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A MATHEMATICAL MODEL OF WORD RECOGNITION STRATEGIES.

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A MATHEMATICAL MODEL OF WORD RECOGNITION STRATEGIES

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ABSTRACT

This study attempted to demonstrate that it is possible to calculate a multiple regression equation which will describe which word features an individual is consistently using in comparing words. The multiple regression technique was hypothesized to be superior to previous techniques which focused on describing a single feature comparison strategy. By employing a regression technique, a simultaneous analysis of the various kinds of word features being used by an individual could be made. Of the five classes of word features described by Gibson and Levin (1975), visual, syntactic and phonemic features were ones used in this study.

The first step in attempting to support the hypothesis that an individual's word comparison strategy can be described by a multiple regression equation required the construction of measures of word features. Only word features for which valid and reliable measures could be constructed were used. These included measures of visual similarity, syntactic and phonemic features. The measures of visual features expanded on the work of Dunn-Rankin (1968) dealing with letter similarity; those on phonemic features analyzed the data contained in the

works of Miller and Nicely (1961), and Fairbanks and Grub (1961) dealing with phonemes using Shepard's (1962a) multidimensional technique; and the syntactic measure was derived from a study which estimated the similarities in meaning between words based on the responses of a group of college students.

By asking individuals to indicate the overall similarity between selected word pairs, it was possible to calculate a multiple regression equation which describes which word features (independent variables) an individual was consistently using in comparing words. The procedure uses the estimates of the various word similarity features as data points for the independent variables and the individual's responses as data points for the dependent variable. Using a stepwise regression technique, the beta weights associated with each independent variable were calculated. It is assumed that a statistically significant beta weight is an indication that the individual has employed this feature in his overall strategy in comparing the words.

The procedure was successful since at least two-thirds of the multiple linear regression equations calculated contained significant beta weights for one or more of the word features. A more stringent criterion ($R^2 \leq .25$) of "practical" significance was applied and approximately one-half of the multiple linear regression equations qualified as being "practically" significant.

The features most frequently found to have significant beta weights were, first letter, last letter, and meaning. Visual similarity followed next with phonemic and ascending and descending letters being hardly used by the subjects. Further analysis indicated that reading ability was related to the predictive power of the regression equation. It was also determined that there did not seem to be any "rigid" type of strategy associated with reading level. The major determinant seemed to be consistency in the application of the individual's strategy. Various flaws in the instrument, sample, and the methods of measuring the word features were discussed. The lack of sample representativeness was cited as being a major factor in limiting the generalization of the findings and confirmation of any developmental trends. Because of the relatively conservative methods used to derive the values for the indices in that similarities were always underestimated if insufficient data was present, there may have been a tendency for the procedure to decrease the R^2 for the calculated equations. Suggestions were made to improve some of the measures and to insure stricter controls over various aspects of the study.

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CHAPTER 1

OBJECTIVES AND CONCEPTUAL FRAMEWORK FOR THE STUDY

In the period between the publication of Huey's The Psychology and Pedagogy of Reading (1908), and Gibson and Levin's The Psychology of Reading (1975), there has been abundant research in the area of word recognition. Huey was the first author, however, to consolidate the body of knowledge dealing with word recognition in a systematic fashion. Research during the interim period has also been successful in cataloging the numerous features that are thought to be important in word recognition. Excellent reviews of the most important works are to be found in Chall (1967), Williams (1973), and Samuels (1973). Gibson and Levin (1975) point out ". . . it (word recognition) is an interesting body of research in its own right, and gives us some answers about the formation (or extraction) of higher order units." It is hardly surprising, however, that the literature on word recognition has been closely intertwined with that of reading. Much of the research in word recognition has not been always "in its own right" but has been conducted with an application to reading theory.

Because of practical considerations, much of the research in word recognition has been guilty of over-generalization. Studies of word recognition based on the analysis of one or two features of words are sometimes used to describe the overall strategy of many individuals. While it is true that single feature analysis provides valuable information about the salient features of a word, this research is hampered by the fact that a word possesses many kinds of features which may or may not be extracted in the perceptual process of recognition. Some individuals may attend to one feature, for example, while others may not. Single cue studies average these biases and essentially tell us that more people tend to employ a particular feature than those who do not. In addition, single cue analysis ignores the possibility that a hierarchy of cues might exist. An individual might, in fact, employ a feature at a specific moment but in the presence of more salient features, ignore one or more features under investigation.

An exception to single feature analysis is an analysis which deals with several features and different classes of features as well. Marchbanks and Levin (1965) investigated letter position (e.g., first or last letter in the word) and word shape. They were able to show that letter position was a more dominant feature overall than the shape of the word. Although there was an attempt to overcome the possible hierarchical effect of various features, the results of this study did not provide any clues as to the type of strategy an individual might be using when employing the different features under investigation. Individual differences were "washed out" in the final analysis.

Any good analysis of word recognition should address itself to two problems. The first is that it must be able to accommodate the simultaneous analysis of multiple features which may belong to different classes of information such as word shape and phonemic, or linguistic types of features. The second is that the method should be able to provide feedback on a particular individual's use of the features.

This dissertation is an attempt to provide and validate such a method. In order to solve the two major problems cited, it was hypothesized that a multiple linear regression model could be devised which would effectively deal with the problem of multifeature analysis and also provide information on the individual's strategy in employing these features in word recognition. The general form of the multiple linear regression model is:

$$Y = \alpha + \beta_1 X_1 + \beta_2 X_2 + \ldots\ldots\ldots\ldots + \beta_n X_n$$

Where: Y = the criterion variable (i.e., the variable being predicted)

α = the regression constant

β β_1, β_2, and β_n the coefficients or weights associated with X_1, X_2, and X_n the predictor variables.

If word features can be employed as the predictor variables in this equation, then the weights associated with each variable will provide a measure of how much emphasis is being placed on that word feature. If the weight for X_1 is zero or near zero, then this would mean that a particular feature is not utilized to a significant degree, for example.

