subset of individuals beginning in their late 50s, changes in language processing that might occur would seem to be trivial in comparison with those that occurred in the early stages of language acquisition. Moreover, there are persuasive arguments that age-related changes in processing represent a global quantitative change, such as generalized slowing of information processing (Cerella, 1985; Myerson, Hale, Wagstaff, Poon, & Smith, 1990), rather than a qualitative change in processing. From this perspective, there is no a priori reason to expect that a change in information-processing rate should result in a change in the influence of factors such as word frequency, length, or neighborhood density on word-naming performance.

On the other hand, it is conceivable that there continue to be subtle changes in word processing across the life span that arise from continued exposure to old words and slow acquisition of new words. Any increase in the number of items in the lexicon is likely to be accompanied by an increase in the variety and richness of semantic representations associated with these additional words. Moreover, the additional reading experience that is likely to accrue over time may also influence the representation of lexical knowledge. These comparatively subtle changes may exert an influence on word processing, discernible as a change in the influence of particular factors on word-reading performance across the life span. Studies (e.g., Samuels, LaBerge, & Bremer, 1978) of reading acquisition in children have suggested that there is a process of unitization in which words gradually become compiled into more unitary representations rather than as assemblages of sublexical parts such as letters and letter clusters. This process of unitization is similar to what happens in many other skills in which previously separate representations (or actions) become compiled into single complex representations (Goldstone, 1998; Hayes-Roth, 1977; Stanovich, Purcell, & West, 1979). If the process of unitization continues through adulthood, then the prediction is that the influence of sublexical factors should decrease and the influence of lexical level factors should increase. For example, orthographic length is a sublexical factor because it specifies the number of letter units in the word. Orthographic neighborhood density is also sublexical because it depends on letter level overlap between words. In contrast, word frequency is a lexical factor because it specifies the frequency of occurrence of the whole word unit, without reference to its constituents. In terms of these variables, unitization of lexical representations suggests that the predictive power of frequency should increase whereas the predictive power of length and neighborhood density should decrease. Consistent with this prediction, there is some evidence for larger frequency effects in older adults compared with younger adults (Balota & Ferraro, 1993, 1996).

Alternatively, the computational constraints placed on a system that is gradually acquiring more lexical representations could push the influence of factors in the opposite direction. Increasing reading experience and lexical knowledge is likely to increase the number of contexts in which particular spelling patterns (e.g., bigrams, word bodies, etc.) occur. Increasing the number of contexts in which particular spelling patterns occur may decrease the importance of individual word contexts. In this case, it may be more efficient to abstract a relatively small amount of sublexical information and apply it to as many words as possible rather than to acquire and represent words with more unitary representations. In this case, the process of expanding one's lexical knowledge results in increasing reliance on sublexical factors and less reliance on lexical factors. This perspective predicts that the predictive power of sublexical factors such as length and neighborhood size should increase with age whereas lexical factors such as whole word frequency should decrease.

It is important to be clear about the labeling of factors such as lexical and sublexical. In the present context, we mean nothing more complicated then whether the measure is derived by treating words as units (e.g., frequency) or as groups of smaller units (e.g., length and letter level similarity). Thus, neighborhood density is termed as sublexical because the measure defines similarity between words in terms of letter level overlap.

There are several important differences in how these questions are addressed in the present experiment compared with previous experiments. For example, studies examining the influence of word frequency on word recognition performance typically dichotomize frequency by selecting a set of high frequency words and comparing average performance for these words with average performance for the low frequency words. Similarly, studies examining the joint effects of neighborhood density and word frequency require the selection of four sets of words that represent the crossing of word frequency and neighborhood density. On a practical level, this approach becomes increasingly difficult as additional factors are either manipulated or controlled for because the pool of acceptable stimuli decreases considerably. Indeed, in most such studies, the number of stimuli is quite small, reducing the ability to generalize to the entire lexicon. This factorial approach also ignores that the factors most frequently examined in these studies are on a continuous scale that is only loosely approximated by the dichotomized factors. The present study is notable in that we examine the influence of these factors in the context of a large-scale regression analysis that preserves the continuous scale of these factors. In this study, rather than identifying a small set of stimuli, we collected and analyzed naming latencies for nearly all of the single-syllable words in the English language—2,820 words in total. Using regression analyses, we examined the predictive power of three factors in naming performance: word frequency, orthographic length, and orthographic neighborhood density. The specific question we address is whether the predictive power of these three factors is different in younger and older adults.

