MEASURING VOCABULARY KNOWLEDGE : RELATIONSHIPS BETWEEN KNOWLEDGE, WORD FREQUENCY, AND RESPONSE TIME

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ABSTRACT

The assessment of vocabulary knowledge has posed a number of problems, particularly with regard to response bias. These problems have resulted in wildly differing estimates of children's vocabulary growth. Such estimates assume importance when school texts are controlled for vocabulary diversity, and in pedagogical debates concerning the need for vocabulary instruction. In this paper we outline the problems, and suggest a solution based on a simple response to sets of words and word-like nonsense items. We present pilot data relating vocabulary knowledge, word frequency, and decision response-time, focusing on methodological issues, and speculating about the question of total vocabulary size.

The rate of children's vocabulary growth over the school years is of some importance in a number of practical and theoretical areas. One such area is the development of school texts for which the increase in new words is often monitored according to grade level. Another is the issue of the optimal instructional approach which capitalizes upon supposed discontinuities in children's lexical and conceptual development (see Miller, 1978).

The empirical bases for decisions in both of these areas, however, are unclear. Anderson and Freebody (1981) have shown that researchers differ in their estimates of vocabulary growth by a factor of about ten at any given age level. Clearly some of these discrepancies can be accounted for in terms of differing conceptions both of what constitutes a word and of how many words there are in the entire English language. Some of the variability however is accounted for by differences in the method of assessing word knowledge. Essentially, three types of measures have been used: a) recognition measures, particularly and increasingly multiple-choice measures, word-to-word, and word-to-picture matching tests, b) constructed answer measures, in which the respondent is asked to define the word, provide a synonym, or use the word in a sentence, and c) "checking" or "yes/no" measures, in which the respondent merely checks the known words, or answers "yes" or "no" to known and unknown words respectively.

Each method has problems. It has been shown that the particular distractors chosen for recognition questions can have strong differential effects on performance (Lepley,1965). Further, younger and less test-wise respondents do not always examine all the distractors before making a choice (Brown, 1975).

Constructed answer methods suffer from more obvious problems of unreliable scoring. The degree of precision of a definition, the proximity of a synonym, and the level of knowledge indicated by the context of a sentence are all difficult discretionary issues in the assessment, particularly when the respondent is elaborating upon words which are particularly known - that is, with the most interesting and metrically critical set of words.

An obvious weakness of the "yes/no" method is that respondents may differ in the degree of knowledge of a word's meaning they need to feel before they are prepared to say "yes". The problem of accounting for differing response criteria can be seen as analogous to adjustments based on a "high threshold" model of correction for guessing (Anderson and Freebody, 1983), or on the Theory of Signal Detection, "TSD" (Pastore and Scheirer, 1974; Zimmerman, Shaughnessy, & Underwood, 1977). In the former model the respondent is assumed to require a high degree of confidence before responding; in the latter, the subjects' criterion levels are calculated on an individual basis and employed in the adjustment.

Recently, in assessing the domain validity of the "yes/no" test of vocabulary knowledge using the high-threshold model, Anderson and Freebody (1983) found that performance on the "yes/no" test predicted fifth-graders' word knowledge, as revealed in detailed follow-up interviews, significantly better than did performance on multiple-choice tests on the same words. This finding is particularly impressive when it is noted that the items were drawn from the vocabulary subscale of the Stanford Achievement Test (1973), a scale whose production would have been the result of very thorough psychometric development. This prompted Anderson and Freebody to conclude that

> when the word tested in a standardized multiple-choice item is difficult something about the item will tend to give away the correct answer, whereas when an easy word is tested the item will tend to lead the student away from the correct answer (p.14)

Given the apparent domain validity of the "yes/no" method, the next step is to relate performance to some linguistic parameter which will lead to improved estimates of total vocabulary knowledge. Carroll's development of the log-normal model of word distribution using adult and school-level written materials (Carroll, Davies & Richman, 1971), has offered a word frequency index which permits extrapolation to total vocabulary size at various levels. That is, based on the American Heritage Word Frequency Book (Carroll et al., 1971) henceforth called the *AH* corpus, a large survey of written materials for school children, the number of words in a corpus at various frequency levels can be specified. With sampling from milestone frequency bands, it should then be possible to estimate, after certain appropriate adjustments (the nature of which will be detailed below), an individual's total knowledge of words in the corpus and, by extrapolation, in the language as a whole.