In order to generate a reliable estimate of a person's strategy employing word features, it is necessary to obtain that person's judgment while given the chance to use the features at least five times for each feature under investigation. The choice of five judgments per feature is rather arbitrary but is in line with accepted estimates of the sample size necessary to provide reliable estimates of population parameters.

A simple method which allows us to provide the opportunity for an individual to repeatedly make judgments about words based on their features is the method of paired comparisons. The individual is shown two words and is asked to provide a scaled estimate of how much similarity exists between the two words. The individual is allowed to use whatever features he or she wishes to attend to in making the comparison. It is assumed that for a long list of tasks the individual will make judgments which are reflected in the sizes of the beta weights associated with each feature.

Therefore the final product of this series of word comparison tasks is the calculation of a multiple linear regression equation describing the person's word comparison strategy. This equation can be used to predict an individual's judgment when asked to compare two words.

The following generalized data matrix must be generated in order to proceed with the derivation of an individual's strategy. The following is an example of three words, W_1, W_2, and W_3 paired in all possible combinations. The actual study uses twenty-four words and therefore, far more pairs but for the sake of simplicity in illustrating the model, only three are used here.

Word Pairs	Feature F_1	Feature F_2	Feature F_n	Subject's Response	Predicted Response
W_1-W_2	X_1	Y_1	Z_1	R_1	$\hat{R}_1$
W_1-W_3	X_2	Y_2	Z_2	R_2	$\hat{R}_2$
W_2-W_3	X_3	Y_3	Z_3	R_3	$\hat{R}_3$

Where: X_1 = Estimate of the similarity between W_1 and W_2 based on only feature F_1.

Y = Estimate of the similarity between W_1 and W_2 based only on feature F_2.

Z = Estimate of the similarity between W_1 and W_2 based only on feature F_n.

R_1 = Subject's judgment as to the perceived similarity between W_1 and W_2 on a Likert scale.

R = Predicted response that will be derived from a solution of the general linear model.

In an analogous fashion, the other cells in the data matrix are derived. Using a stepwise regression computer program (Kim and Kohout, 1975), the completed data matrix is used to produce the linear equation representing the individual's strategy in comparing the words.

$$R = \alpha + \beta_1 F_1 + \beta_2 F_2 + \ldots\ldots\ldots\ldots + \beta_n F_n$$

The derivation of the estimates of similarity for each feature being investigated is the initial step in this method. The accuracy of prediction is contingent on the collection of valid and reliable measures of the features from which the individual's strategy is predicted. The following sections of this dissertation detail the rationale behind the inclusion of the features and also how the features are measured for each pair of words.

Much of the work dealing with word recognition up to the late 1950s was used to justify the reading methods that were prevalent in the schools. Jeanne Chall (1967) documents in considerable detail the research that had been used to rationalize the various beginning reading methodologies. She points out that the newer reading methods were emphasizing word recognition strategies reminiscent of the Cattell (1886) findings but which were not supported by the research post-dating Cattell's work. Some of the more recent work dealing with specific "determining" features of words has been published by Levin and Williams (1970) and Gibson and Levin (1975). The general consensus among these authors is that the literature has isolated most if not all of the salient features of words.

Various schemes have been suggested for organizing the many salient word features into workable categories (Gibson and Levin, 1975; Bower, 1967; Fillenbaum, 1969; Katz and Fodor, 1963; Perfetti, 1972). However, except for the work of Gibson and Levin, the other methods of classification have tended to incorporate only semantic and syntactic features. These methods sought to classify words more in terms of the meanings associated with them or the grammatical classes to which they belonged.

Gibson and Levin's (1975) classification is an extension of Gibson's earlier work (1971). Essentially, the system defines a word as a "complex of features" a composite representation of five classes of information: graphic, phonological, orthographic, semantic and syntactic. Because this dissertation is an attempt to validate a method of investigating the usage of word features, it was felt that the features included in the study should be representative of the five classes of word features.

The following discussion of the salient features of words draws heavily from Gibson and Levin's (1975) description and also from the work of Gibson (1971), Samuels (1968), Marchbanks and Levin (1965), and Huey (1908).

One of the first questions that might be asked is why a feature analysis of the words occurs at all since one could argue that words are seen in their entirety and not by their components. Cattell's (1886) work has always been used to demonstrate the validity of a whole word theory, but the later work by Huey (1908) easily demonstrated that certain dominant characteristics of words were important in word recognition. It was the work of Neisser (1967) that showed how accurate a feature analytic model could be in describing the word recognition process. Thus, rather than ask the question, "Why feature analysis?", the appropriate question becomes, "Which features are important?"

CHAPTER 2

HISTORY OF WORD RECOGNITION MODELS

The literature dealing with word recognition strategies or models dates back to the latter half of the nineteenth century to the experimental work of J. Mckeen Cattell (1885, 1886). Cattell systematically studied the perceptual latencies for words of various lengths by means of a tachistoscope. He was able to demonstrate that when single words were momentarily exposed, they were recognized as quickly as single letters. The major finding emerging from his research was that words are read as wholes, not letter by letter.

Following Cattell's work, Erdmann and Dodge (1898) argued strongly for a theory of word recognition in terms of whole words. They concluded from their research that the length of a word and its characteristic general form as a visual whole seemed to be the main means by which words were recognized by practiced readers. Huey (1908) reviewed the entire field of the psychology of reading at the beginning of the twentieth century and remarked that the conclusions of Erdmann and Dodge should not be taken as the final word on the matter. Huey cited work by Goldscheider and Miller (undated) which indicated that words were recognized because of the presence of "determining" letters which allowed the reader to sound out the whole word. In addition, the more unfamiliar the word, the more liable was the reader to proceed letter by letter. Huey cited work by Zietler (undated) who concluded that these "determining" letters once recognized created the formation of an inner mental contribution which then resulted in the perception of the word as a whole. Thus the word-form is apparently assimilated as a whole, secondarily; but primarily it is perceived only in its dominating constituent parts. Furthermore, alteration of the "non-dominating" parts of the word might go unnoticed by the reader.