Method

Participants

Thirty-one younger adults were recruited from the undergraduate student population at Washington University. Twenty-nine older adults were recruited from the Aging and Development Subject Pool in the Department of Psychology at Washington University. All individuals were paid $20 for their participation. The young participants had a mean age of 22.6 years (SD = 5.0) and14.8 years of education (SD = 2.0) and scored 35.1 (SD = 2.7) on the Shipley vocabulary subtest (Shipley, 1940). The older adults had a mean age of 73.4 years (SD = 3.0), 15.7 (SD = 2.8) years of education, and an average score of 37.1 (SD = 3.0) on the Shipley vocabulary subtest. The differences in vocabulary scores and years of education for younger and older adults were not significant ($ts < 1$).

Apparatus

An IBM-compatible Compudyne 486 computer was used to control the display of stimuli and to collect response latencies. The stimuli were displayed on an NEC (Sacramento, CA) 4G 14-in. color VGA monitor in 40-column mode in white on a blue background. The naming latency for each word was measured using a Gerbrands Model G1341T voice-operated relay interfaced with the computer. All measurements were accurate to within 1 ms. Presentation was synchronized to the vertical retrace of the monitor, and response time was measured from the onset of the stimulus until the onset of the participant's response.

Materials

The words consisted of 2,870 single-syllable words appearing in the training corpora of the models presented by Plaut, McClelland, Seidenberg, and Patterson (1996) and Seidenberg and McClelland (1989). These words ranged in frequency from 68,246 to 0 counts per million according to Francis and Kucera (1982). The words ranged from two to seven letters in length. In analyses reported by Spieler and Balota (1997), data from 50 words were not analyzed. These words included heterophonic homographs and words that were represented in only one of the models' training sets. The same exclusions were retained in the present study to maintain consistency with the previous analysis of young adult data. This resulted in 2,820 items being included in all analyses.

Procedure

Each individual participated in two separate experimental sessions. In each session, participants named 1,435 words. Words were presented in a different random order for each participant. At the beginning of each of the two experimental sessions, individuals were seated in front of the computer and given the instructions for the experiment. Participants were told that they would be shown single words at the center of the computer screen and that their task was to name the words aloud as quickly and as accurately as possible. They were told to avoid making any extraneous noises that might trigger the voice key, and they were also told not to precede any of their responses with vocalized pauses such as "um" or "err." Participants were told that some of the words were very common whereas others were quite rare. Each trial consisted of the following sequence of events: (a) A fixation consisting of three plus signs (+ + +) appeared in the center of the computer screen for 400 ms, (b) the screen went blank for 200 ms, and (c) the word appeared at the position of the fixation and remained on the screen until 200 ms after the initial triggering of the voice key. After each naming response, participants pressed a button on a mouse to go on to the next word. If there was an error or if an extraneous sound triggered the voice key, participants were told to press the right button on the mouse. If everything appeared to have worked properly on that trial, participants were told to press the left button on the mouse. Pressing the mouse button initiated a 1,200-ms intertrial interval.

Participants were given breaks after every 150 trials. Two buffer trials consisting of filler words not appearing in the training corpora were inserted at the beginning of each block of trials. In addition, at the beginning of each session, participants were given 20 practice trials to familiarize them with the task. Each experimental session lasted for approximately 60 min.

Results

Response latencies for trials that participants marked as errors and response latencies faster than 200 ms and slower than 1,500 ms were excluded from all analyses. Also, items that fell more than 2.5 standard deviations beyond each participant's mean response latency were also dropped from these analyses. These criteria eliminated 4.80% of the observations in younger adults. An identical screening method was also applied for the older adults, resulting in the elimination of 4.90% of the naming responses in the older adults. Mean latencies were then computed for each item across participants, separately for each group.