We present here pilot data on this issue. Of particular interest are

a) the relationship between word frequency and adjusted probability of knowledge;
b) estimates of each individual's knowledge of the words in *AH* and in the total language contrasted with previous estimates of vocabulary growth;
c) the relationship between response time (to decide if the word's meaning is known or not), knowledge, and word frequency, and how this information may be used in the prediction of word knowledge;
d) the patterns of "yes/no" response and response time to various kinds of non-English letter strings.

Our pilot findings will be discussed under each of these four headings.

Procedures and Words

The items for the test were selected from 11 log-frequency milestones in the *AH* corpus. Sixty basic (i.e. non-derivative) words were chosen at spaces of 5 Standard Frequency Index (SFI) units (where SFI=10 [log (word's rate of appearance) + 10]). These were stored in 11 separate arrays on a microcomputer. For each respondent the computer randomly selected 20 words from each frequency array. In addition, three sorts of non-English letter strings were randomly inter-mixed: One set of "nonsense words", which we call "brutes" ($n = 48$), were constructed by varying one or two letters or vowels in an English word or by randomly combining pronounceable syllables (e.g. *blint*, *baratia*, *flane*); a second type of nonsense word was formed by unconventional yet grammatically plausible combinations of base words with affixes (e.g. *observement*, *assistness*, *grinful*). Because in all cases the affix could theoretically combine with the class form of the base, these we called "legal" nonsense words ($n = 36$). Finally a third group was created by the illegal coupling of bases and affixes. That is, where for instance an affix was a nominalizer (e.g. *ment*) it would be combined, illegally, with a noun (e.g. *successment*, *achievise*, *computify*). These were called "illegal" nonsense words ($n = 36$). In all, then, 120 nonsense items were mixed in with the 220 English words sampled from 11 frequency levels, resulting in a total test length of 340 items.

These were presented, one at a time, on the screen of the computer. Four response keys on the keyboard were available to the respondent. To the computer's question "Do you know the meaning of the word: ________ ?" the respondent

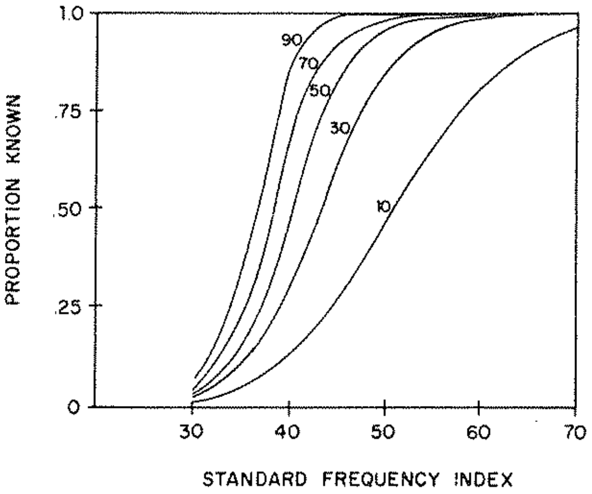

Figure 1. Hypothesized relationships of proportion of words known by word frequency and by ability percentile (Anderson & Freebody, 1983)

could strike the "yes" or "no" key. The computer then asked "Are you ready for the next word?" If the respondent answered "no", it was assumed an error was made and the computer then directed the respondent to either the "change my answer" key or the "let me look again" key. Subsequent response times were aggregated. After a number of practice items the respondents were instructed to proceed at their own rate, without rushing, and being sure to answer "yes" only if the word's meaning was known. Respondents were told that the list contained both a range of real English words, from easy to hard, as well as non-English word strings. The computer recorded item number, order in the list, response, and response time (accurate to one-sixtieth of a second).