Huey disagreed with Cattell and Erdmann and Dodge in their beliefs that the dominant characteristic of words was their general configuration. He agreed with Goldscheider and Miller, and Zeitler in that he believed that certain dominant features (determining parts) of a word were the cues or features which practiced readers employed to identify words. As an example of the dominance which certain parts of the word played, Huey mutilated selected parts of words to demonstrate the greater amount of information that could be obtained from the first half of the word versus the second half of the word. He also showed that the upper half of the word is more important for perception than the lower half of the word.

Huey's work remained the definitive statement on word recognition and reading for many years. According to some authors, notably Kolers (1968), since Huey's work in 1908 the advancement in knowledge as to the processes involved in word recognition has not evolved significantly. Kolers, who has done considerable work on various facets of word recognition and reading skills (1968, 1969, and 1973), gave tribute to Huey in the following fashion:

> Huey reviews the experimental evidence and describes what he knew about reading as a psychological process. What is amazing to someone reading the book (Huey, 1908) sixty years later is not only the breadth and scope of his vision but also the amount of information in it is still on the "front lines" of research. Remarkably little empirical information has been added to what Huey knew, although some of the phenomena have now been measured more precisely. His characterization of reading as an information processing activity has not been surpassed. (Kolers, 1968)

One of the most recent attempts to consolidate the literature on word recognition (Gibson and Levin, 1975) also pays homage to Huey.

> Over sixty years ago, he (Huey) raised many of the basic problems that concern us today and many that we will treat. . . . His theories and experiments are surprisingly up to date, and we are poorer for the fact that his analysis of the reading process did not have the influence on psychological and educational research that it merited.

Between the publication of Huey's book in 1908 and that of Ulric Neisser's Cognitive Psychology in 1967, there was no single author or experimenter of equal or near equal stature or accomplishment in the area of word recognition or as it was sometimes referred to, pattern recognition. It is interesting to note that Neisser makes no mention of the work of Huey on word recognition in his book. He does mention a contemporary of Huey's, Pillsbury (1897) who, like Cattell, believed that the whole word was recognized all at once.

Neisser carefully weighs the evidence for a template matching theory of word recognition and a feature analytic theory of word recognition. In view of the supportive evidence, Neisser stressed the overwhelming evidence supporting a feature analytic model of word recognition. Neisser's conclusions are heavily based on the work of Selfridge (1959) who described a theory of information processing applicable not only to computers but also humans. Selfridge's work was closely tied to the attempts of researchers to generate programs that would allow computers to recognize words (Lindsay and Norman, 1972). A similar approach using the terminology usually associated with computers has been endorsed by Venezky and Calfee (1970). Again, the emphasis is on an information processing model similar to one that would allow a computer to recognize words.

For the purposes of this dissertation, the question of which features to study is critical because a major aspect of this research is to generate estimates of feature similarities between pairs of words. Undoubtedly, many features exist but to what degree these features can be reliably measured is an extremely complex question which no single work will be able to answer. Inasmuch as this dissertation is mainly an attempt to show the validity and reliability of a method, it is not possible to provide the ultimate answer to how accurately the word features can be measured. In some cases, the systems used to measure these features have been experimental in nature and will certainly need more research in order to validate them properly. With this caution in mind, let us look at how the features used in this study have been selected and in the section on methods, describe how they were measured.

Graphic Features

The graphic features of words (i.e., size, shape and position) are perhaps the most readily apparent and one might be led to assume that these features are the most important. There is very little evidence to show that graphic features are dominant charcterisitics of words. They were among the first to be studied in the early research in word recognition (Huey, 1908; Paterson and Tinker, 1940). Type style except for the instance of upper case versus lower case letters is unimportant in word recognition (Gibson and Levin, 1975; Robeck and

Wilson, 1974). Considering the multitude of type styles that exist (e.g., monotype baskerville, elite, courier, bodoni book, century, roman, schoolbook), it is surprising that reading rate is relatively unaffected by type font. It would appear that it may be only at the adult levels that type size is an important factor (Tinker, 1963; Robeck and Wilson, 1974). This would seem to be in sharp contrast to the assumptions now held by the publishers of children's books who insist on using very large print.

Early studies of word configuration (Cattell, 1896) provided the data for the initial speculations on whether or not word shape or configuration was a significant cue in word recognition. Anderson and Deaborn (1952) reviewed the literature on word configuration and concluded that children are more prone to utilize nonshape cues such as letter sounds and letter grouping whereas adults will tend to utilize word shape cues in which the outline or configuration of the word is the dominant feature. Samuels (1970), Chall (1967), and Gibson and Levin (1975) discount the theory that total word configuration plays a part in word recognition. They believe that the configuration is a cue to the kinds of graphic features that the word contains and by itself is insufficient to trigger recognition. Thus they argue that the configuration  (as in the word "such") is not enough to produce recognition unless one further hypothesizes that the shape  directs the reader to infer that the last letter of the word is an ascending letter. This study will attempt to find if the configurations of ascending and descending letters are vital to word recognition. In conjunction with the ascending and descending letter analysis, an overall estimate of word configuration will be employed. This estimate will be derived from the similarity of the letters of the individual words. In this study, configuration and word length are inseparable because length is an integral dimension of configuration (e.g., tog versus tossing). In the example shown, the length of the second word has reduced the configural similarity. This measure will be derived using Dunn-Rankin's (1968) estimates of letter similarities.

The beginning letter of a word has been one of the most investigated cues in word recognition (Huey, 1908; Anderson and Dearborn, 1952; Samuels, 1970; and Gibson and Levin, 1975). In one of the more recent studies, Marchbanks and Levin (1965) were able to show that first letters were the most preferred cue used by kindergarteners and first graders. They concluded that this was similar to findings using adult readers.