The first question concerns the amount of variance accounted for in each age group by the three predictors of naming latency. Shown in Table 1 is the variance accounted for by each of the three

Table 1
Variance in Naming Latency Accounted for by Three Predictors When Entered as Sole Predictor for Young and Older Adults

Predictor	Variance	Beta weight	t	$p<$
Younger adults				
Length	.144	.379	21.76	.001
Log frequency	.080	−.284	15.70	.001
Coltheart's N	.139	−.373	21.31	.001
Older adults				
Length	.104	.322	18.06	.001
Log frequency	.147	−.384	22.08	.001
Coltheart's N	.090	−.301	16.74	.001

Table 2
Simultaneous Regression Analysis With All Three Predictors for Younger and Older Adults

Predictor	Beta weights	t	$p<$	Semipartial R^2
	Younger adults[a]			
Length	.241	10.81	.001	.0399
Log frequency	−.238	14.18	.001	.0666
Coltheart's N	−.177	7.90	.001	.0217
	Older adults[b]			
Length	.227	10.26	.001	.0213
Log frequency	−.351	21.09	.001	.0878
Coltheart's N	−.099	4.43	.001	.0032

[a] R^2 = .225, $F(3, 2816) = 272$, $p < .001$. [b] R^2 = .237, $F(3, 2816) = 292.28$, $p < .001$.

predictors when entered as sole predictors.[1] For both groups, all three predictors account for significant amounts of variance in naming latency. Shown in Table 2 are the results of simultaneous regression analyses for the naming latencies for younger and older adults. The variance accounted for by these three simple predictors is rather substantial given the number of other influences that have been identified in studies of visual word recognition. Indeed, the 22.50% of variance in younger-adult groups and the 23.40% of variance in older-adult groups are substantially better than recent connectionist models of word naming that account for 10% or less of naming-latency variance (Balota & Spieler, 1998; Spieler & Balota, 1997). The full correlation matrix is presented in Table 3.

One question raised in the introduction was whether the relative strength of these predictors would be similar in younger and older adults or whether there might be age-related changes in the importance of particular factors. Shown in Table 2 are the semipartial R^2s for each of these three predictors. In both groups, frequency (or, more accurately, log frequency) has the largest unique contribution, followed by orthographic length and, finally, Coltheart's N. However, it appears that the contribution of frequency is greater for the older adults than for the younger adults. Indeed, the pattern of results suggests that sublexical factors such as length and neighborhood density decrease in importance with age and that a whole-word measure increases in importance.

To better evaluate the notion that there is a difference in the predictive power of these three factors in younger and older adults, we performed simultaneous regression analyses on each participant's naming latencies. From these we obtained standardized regression coefficients for each predictor for each participant. We

Table 3
Correlation Matrix

Variable	1	2	3	4	5
1. Length	—	−.084	−.668	.379	.322
2. Log frequency		—	.144	−.284	−.384
3. Coltheart's N			—	−.373	−.301
4. Younger adult RT				—	.650
5. Older adult RT					—

Note. All ps < .01. RT = response time.

Table 4
Mean Standardized Regression Coefficients for Each Predictor, Averaged Across Participants for Each Group

Group	Length	Log frequency	Coltheart's N
Younger adults	.1009	−.0877	−.0661
Older adults	.0867	−.1239	−.0437

then submitted these regression coefficients to an analysis of variance (ANOVA) in which age and predictor were factors and the dependent measure was the standardized regression coefficient. Taking this approach, we could ask whether the age difference in the pattern of these three predictors is significant and is consistent across individuals (for a similar approach, see Balota & Chumbley, 1984; Lorch & Myers, 1990). For more extensive discussion and derivation of this method, the reader is directed to Lorch and Myers (1990). We used this method of analysis because it took advantage of two aspects of our data. First, it took advantage of the fact that the predictors that we were using were continuously valued compared with factors in most experimental designs. Second, because our question is whether the pattern of regression coefficients is different across groups, we tested for a difference in a way that preserves the within-group variability that is not preserved in the overall regression analyses. The regression coefficients were analyzed in a 2 (age) X 3 (predictor) mixed-factor ANOVA. The results revealed a reliable main effect of predictor, $F(2, 116) = 233.80$, $MSE = 0.0028$, $p < .001$. As in the regression analysis on naming latencies that averaged over participants, this analysis showed that length and frequency were particularly strong predictors whereas Coltheart's N was generally weaker. The present analysis also revealed a reliable Age × Predictor interaction, $F(2, 116) = 4.76$, $MSE = 0.0028$, $p < .01$. As can be seen in Table 2, for the overall analysis, and in Table 4, for averaged regression coefficients for the individual analyses, the results show that there is an increase in influence of word frequency and a decrease in influence for both word length and neighborhood density. Supporting this, younger adults showed larger coefficients for Coltheart's N, $F(1, 58) = 4.12$, $MSE = 0.0018$, $p < .05$, and smaller coefficients for frequency compared with older adults, $F(1, 58) = 17.70$, $MSE = 0.0011$, $p < .001$. Younger adults also showed numerically larger coefficients for length relative to older adults, although this difference was not significant ($F < 1$).