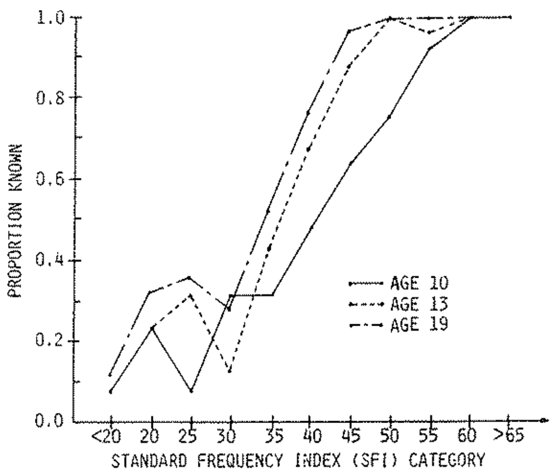

Figure 2. Raw proportions of words at 11 frequency bands to which each respondent said "yes".

Our pilot sample consisted of only three respondents - a 10 year-old grade 5 girl, a 13 year-old year 7 boy, and a 19 year-old female undergraduate teacher-in-training. Judging from parental background and academic attainments, it is reasonable to consider all 3 as "above average" in general language competence.

RESULTS: WORD FREQUENCY AND KNOWLEDGE

Anderson and Freebody (1981,1983) hypothesized that the relationship between the probability of knowledge of word meanings and frequency of word usage would be described by a family of normal ogive functions varying for individuals at different levels of word knowledge (as in Figure 1). This could be merely speculative, since substantial curve-smoothing techniques were used, and the bank of words was not sufficiently large at the low-frequency end of the scale to permit confidence in the fitted curve.

For the three respondents studied here the proportions of words known at each frequency band are presented in Figure 2. A preliminary TSD analysis was conducted for each respondent based on overall task performance. This yielded both d' and β indices describing the respondents' ability to discriminate words from non-words. All β values exceeded 1.0 (being 1.60, 1.67, and 1.98 for the 10,13, and 19 year-olds respectively). These values

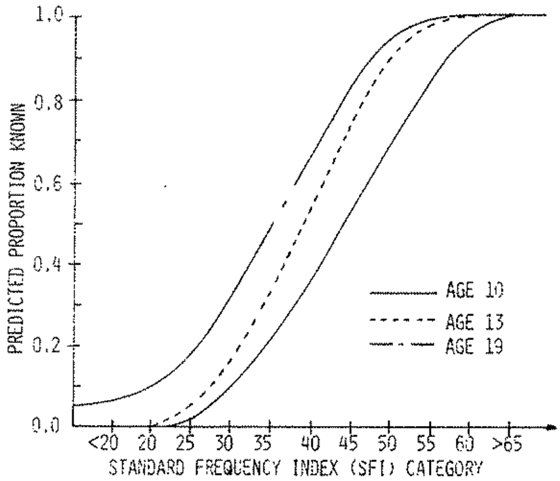

Figure 3. Predicted proportion known by the three respondents after adjusting for false alarm rates.

	AH Estimates			Age 10 Estimates			Age 13 Estimates			Age 19 Estimates		
SFI	no. entries	prop. basic words	no. basic words	prop. known	no. basic	no. total	prop. known	no. basic	no. total	prop. known	no. basic	no. total
65+	451	.70	316	1.00	316	451	1.00	316	451	1.00	316	451
60	867	.52	451	.96	433	832	1.00	451	867	1.00	451	867
55	1934	.40	774	.85	658	1644	1.00	774	1934	1.00	774	1934
50	3548	.30	1064	.70	745	2484	.92	979	3264	.97	1032	3442
45	5777	.22	1271	.54	686	3120	.75	953	4333	.84	1068	4853
40	8587	.15	1288	.37	477	3177	.55	708	4723	.68	876	5839
35	10895	.10	1090	.22	240	2397	.35	382	3813	.50	545	5448
30	11840	.07	829	.09	75	1066	.18	149	2131	.33	274	3907
25	12100	.05	605	.01	6	121	.05	30	605	.19	115	2299
20	28798	.05	1440	-	-	-	-	-	-	.09	130	2592
-15	1935	.05	97	-	-	-	-	-	-	.07	7	136
Tot	86732	-	9225	-	3636	15292	-	4742	22121	-	5588	31768