There have been many hypotheses put forward to try and explain why the initial letter is such a dominant cue.

Gibson and Levin (1975) believe that the first letter has a higher predictive value than any other letter for inferring the whole word. The authors, however, do not elaborate why this should be so. Marchbanks and Levin (1965) indicate that emphasis on the first letter may be due to a primacy effect. This effect parallels a serial position effect where the last and first objects in a string of objects are the most noticeable and easily remembered. They also tenuously state that the primacy effect may be due to the white space adjacent to the left of the first letter. Anderson and Dearborn (1952) were able to show that even for poor readers, the effect was still significant. In addition, in experiments using Hebrew readers (Anderson and Dearborn, 1952) who read right to left, these readers also display a disposition towards the first letter (i.e., for them the right-most letter). Thus it can be concluded that the effect is not genetic but learned. If a pure probabilistic model is used, it is easy to demonstrate that less errors occur in predicting succeeding letters of a word if the subject is given the first letter versus a middle letter. Shannon's theory of communication (Shannon, 1948) which outlines the variations in probabilities that exist for different letters in a given word, confirms this fact.

The final letter in a word possesses similar qualities to the first letter in terms of its cue value. In fact, experimentation on the first letter effect usually attempts to measure the final letter effect. Thus the studies cited for first letter effect (Marchbanks and Levin, 1965; Anderson and Dearborn, 1952), have shown a similar effect for both first and last letters. It has been suggested that whereas the initial letter provides a clue as to the word prefix, the last letter provides a clue as to the word suffix. For example: "n" would indicate a word ending in "ion" and "g" would indicate an "ing" ending. In addition to the grammatical rationale as to why last letters have such a high cue value, there is the serial position effect which is true not only for first members of a string of stimuli, but also the last member. Shannon's theory would also tend to add to the evidence supporting a high cue value for last letters. Both first and last letter similarity will be investigated although the analysis will be done using only dichotomous data. It was decided to use a dichotomous measure here because previous work has always focused on the dichotomous nature of the feature. In order to make the results of this study comparable to that of past research, this feature has been dichotomized although a continuous scale employing Dunn-Rankin's (1968) scaling of the similarity of English letters could have been used.

Orthographic and Phonological Features

Orthographic rules govern the order of letters and groups of letters in words. The letter "q" is always followed by the letter "u" while the cluster "km" is not permitted unless it crosses a boundary such as in the word "milkmaid." In a similar manner, phonological rules govern the permissible sequences of sounds in a word. The congruence of sounds and graphic units is not random. Poets have demonstrated a knack for constructing legal nonsense-words (orthographically and phonologically correct words that are not part of the language). The poem, Jabberwocky by Lewis Carroll, is a prime example of legal nonsense words. Thus words like "tove" and "wabe" are legitimate but nonsensical. Words from other languages form unpronounceable units because the phonological rules are different from those of English. Despite the outcry of many regarding the seeming chaos that exists between the orthography and phonology of English, the evidence points to the fact that there are regular, sound to graphic unit, correspondences. Venezky's work (1966) demonstrated that the correspondence may not be as obvious as other languages but they do exist nevertheless. All real words are orthgraphically and phonemically correct. Nonsense words may be either or both. Investigating these features independently of each other is a complex task. In fact, the most successful experiments to demonstrate the possibility of both factors being independent have been carried out using congenitally deaf subjects (Gibson, Shurcliff, and Yonas, 1970). Their subjects, who could not have known the phonological properties of the experimental words, were able to read pronounceable words easier than unpronounceable words. Gibson et al. concluded that the pronounceable words were differentiated solely on the basis of orthographic features. Because of the inherent difficulties in trying to separate the effects of phonological and orthographic features, this study will not attempt to separate their independent effects. The assumption will be made that orthographic features can be reliably measured by investigating phonological features. Thus orthographic features will not be independently investigated in this study.

Arguments have been advanced to show that in recognizing a word the visual input is first transformed to a phonemic representation. The theory indicates that when a word is first seen, the reader carries out a phonemic search of his internal lexicon. In a Rubenstein, Lewis, and Rubenstein (1971) study using real familiar words, legal nonsense-words (orthographically and phonologically correct) and two types of illegal nonsense words, one which was illegal but considered by the authors to be pronounceable (e.g., fuzg, topk), and one which was both orthographically and phonologically illegal (e.g., tritr, codg), the authors found that the subjects showed the shortest latencies for recognition of the real familiar words, the longest for legal nonsense words, and the two illegal categories were in between. Rubenstein et al. thus concluded that phonemic coding was necessary because no phonemic coding was necessary for the illegal words while this was necessary for the legal nonsense words and therefore, a longer latency time was evidenced. Eriksen and Eriksen (1974) indicated that initial graphemic and phonemic similarities facilitated word recognition responses. Nelson, Brooks, and Borden (1974) found that under conditions of oral presentation, the phonemic and graphemic terminal and initial positions of words are facilitative in word discrimination tasks.

The exact nature and influence of phonemic features is not clear-cut because, as Gibson and Levin (1975) point out, other researchers (Baron and Thurston, 1973) have shown that pronounceability is not a source of facilitation in word recognition. This is clearly in contrast to other literature cited by Gibson and Levin demonstrating the efficacy of phonological cues and the developmental process which occurs. As a word of caution and in deference to the work of Baron and Thurston, Gibson and Levin have not unanimously agreed with the position that phonemic cues facilitate word recognition.

Only the initial and final phonemes of words will be investigated in this study. This is due in part to the fact that Eriksen and Eriksen (1974) and Nelson, Brooks and Borden (1974) were able to demonstrate the dominance of these features and also in part to the fact that phonemic data on words are not readily available in a psychologically scaled format. Saporta's work (1961) dealing with psycholinguistics cites only one study which describes a true psychological scaling of linguistic features of words. This is the work of Miller and Nicely (1961).