General Discussion

In the introduction, we suggested that there were three possible outcomes of a comparison of word-naming performance in younger and older adults. First, there was some reason to suggest stability of factors influencing word naming across the life span because the bulk of language learning is long completed by the

[1] The results for the younger adults are similar to those reported by Spieler and Balota (1997) except that the frequency values used in the present analyses were from the Francis and Kucera (1982) collapsing across token category, and Coltheart's N was calculated from this slightly larger sample. The correlations between these frequency and neighborhood values and the previous values are greater than .95.

time individuals reach the age of young adults. The remaining age-related changes in language processing would be relatively trivial and not likely to exert much influence on the gross types of measures that we used in the present study, or these factors might change at the same rate. Second, we suggested that the increased reading experience might increase the tendency to represent words as single units. This perspective would predict that there should be an increase in the predictive power of word frequency, a whole-word measure, and a decrease in the predictive power of sublexical factors such as orthographic length and neighborhood density. Third, there was reason to believe that the process of acquiring new words and continued experience with other words in the language might put some additional emphasis on sublexical processes. This might arise because increasing reading experience (and increasing vocabulary) might result in knowledge about sublexical units, such as letter patterns less bound to specific word contexts. This would predict an increase in the influence of sublexical factors on word naming across the life span. Our results were most consistent with the second view, that age differences reflect a shift from sublexical to lexical level representations.

Unitization

Words are stimuli that have multiple levels of internal structure, including letters, letter bigrams, syllables, and so forth. Early in the process of learning to read, individuals must devote considerable attention to individual letters and other sublexical characteristics. As reading skill increases, attention to these sublexical components is less necessary. Indeed, there is evidence that readers may have less conscious access to sublexical components as reading skill increases and as familiarity with particular words increases. The present results showed that the frequency was a stronger predictor of word-naming performance in older adults than in younger adults and that word frequency accounted for more unique variance in older adults than in younger adults. Moreover, the two sublexical factors—length and neighborhood density— decreased in predictive power in the older adults compared with the younger adults, albeit nonsignificantly for length. This seems to support the notion that older adults may have more unitized representations of words and that they may rely less on processing of the component features of the word (see also Allen & Madden, 1989; Allen, Madden, & Crozier, 1991).

The preceding discussion suggests that one might find a correlation between measured vocabulary and the relative strength of frequency versus length and neighborhood density as factors influencing word recognition. To examine this, we correlated the beta weights for each individual for each of the three predictors with the individual's Shipley vocabulary score. Contrary to this prediction, none of the correlations were significant, and all were quite low (all $rs < .15$). It is possible that the present vocabulary scores are not particularly sensitive measures of reading skill. Moreover, the present participants have a rather restricted range of vocabulary scores, making this a poor data set for testing this prediction.[2]

Although we favor the unitization account, this is not the only account for the present results. There is clear evidence that visual acuity decreases with age (see Kline, 1991, for a review). If older adults had lower levels of visual acuity than younger adults, then older adults might rely more on whole word shape and less on the resolution of sublexical units than might younger adults. Indeed, if local and global processing proceeds in parallel (e.g., Ans, Carbonnel, & Valdois, 1998), reduced acuity might simply slow processing of local features sufficiently to allow word level factors more opportunity to influence performance. Thus, although the words were presented clearly in a highly discriminable format, because we did not collect measures of visual acuity in the present study, it is not possible to distinguish between the visual acuity account and the unitization account.