Table 1. Estimates of basic and total words in AH and known by the three respondents.

indicate that the instructions were effective in inducing a conservative response strategy. The d' values (.99, 1.27, and 1.63 for the 10, 13 and 19 year-olds) show increasing sensitivity to the real/non-word distinction with increasing age.

Since each respondent's false alarm rate was non-zero (.167, .150, and .108 for the 10, 13 and 19 year-olds), raw "yes" rates to real words ("hit" rates) were adjusted, using the high threshold formula. The best-fitting regression curves were then computed for each respondent. These are displayed in Figure 3. In all three cases a cubic equation provided significantly better predictive fit ($\rho<.05$) than linear or quadratic equations. The proportions of variance explained by the cubic equations for the 10, 13 and 19 year-olds were .990, .956, and .952 respectively, indicating an exceptionally high degree of fit. The cubic equations plotted in Figure 3 are good approximations to normal ogive functions and are very similar to the curves hypothesized earlier (see Figure 1). One interesting departure from prediction is the shape of the 13 year-old's curve. For this respondent, the relationship between knowledge and frequency resembles that of the older respondent at the higher end of the frequency scale, and that of the younger student at the lower end of the scale, resulting in a steeper-than-expected curve through the middle of the range. If this effect is found not to be idiosyncratic, then it will imply a developmental pattern of lexical acquisition - namely, that more heavy-duty word meanings are consolidated in those years (say, 11-15 or so) without a concomitant expansion in the knowledge of rarer items.

ESTIMATES OF TOTAL VOCABULARY KNOWLEDGE

As a first step toward the estimation of total vocabulary size, the number of words in the large AH corpus known by each respondent was approximated. To do this the number of words in AH at each of the 11 frequency bands was determined from the proportional distribution provided by Carroll et. al. 1971, (p.xxxii). These are represented in the second column of Table 1.

In addition, the proportion of non-derivative or "basic" words at each frequency band was estimated, since such a proportion cannot be assumed to be equal across the bands. This was done by averaging across the proportions obtained from three 115 words (i.e. 1-column) samples in the book taken at each band, then establishing the mathematical relationship between proportion of basic words and frequency level. The best-fitting curve was quadratic ($\rho[\text{basic}] = .1875 + [-.013]\ SFI + [.00032]\ SFI^2$; $R^2=.992$), and the proportions computed on this basis are contained in column 3 of Table 1. The 4th column contains the raw numbers of basic words at each frequency band based on the proportions in the 3rd column.

Finally, Table 1 contains estimates for the three respondents, including total basic and derivative words. The proportions of known words are based on the best-fitting normal ogive function for each respondent. Since the test contained only basic words, the basic word knowledge estimates may seem the only relevant ones here. However the assumption is not unreasonable that knowledge of a basic word at a given frequency is highly correlated with knowledge of derivatives at that same frequency, since, in almost all cases the basic form of a word is a more frequent occurrence than its derivative forms. Hence, estimates of total word knowledge are provided.

A number of aspects of Table 1 are noteworthy. First, our estimates of both basic and total word knowledge for these respondents fall at the lower end of the current range of estimates (see Anderson & Freebody, 1981, for a summary). Estimates of total word knowledge compare in general with the middle of the range of previous estimates. It should be noted, however, that previous estimates apply to average language-competent individuals whereas the respondents tested here are above average. This suggests that the "yes/no" procedure for estimating word knowledge adjusted for false alarm tendencies results in more conservative estimates of total vocabulary size.