The work of Miller and Nicely (1961) is one of the first systematic analyses of the study of the phonemic properties of consonant similarities. In their study, subjects were asked to identify common consonant phonemes under conditions involving different noise levels. Five different groupings of the consonant phonemes were detected: p,t,k; f,θ,s,ʃ; b,d,g; v,ð,z; and m,n. In oral reading, it would therefore seem plausible that these groupings would provide a suitable means of discriminating between the phonemes. Intragroup comparisons between the phonemes would provide greater similarity estimates than intergroup comparisons. One could make the assumption that the more similar the phonemes were then the greater the probability that they would be confused with each other under varying conditions of noise levels. A similar study using some common vowel phonemes was carried out by Fairbanks (1961). Data from the Miller and Nicely (1961) and the Fairbanks (1961) study will be used to generate estimates of the psychological similarity between phonemes. These similarity estimates derived from confusion matrices published in the studies will be obtained through the use of multi-dimensional scaling techniques (Shephard, 1974). Through the use of multi-dimensional scaling, a confusion matrix (in which the cells of the matrix represent the frequency with which phonemes are mistaken for each other or identified as themselves) can be transformed into a psychological space in which the phonemes are located in relationship to the perceived distances between them. Therefore, phonemes which are easily confused with each other are perceived to be very close together in psychological space.

Syntactic and Semantic Features

Syntactic features refer to those features which are grammatical in nature. For example, "ran" is the past tense of the intransitive verb "run." Gibson and Levin state that some linguists (Chafe, 1970) believe that the verb is the "heart" of the sentence and implies much of the rest of it. If so, then one could speculate that verbs should be recognized more easily than other words. Unfortunately there is no evidence to support this. Because of the inherent nature of the task being used in this study, syntactic features are even less applicable than might be expected. Syntactic variables assume importance in context and really do not operate in isolation as in a task involving a few words at a time. For this reason, no syntactic features will be studied in this dissertation. Semantics deal with the features relating to the meanings of words. The work of Osgood, Sebeok, and Diebold (1965) on the semantic differential scale has been interesting in that it has expanded the number of dimensions we normally associate with the meaning of a word. Unfortunately, their work does not have very much direct application to the area of word recognition. Like syntax, words generally develop much of their meaning when placed in context with other words. Although many words can exhibit meaning in isolation (e.g., aloha), Gibson and Levin are hesitant in ascribing full credit to the role of meaning in word recognition. Studies attempting to investigate the relevance of meaning to word recognition have shown that retention of meaningful words is better (Gibson, Bishop, Schiff and Smith, 1964) and concrete words (e.g., bird) are more easily recognized than abstract words (e.g., pity) (Riegel and Riegel, 1961). On the other hand, Taylor (1958) found that meaningful words were not recognized earlier than non-meaningful ones. Postman and Rosenzweig (1956) found no difference between familiar English words and familiar syllables. Perhaps as Gibson and Levin point out, the context surrounding a word provides redundancy which cannot be captured in isolation studies. Therefore the contradictory results may be idiosyncratic to the words used in this study. An additional factor which confounds any study of meaning is frequency or familiarity. Frequently occurring words in the English language tend to be more familiar and have more meaning associated with them (e.g., flattened ball versus oblate spheroid).

The studies on meaningfulness have generally either supplied pictorial references for each word or contrasted a commonly occurring real word with a nonsense word (Taylor, 1958; Postman and Rosenzweig, 1956). Thus, either the meaning of the word was determined by the experimenter or the words were contrasted with others that had no meaning. The pool of words used in this study consists of real legal English words. Subjects are allowed to impress whatever meaning they wish on the words. Gibson and Levin indicate that even in phrases there is contextual redundancy which aids in word recognition. Consequently in order to provide more contextual cues to aid in the study of the semantic features of the words, they are imbedded in short phrases. It is hoped that this will increase any effect due to the semantic features of the words.

The most common measure of meaningfulness is derived from word association norms. It was not found to be useful to use word association norms as a measure of meaningfulness in this study because the words for which association norms could be found (Palermo and Jenkins, 1964) tended to be words found in readers above sixth grade level as measured by Harris and Jacobson's (1972) vocabulary list. Consequently a measure of word meaningfulness between the word pairs used in this dissertation was derived in a separate study. In this study, subjects were asked to provide an estimate of the amount of similarity in meaning that they felt was held in common by each pair of words used in this dissertation (a copy of the instrument can be found in Appendix B). The subject's estimate was to be scaled on a Likert scale of 0-6 in which the higher the number, the more meaning the words had in common. The task was purposely designed to be ambiguous in order to allow the subjects to impose any dimension of meaning they wished. It should be obvious that this was not intended to be the definitive study in word meaning. The main intent was to provide an estimate of the amount of meaning that could reasonably be expected to exist between the words. Because of the nature of the test, it would appear that a measure of the number of associations held in common by each word was obtained. This is not a negative finding since associations are a legitimate type of semantic feature.

CHAPTER 3

HYPOTHESES

The following features were used to define individual strategies in comparing words:

F_1 General configuration (including length)

F_2 Ascending letters

F_3 Descending letters

F_4 First letters

F_5 Last letters

F_6 First phoneme

F_7 Last phoneme

F_8 Meaningfulness

The exact method for measuring these features is described in the method section. The initial idea for combining the features F_1-F_8 in a linear regression equation of the form:

$$Y = \alpha + \beta_1 F_1 + \beta_2 F_2 + \ldots\ldots\ldots\ldots + \beta_8 F_8$$

was obtained from the work of Ward (1963) and Christal (1967). Their studies indicated that the general linear regression technique could be applied to decision making theory in which the individual's strategy used in making a decision could be "captured" by the linear equation.

A number of basic assumptions are made in using the "policy capturing" scheme. The first assumption is that an individual uses a linear strategy in making his decision. Although the linear model can be adapted for non-linearity through the use of a polynomial equation, there is no prior evidence that would lead anyone to believe that a linear model is not applicable. A linear solution would also be the most parsimonious solution. A second assumption being made and one which has already been stated is that the individual will display a consistent strategy. Randomness in decision making cannot be captured by the linear regression model.