Relation to Previous Studies

The finding that word frequency exerts a stronger influence on word recognition performance in older adults than in younger adults has been suggested by other researchers (Balota & Ferraro, 1993), although there are also reports of equivalent frequency effects in younger and older adults (Allen, Madden, Weber, & Groth, 1993). However, there are several important differences between these previous studies and the present results. In most of these preceding studies, the effect of word frequency was assessed by selecting a number of words at the low end of the frequency scale and a set of words at the high end, computing mean response time for these two classes of words, and comparing the size of the difference in younger and older adults. There are several interpretive limitations to this approach. Most obvious is the question of whether the increased frequency effect observed in older adults may be due to a general change in information processing such as generalized slowing (e.g., Cerella, 1985; Myerson, Hale, Wagstaff, Poon, & Smith, 1990) or if it may instead be due to more localized age differences in specific processes involved in word recognition. Although there are a variety of analytic strategies to help distinguish between these two possible accounts, it is exceedingly difficult to unambiguously attribute the larger frequency effects in older adults to specific word recognition processes. The present approach of sampling a large number of words and examining the variance components attributable to word frequency, length, and neighborhood density seems less susceptible to these interpretive problems. There is nothing in the generalized slowing hypothesis that would lead one to the a priori prediction of a change in the relative predictive power of these three factors. Indeed, the perspective of most generalized slowing theories that there is a simple quantitative change in information processing rate would seem to predict that the relative power of these predictors should be invariant across age groups.

Most previous studies of word recognition performance in younger and older adults have involved the lexical decision task. In this task, individuals are presented with letter strings, and they are asked to decide if the letter string forms a word (e.g., *food*) versus

[2] This analysis was repeated using vocabulary as a covariate. The results were qualitatively identical to the original results. There was a main effect of predictor, $F(2, 114) = 3.27$, $MSE = 0.0091$, but not age, $F(1, 114) = 2.48$, $p > .15$, and an interaction between age and predictor, $F(2, 114) = 4.04$, $MSE = 0.0122$. This result should not be surprising given the restricted range and overlap of vocabulary scores for the two groups and the lack of correlations between vocabulary and any of the present predictors. Although it is an empirical question, we would expect to find correlations between vocabulary and predictors in samples that had a greater range of vocabulary and reading skill than the present sample.

a nonword (e.g., *flirp*). Relating lexical decision performance to age-related changes in word recognition is not simple, because in addition to implicating word recognition processes, there is ample evidence that the lexical decision task also places considerable reliance on other decision-related processes (Balota & Chumbley, 1984; Balota & Spieler, 1999; Gordon, 1983; Seidenberg, Waters, Sanders, & Langer, 1984).

Implications for Models of Word Naming

The notion that the representation of lexical knowledge may change over the life span is relevant for current computational models. For current connectionist models of word naming, the model is trained on a particular training corpus. Once the model has attained near perfect levels of accuracy in naming words in the training corpus, the learning mechanism is turned off. Of course, this does not represent the claim that humans similarly cease all learning, but rather it reflects the fact that implemented models will not benefit from any further training. The critical idea here is what happens as the models approach asymptotic performance. Because the models learn the high frequency words fairly early, additional training is geared toward the acquisition of the low frequency words. The effect of the further training necessary for high levels of accuracy is to compress the difference between high and low frequency words. Furthermore, Plaut et al. (1996) presented several models that incorporated several modifications to the representation of orthographic and phonological information that allowed the models to more efficiently learn the mapping of orthography to phonology, and at least one of these models (Simulation 3) is even less sensitive to word frequency than the Seidenberg and McClelland (1989) model (Balota & Spieler, 1998; Spieler & Balota, 1997). The point is that continued learning in the models as well as modifications to the models to improve learning efficiency may be moving the models toward less sensitivity to word frequency. Interestingly, the present results suggest that the opposite may occur in the human data. Namely, as individuals become more experienced with words in the language, then influence of word frequency does not decrease but rather increases. If correct, such a result may point to a problem in current connectionist models. That is not to claim that this is in any way a fatal or insurmountable difficulty, but it is a problem nonetheless. It may be the case that a complete account of word naming needs to include some mechanism that allows for the gradual change in the nature of lexical representations that result from additional exposure to words.

The present results provide a unique picture of age-related changes in performance. The results show a decrease in the influence of sublexical factors and an increase in the influence of lexical factors in older adults relative to younger adults. Such an age-related change is consistent with a notion that continued reading experience may influence the nature of lexical representations and change the relative importance of particular factors in determining performance. In domains such as language processing, we suggest that these types of large-scale regression analyses may provide a picture of age differences in processing that is unavailable using traditional factorial experimental designs.

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