A second point to note is that estimated growth in total word knowledge decelerates over the years covered by these respondents. From 10 to 13 years the annual base percentage growth of total word knowledge is estimated at about 15%, while from 13 to 19 years the annual knowledge growth is about 7%. For estimated basic words, the annual deceleration rate is somewhat more pronounced being about 10% for the 10-13 years' span and 3% for the 13-19 years' period.

These decelerations are partly a result of the size of the corpus upon which the estimates are made. Any sample corpus, compared to the entire English lexicon, will be proportionally deficient in the lower ranges of frequency. That is, if the AH had covered 10 million words of running text instead of 5 million, there would be a proportional increase in the very rare words. Thus, the smaller the corpus on which the estimates are based, the more disadvantaged is the respondent with the larger vocabulary of rare words. With respect to Table 1, for example, if the two lowest frequency categories had contained 10 times the amount of words in the AH corpus, the advantage would have accrued to the 19 year-old only, thus levelling out the growth rates somewhat. However, an informal test of this levelling indicated that there is nonetheless some deceleration of growth: We applied the theoretical distribution of words developed by Carroll et.al. (1971) to a much larger corpus - the Compact Edition of the Oxford English Dictionary (1971) which we estimate from sampling to contain about 220 thousand separate entries. Using the theoretical frequency distribution to estimate numbers of entries at each frequency band from the Oxford, and then determining the proportion at each band for the respondents, we find that basic word totals for the 10, 13, and 19 year-olds are, respectively 1970, 2736, and 3629. These figures, in turn, reflect yearly percentage growth rates of about 12 and 5 for the 10-13 and 13-19 periods respectively. Thus, even after attempting to correct for sampling distribution distortions, we have found a suggestion of deceleration in vocabulary growth over the teenage years.

The notion of deceleration of reading vocabulary is not an implausible one. It is in the nature of lexical distribution that many words appear extremely rarely, and there are, by comparison, an extremely small number of words which perform the heavy duties in spoken and written communication. Once this heavy-duty group is mastered, the vast legions of rare words are, by definition, encountered highly infrequently. Apart from job-based requirements to master a new technique or a substantial new knowledge domain, adults may learn only a very few new words in the course of a year.

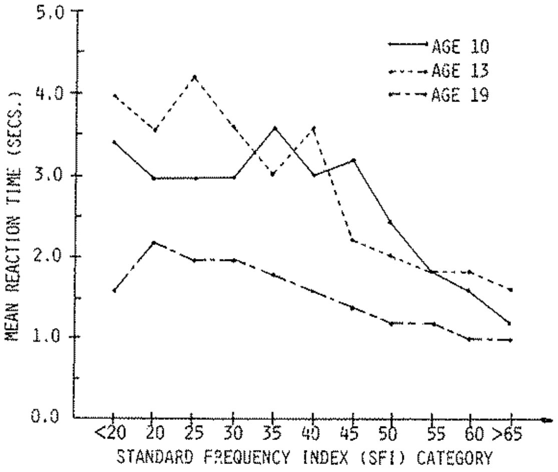

Figure 4. Raw mean response times to words at 11 frequency bands for each respondent.

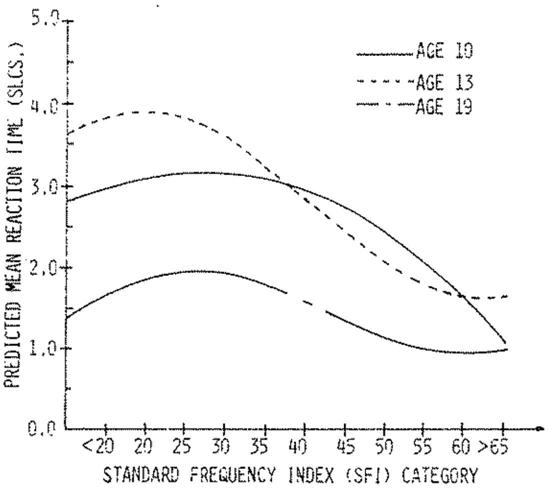

Figure 5. Predicted mean response times for the three respondents.