The general hypothesis that a person's word comparison strategy can be represented by a multiple linear regression presents a number of novel questions in terms of generating a list of specific testable hypotheses. For example, it is not specified in the literature as to exactly what is a "good" linear equation. The quality "goodness" can be described either in terms of the traditional $\underline{p} \leq .05$ as of statistical significance or in terms of the practical or utilitarian significance. Statistical significance generally represents the lower criterion for "goodness" while the practical significance, the upper criterion. While the linear equation describing an individual's word comparison strategy might attain statistical significance it may not have any practical significance whatsoever. The problem of relating practical to statistical significance was the focus of an unique work (Lai, 1972) dealing with a non-central ANOVA model. Lai (1972) believed that a simple test of statistical significance was not sufficient in many instances where a practical test would be more appropriate. The Lai model attempted to derive a practical test of significance for the ANOVA model. Conceptually this study is related in that the traditional statistical test of significance is insufficient to adequately evaluate the equations that will be used to describe individual word recognition strategies. Unfortunately the Lai paradigm is not adaptable to this study because no practical criteria relating to this study could be generated from the Lai model. Because of the lack of theoretically based practical criteria, this study will arbitrarily define a linear multiple regression equation as having attained practical significance when $\underline{R}^2 \geq 0.25$.

Keeping in mind the differentiation between statistical and practical significance, two general hypotheses will be tested in this study. The first is that an individual's word comparison strategy can be captured and defined as a linear multiple regression equation in which there will be statistically significant beta weights associated with the word features being used by the individual. This implies that features not used will not have their associated beta weights reach statistical significance. The second is that individuals with higher reading ability will tend to have strategies that are practically significant. High reading ability is defined as a reading score on the reading subtest of the Cooperative Primary test which exceeds the median score for the appropriate subject group.

CHAPTER 4

METHOD

Criterion Task

A word paired-comparison task was used as the criterion measure ($\hat{Y}$) in this dissertation. A wide variety of methods were available for use but there were a number of constraints which finally led to the selection of paired comparisons. Relatively large subject pools were needed in this study; consequently a group administered task would be the most convenient. Subjects would have to be tested in classrooms, thereby eliminating any bulky equipment such as tachistoscopic devices. Given these two constraints, a group administered pencil and paper task seemed to be most effective. A third constraint was that subjects from a wide range of ability levels were being given the task (grades 1-3 and college level students), thus the task had to be applicable to a wide range of grade levels. Work by Marchbanks and Levin (1965) and Dunn-Rankin (1968) with elementary school students indicated that elementary grade level students could perform a word comparison task. In the case of the Marchbanks and Levin study, the students (first grade students) were asked to select from a group of pseudowords the one that was most similar to a target word. The authors did not indicate any problems with getting the students to understand the instructions. In the Dunn-Rankin (1968) study, a paper and pencil instrument was presented to the students. The students were then asked to select one of two comparison words which was most similar to a target word. Again, the author did not indicate that the task was too difficult. In a more recent study by Powell (1971), a Likert type scale was administered to primary school students to test their attitudes toward reading for pleasure. Reliability estimate of 0.85 was obtained for a grades 1-3 administration. In the Powell (1971) instrument, the Likert scale was a three point scale represented by three circular faces. The face varied from a sad face, a plain face, to a smiling face. Based on the seeming success that was obtained from these studies, it was felt that a paper and pencil instrument employing a word comparison task and a simplified Likert scale would be an appropriate task for the subjects.

Review of the work by Fagan, Cooper and Jensen (1975), which listed measures that had been used in the primary grades, indicated that test lengths varied between thirty to sixty items depending on type of task given. These limits seemed to represent a practical upper limit and a statistical lower limit. Because eight features were specified and it was felt that each feature had to be presented on the average, not less than five times to the subject, the lower limit of the length of the test was approximately forty items. Rather than use the lower limit, it was decided that the upper limit of sixty items was more appropriate because it would tend to increase the reliability of the instrument and still be a manageable task to primary school students.

Selection of Word Pool

The English language contains approximately 600,000 words. Random sampling of this corpus of words was judged inappropriate for the selection of the words to be used in this study because the grade level of the target population was a critical factor. Since grades 1-3 students were being used in the study, there was no assurance that a random sample of words would have included words appropriate only to these grade levels.

The selection of the words used in this study was carried out with certain general criteria in mind. There should be sets of homonyms, visually similar words, words of less than seven letters, and words having a second or third grade difficulty level. The homonyms used in this study were obtained from Kirkland's (1968) handbook of homonyms. Grade level difficulties were obtained from Harris and Jacobson's (1972) study of basic elementary reading vocabularies. In the case of the latter it was assumed that the grade level at which the words were introduced in the most common basal readers used in the United States is an approximate equivalent of its difficulty level. This method of determining difficulty level was selected over the more common word frequency count method because the latter method concentrates on words that occur in textual materials from a variety of sources, many of which children are not exposed to.

Homonyms were selected because they presented an unique opportunity to investigate the relationship between visual similarity and phonemic similarity. An attempt was made to include homonyms that were extremely visually disparate. Four homonyms of varying word lengths were included in the final list in order to provide sufficient variation in the task. In addition, one of the homonym pairs consisted of a word almost twice as long as the other. This was done in order to try and separate the effect of word length and its phonemic characteristics.

Selection of the words according to their visual similarity was intially accomplished through subjective inspection of the words as to whether or not they had approximately the same number of curved letters or ascending or descending letters. Hundreds of possible words of varying degrees of phonemic and visual similarity and difficulty level were screened. The final choice of the twenty-four words shown in Table 1 was derived through intuition and application of the general criteria previously stated. Close inspection of Table 1 will show that there are visually similar words with different final letters (1 and 3, 20 and 21, and 23 and 24); similar final phonemes but different final letters (1 and 2, 5 and 10, 6 and 11, and 13 and 14); similar initial phonemes but different first letters (13 and 14, and 19 and 20). There is considerable overlap among the words mainly in terms of their visual charcteristics due in large part to the constraint that the words could not exceed seven letters or third grade difficulty levels. It will be noted that words 17, 19, and 20 are more difficult than a third grade level. The inclusion of these words and also words that were barely able to meet the difficulty level criterion presented problems in terms of ability of the target subjects to understand the words or at least to be able to pronounce them.