	Standard Frequency Index (SFI)			
	30	25	20	15
Age 10	2.34 (14)	2.93 (19)	2.66 (16)	3.23 (19)
Age 13	3.30 (18)	4.53 (14)	3.64 (16)	4.17 (19)
Age 19	1.83 (15)	1.65 (13)	1.99 (14)	2.05 (18)

Table 2. Mean "no" response times for the three respondents to words in the four lowest frequency bands (n for each mean is in parentheses).

RESPONSE TIMES

Figure 4 presents the relationships between raw mean response times and Standard Frequency Index. All three respondents displayed a positive correlation between response time (RT) and word frequency. There is little difference between the response patterns of the 10 and 13 year-old respondents, while the 19 year-

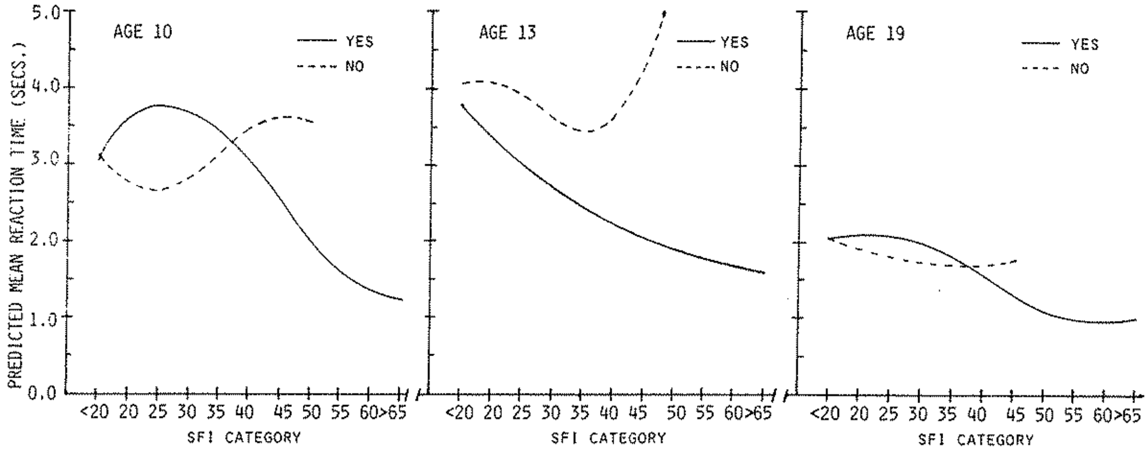

Figure 6. Predicted "yes" and "no" response time curves for the three respondents.

old responded much more quickly across the whole frequency range with the exception of the most frequent words. However, the RT curve of the 13 year-old reveals an interesting trend, in that, for the higher range of frequency (SFI>45), his curve parallels that of the older respondent. In contrast, the pattern of his RT's behaves more like that of the younger respondent for the rarer words. In particular, it is more variable and slower than that of the older respondent. It can be noted that this observation is analogous to the parallel point made earlier concerning the apparent developmental pattern of lexical acquisition. There seems to be a lower limit on decision speed for the very easy words around a mean of 1 to 1.5 seconds.

In an attempt to explore regularities between response time and word frequency, we compared the fits of linear, quadratic, and cubic equations to the RT/frequency data for each respondent. For the two older respondents, a cubic equation provided significantly better fits than lower order functions (R^2[13-year-old] = .90; R^2[19-year-old] = .96). For the youngest student, however, the best fitting equation was a simpler quadratic function (R^2[10-year-old] = .88). These best-fitting functions are presented for comparative purposes in Figure 5. The middle frequency ranges appear to be associated with reliable increases in decision time. It may be that words in these ranges have been occasionally encountered by the respondents, resulting in a sense of "visual familiarity". This, in turn, may lead to a search for meaning or attempts at successful constructions of meaning. That is, taking more time.

There does, in addition, appear to be a diminution of response time for the very unfamiliar words. It has been argued that the recognition of ignorance or "knowing not" can be as rapid as the recognition of "knowing" (e.g. Kolers & Palef, 1976). To confirm this suggestion, it would need to be shown that mean RT accompanying a "no" response decreased with decreasing frequency. The relevant data are presented in Table 2. They indicate that there is no enhancing effect of extreme unfamiliarity on response speed. Visual inspection suggests a slight tendency for the very rarest words to lead to a somewhat slower "no" response.

Differentiating between "yes" and "no" RT's and their relationship to word frequency led to two observations. First, the relationship between "yes" responses and frequency is highly orderly for all 3 respondents. The best-fitting curves are shown in Figure 6, with R^2 values for the 10, 13, and 19 year-olds being .91, .92, and .97 respectively. The relationship between "no" RT and word frequency is substantially less orderly (R^2's of .67, .62, and .73 respectively). Second, it is the "yes" response only which shows a reliable tendency to become slower over the middle frequency range. In all three cases the "no" response becomes faster over the SFI range of 50-35.

	Nonword Category		
	Brutes	Illegals	Legals
Age 10	.187	.139	.167
Age 13	.021	.250	.222
Age 19	.063	.056	.222

Table 3. False alarm rates to the various sorts of nonwords for the three respondents.

In summary, RT, regardless of the nature of the response, has highly orderly relationships to word frequency, but this relationship is particularly enhanced when "yes" responses are examined. There is a strong and reliable increase in "yes" time across the middle frequency range (e.g. 55-30 SFI), suggesting the respondents' need to experiment with or construct meanings for these possibly visually familiar items.

RESPONSES TO NONSENSE ITEMS

Anderson and Freebody (1983) showed differing patterns of "yes" responses to nonsense items (i.e. "false alarm" patterns) for respondents at varying vocabulary levels. They hypothesized that more linguistically competent individuals aggressively and increasingly accurately apply the English rules for combining base words and affixes to generate hypotheses concerning the meanings of new words. Respondents less sophisticated in language use on the other hand would be likely to engage not only in morphemic generativity, but also in "phonemic experimentation". As a result of this they will claim to know the meanings of words close to English words in their graphic or phonetic characteristics. To address this hypothesis the three types of nonsense items described earlier were included. Recall that these were termed "brutes" (English words minimally changed and random combinations of syllables), "legals" (grammatically legal but unconventional base plus affix combination), and "illegals" (ungrammatical and unconventional base plus affix combinations).

From the hypothesis outlined above we would predict that the youngest student would false alarm to an equal number of brutes, legals, and illegals; the 13 year-old would say "yes" to fewer brutes but would not distinguish greatly between legals and illegals; and the oldest respondent would be predicted to have a significant false alarm rate only on legal nonsense words. Since the overall false alarm rates for the three respondents were comparable, we are in a good position to compare differential patterns of false alarm rates.

The rates of saying "yes" to the various types of nonsense words for the three respondents are presented in Table 3. In general the hypothesis is seen to be supported. The youngest respondent does not appear to have differentiated between the various sorts of nonsense items, while the other two show some discrimination. The 13 year-old appears susceptible to both sorts of compounded nonsense items while the oldest respondent only to legal nonsense items. Not all possible contrasts are significant, but the 10 year-old false alarms to significantly more brutes than do either the 13 year-old ($p<.01$) and, to a lesser extent the 19 year-old ($p=.06$). In addition the 13 year-old says "yes" to more illegals than the oldest respondent ($p<.01$).

It is plausible to argue, on the basis of these findings, that with increasing language experience the tendency to experiment with basic decoding processes in order to produce a familiar phonemic representation out of an unfamiliar graphic array diminishes, and more morpheme-based generative processes come to predominate. With time these latter processes become more sensitive to the finer points of base-affix combinations. Thereby, the most experienced reader of listener is possessed not only of a conservative and generally accurate way of hypothesizing about the meanings of new words, but also of a technique which facilitates the assimilation of those new words into reading vocabulary. The reader or listener who tinkers with the grapheme-phoneme relationship until a familiar word is produced is not only less likely to arrive at the intended meaning of the communication, but is also using a technique which will by comparison, limit vocabulary growth.