In order to prevent these problems from invalidating the results of the study, the decision was made to read the words to the subjects and also insert the words in phrases which it was thought would help to clarify the

Table 1

List of 24 Words Used in the Study

Word	Grade Level Entry	Remarks
1. rows	2, 3, 4	homonym with 2
2. rose	3, 4	homonym with 1
3. rise	3, 4	visually similar to 1 and 2
4. toast	3, 5	visually similar to 5 and 6
5. feast	3, 4, 5	visually similar to 4 and 6
6. goats	1, 2, 4	visually similar to 4 and 5
7. black	1	visually similar to 8 and 9
8. chalk	3, 5, 6	visually similar to 7 and 9
9. stack	2, 4, 6	visually similar to 7 and 8
10. date	2, 3, 4, 5	visually similar to 11 and 12
11. fate	3, 4, 5, 6	visually similar to 10 and 11
12. joke	2, 3, 4	visually similar to 10 and 11
13. ate	1, 2	homonym with 14
14. eight	1, 2, 3	homonym with 13
15. tea	2, 3, 4	visually similar to 13
16. die	2, 3	homonym with 17
17. dye	5, 6	homonym with 16
18. doe	3, 5, 6	visually similar to 15
19. kernel	5, 6	homonym with 20
20. colonel	4, 5, 6	homonym with 19
21. colored	1, 2, 4	visually similar to 20
22. bark	1, 2, 3	visually similar to 23 and 24
23. bank	1, 2, 3	visually similar to 22 and 24
24. barn	1, 2	visually similar to 22 and 23

meanings of the words. Gibson and Levin (1975) point out that the oral vocabulary of an individual is much higher than the reading vocabulary, thus orally presenting the words to the subjects would tend to eliminate or at least decrease any confounding error due to the child's unfamiliarity with the written words. Similarly it was thought that inclusion of the words in short phrases would assist in eliminating or at least reducing the unfamiliarity of the words. Thus the final instrument consisted of pairs of phrases in which the selected words were imbedded. As a means of checking on whether this procedure did produce substantially different results than if no phrase or oral presentation was used, a non-contextual set of the words was also presented to one group of subjects.

If the entire list of twenty-four words were to be used in a paired comparison task in which each word was compared with every other word, a list of 276 pairs would be obtained. Dunn-Rankin's (1972) work with first, second, and third graders has demonstrated that a list between sixty to seventy word pairs or stimuli is the longest that could be administered without the danger of severe fatigue effects. Consequently, the list was split into two lists of twelve words each with words 1-12 comprising the first list, and words 13-24 the second list. A list of twelve words produces sixty-six pairs in all possible combinations without regard to order. Pairings of the words for all of the instruments in this study were carried out according to procedures described in Ross (1939). Such procedures were employed to correct for stimulus order effects.

The first list comprised of words 1-12 imbedded in short phrases was called Form CSA (Context Subtest A). The second list comprised of words 13-24 imbedded in short phrases was called Form CSB (Context Subtest B). Based on previously cited reviews (Dunn-Rankin, 1968; Powell, 1971; Marchbanks and Levin, 1965) of work that had employed paper and pencil tests on elementary school children, the following format seemed to be of sufficient simplicity and validity for use in the instruments used in this study.

a pretty <u>rose</u>	money in the <u>bank</u>	0	00	000	0000	00000

The subjects responded by marking the number of circles which was thought to represent the degree of similarity existing between the target words underlined. In the test administration, the subjects were carefully shown how to respond to the Likert scale instrument by marking the appropriate number of circles which corresponded with their perceptions of how similar the pairs of words were. Three examples were given and after each example, the proctors and administrators verified that the subjects were responding to the examples. After verifying that the subjects were all responding, the administrator began to read the list of word pairs and their stimulus phrases according to the instructions. Each phrase was read once and then the subjects were told to compare the words. Complete instructions for the two forms of the instrument and the instruments themselves are found in Appendix C. Table 2 contains the list of words in their imbedded phrases. In addition to the list of twenty-four words, two other words were also inserted. These were toy and milk. These are also included in Table 2 along with their imbedded phrases. Toy and milk were paired with themselves, toy-toy and milk-milk, but in different phrases and inserted in the 13th and 50th position of both Form CSA and Form CSB. These identical pairs were inserted to check if individual subjects were responding at random to the instrument. Responses to these were removed from the analysis.

The non-contextual form of the instrument was composed of all possible pairings of the twenty-four words. The resultant list of 276 pairs was then broken in four segments of 72, 72, 72 and 60 pairs each. As in the previous forms, the identical pairs were also added to each segment in the 13th and 50th position. These segments were given

Table 2

List of Words Imbedded in Phrases

Word	Phrase
rows	rows of soldiers
rose	a pretty rose
rise	rise up
toast	light brown toast
feast	luau feast
goats	milk from goats
black	black crayons
chalk	chalk for writing
stack	stack of blocks
date	a dried date
fate	a happy fate
joke	a good joke
ate	I ate lunch
eight	eight kittens
tea	Japanese tea
die	sick animals die
dye	to dye Easter eggs
doe	doe, a female deer
kernel	kernel of corn
colonel	the army colonel
colored	colored blocks
bark	dogs bark loudly
bank	money in a bank
barn	cows in the barn
toy	a pretty toy
toy	a big toy
milk	a glass of milk
milk	milk from cows

the names NCA, NCB, NCC, and NCD (Non Context A, etc.). Other than the oral instructions in the beginning of the administration procedures, the subjects were not given any other information. Copies of NCA, NCB, NCC and NCD and their instructions can be found in Appendix D. All of the data were analyzed using the stepwise regression routines in Nie, Hull, Jenkins, Steinbrenner and Bent (1975).