CONCLUSIONS AND SPECULATIONS

We can summarize our findings under the four original headings thus:

1. The probability that the meaning of a word will be known relates in a highly orderly way to the word's frequency of usage. Specifically, a normal ogive function closely describes the relationship between probability of knowledge and logarithmic frequency.
2. Our estimates of the number of basic (i.e. non-derivative words) in the AH corpus known by the three respondents is toward the lower end of the range of extant predictions. Of the estimated 9225 basic words in the AH corpus, our 10,13, and 19 year-olds we predict would know the meanings of 3636, 4742 and 5588

respectively. The deceleration in growth rate is noted, as is the diminishing ratio of basic to total word knowledge across the years tested. The proportions of estimated basic words in total vocabulary of the three respondents was .24, .21, and .18 with age (compared with .11 for the entire AH corpus). Thus, we hypothesize, vocabulary growth decreases, and that growth which does occur increasingly involves derivative forms.

		Original Values		Adjusted Values	
	p(hit)	p(fa)	HTE	p(fa)	HTE
Age 10	.509	.167	.411	.127	.437
Age 13	.591	.150	.519	.118	.536
Age 19	.655	.108	.613	.067	.630

Table 4. Original and adjusted high threshold estimates (HTE) for the three respondents.

3. A highly orderly relationship between response time and frequence of word usage was found. Upon further analysis this orderliness was found to pertain to "yes" responses which become reliably slower over the middle frequency ranges.
4. Responses to various types of non-English letter strings confirmed a predicted pattern. That is, the youngest respondent displayed no sensitivity among the various types, the middle respondent indicated awareness of the brute versus compound distinction, but only the oldest respondent distinguished between legal and illegal compunds.

To conclude, we would like to speculate briefly about modifications to the standard high threshold formula for assessing proportion of words known, taking into account response time and false alarm tendencies of different sorts.

How might we best use the various pieces of information gained about an individual's response characteristics (false alarm pattern, response time, hit rate) to optimize our predictions about total vocabulary knowledge? One method is to estimate a "generativity index" for each respondent based on the number of legal nonsense compound words which receive a "yes". Presumably there are two ways to respond "yes" - one is to simply respond on the basis of knowledge of the stem portion of the compound; the other to attempt to generate a meaning for the compound itself. In the case of the latter, it is arguable that the respondent should be given credit for such (legal) generativity since it would be a boon in reading running text. It is also presumed that one basis upon which to infer that generativity is occurring is to study response times. The logic of the modification, then, is as follows: The respondent gains credit for those false alarms which arise from legal compounds only if the "yes" response took significantly longer than the mean "yes" response to words at the same frequency level as the stem of the legal compound. In a sense this amounts to partialling out of the overall false alarm rate that portion which we infer to have entailed "legal" generativity.

To exemplify this process, consider the case of the 10 year-old's "yes" responses to windowise and assistness. The former took 8.72 seconds, while her mean response to words of the same frequency level as window was 1.48 seconds (based on n=20, standard error [SE]=.26.) A response time of 8.72 is significantly greater than the upper bound of the 95% confidence interval about the mean of 1.48. Thus we infer that her "yes" response to windowise represented an instance of generativity. In contrast, her "yes" response to assistness took 2.25 seconds, while to words of the same frequency level as assist, her mean response time was 2.22 seconds (n=12, SE=.64). Thus we infer that her "yes" to assistness was of the same order as a "yes" to assist, thereby not indicating generativity. On this basis, three of the 10 year-old's false alarms to legals were recategorized as "generative". The remaining legal false alarms were pooled with brute and illegal false alarms and averaged to form an adjusted overall false alarm rate which in turn, was used in the standard high threshold equation. The results of these adjustments are contrasted, in Table 4 with the original estimates.

In this way we have used RT as a basis from which to infer the degree of adaptive generativity displayed by a respondent, and, accordingly, adjusted our index of corpus knowledge. This, we hope, is a step toward producing a more refined estimate of vocabulary knowledge.

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