Derivation of Feature Similarity Indices

The derivation of the eight feature similarity indices for each of the word pairs used in this study involved the creation of novel ways in which to quantify the measurement of word features. The precision of the measures varied considerably. In some cases there was no previous work of this nature, consequently these measures are untried and as such, may contain many of the pitfalls usually found in experimental instruments. These will be taken up in the Discussion section.

General Configuration Similarity

General configuration similarity or visual graphemic similarity (VG) is a measure of the overall similarity in configuration between two words and in the differences in length between the two words. For example, if we compared a word with itself, the similarity estimate should be a maximum value. But if we considered the instance in which one word is contained within another word, then the measure used must also be sensitive to the differences in length between the two words despite the fact that one word is identically contained in the other.

Example:	TARGET WORD	milk		buttermilk
	COMPARE WORD	milk		milk
	MEASURE OF VISUAL GRAPHEMIC SIMILARITY	MAXIMUM	<	MAXIMUM

There were no similarity measures to be found that compared the visual graphemic similarity between words as an unit. In Karlgren and Brodda (1968) and Dunn-Rankin (1972), methods of generating the similarity estimates between letters of the alphabet were proposed. In the Karlgren and Brodda (1968) study, the method was also applied in order to calculate how similar proposed trade names were to existing ones. In Karlgren and Brodda's (1968) work, similarity in letter order was paramount. Several attempts to obtain the exact nature of the methodology, however, were unsuccessful. Dunn-Rankin's data on the visual similarities between letters of the English alphabet provided a simple method of scaling the amount of similarity between words if the assumption was made that the total amount of similarity between two words is equal to the sum of the similarities between the letters of the two words. Obviously this is not congruent with any Gestalt interpretation of the words but it represents our best estimate of the existing similarity between the words. In his study, Dunn-Rankin was able to plot on a 100 point scale the degree of visual graphemic similarity that existed between the most common letters of the English language. For example using his scale, one finds that the letters "o" and "k" are separated by a distance of 86 points. The letters "r" and "n" are separated by a distance of only 27 points. Scale points are a quantitative reflection of the differences in graphemic feature characteristics that exist between the letters. In example A, the total scaled difference between the two words "joke" and "rise" is 186 points. This difference was then divided by the total number of letters in the word pair to obtain an index which represented the average similarity difference per letter. The natural order of letters in the words is always used to calculate the similarity estimates. Note that for the identical pair of letters "e",

Example A:

j	o	k	e
r	i	s	e

$$34 + 74 + 73 + 5 = 186$$

there is a scaled value of 5 points. This is due to the fact that when subjects are asked to compare even identical letters, there is a small error that occurs in the comparison. Occasionally subjects will perceive a difference when there is none. In example B, words of unequal length are compared. When this occurs, the unmatched letters are automatically given the highest possible dissimilarity value which is 100 points. All possible matchings of the letters in the words are also performed and their similarity estimates calculated. The lowest similarity estimate or what is actually

Example B:	t e a		t e a
	f a t e		f a t e
	20 + 23 + 77 + 100 = 220		100 + 70 + 70 + 25 = 265

$\therefore$ VG = 220 ÷ 7 = 31

the most similar match is the estimate that is used to generate the visual graphemic scaled value. Similarity estimates thus derived are sensitive to the general configurations of the target and compare word and also differences in length that may be present. All of the visual graphemic similarity estimates for the word pairs used in this study are found in Appendix A.

Ascending Letter Similarity

Ascending letter similarity (A) is the ratio of the difference between the number of ascending letters in the target word and the compare words to the total number of letters in the two words. This measure attempts to quantify the perceived similarities between words in terms of the difference in number of ascending letters that are in the target and compare word.

Example C is an instance showing a pair of words with a maximum ascending letter similarity value of 0.

Example C:

d o e	NO. OF ASCENDING LETTERS =	1
d i e	NO. OF ASCENDING LETTERS =	1
	DIFFERENCE	0
	THEREFORE A =	$\lvert 0 \div 6 \rvert = 0$

In example D, there is a difference

b a r n	NO. OF ASCENDING LETTERS =	1
b a n k	NO. OF ASCENDING LETTERS =	2
	DIFFERENCE	-1
	THEREFORE A =	$\lvert -1 \div 8 \rvert = .125$

A similar procedure is used to generate the estimate of descending letter similarity (D). D is defined as the ratio of the difference between the number of descending letters in the target word and the compare word to the total number of letters in both words.

Example E contains an instance in which there is no difference and example F shows what happens when there is a difference.

Example E:

d y e	NO. OF DESCENDING LETTERS =	1
j o k e	NO. OF DESCENDING LETTERS =	1
	DIFFERENCE	0

THEREFORE D = $|0 \div 7| = 0$

Example F:

d y e	NO. OF DESCENDING LETTERS =	1
d o e	NO. OF DESCENDING LETTERS =	0
	DIFFERENCE	1

THEREFORE D = $|1 \div 6| = .167$

Estimates of the ascending and descending similarities for all of the word pairs used in this study are found in Appendix A.

First letter similarity (FL) is a dichotomous measure. The last letter (LL) similarity is also dichotomous. Both measures are derived in an identical fashion. If the first or last letters of the word pairs are identical, a value of one is assigned and if they are different, zero is assigned. Examples G and H show how both measures are derived.

Example G:		Example H:	
	d o e		r i s e
	d i e		b a r n
FL:	d = d or 1	FL:	r $\neq$ b or 0
LL:	e = e or 1	LL:	e $\neq$ n or 0

There is no standardization for length in FL and LL because they are unrelated to the length of the words. Derived values for these indices are shown in Appendix A.

Generation of the Estimates of First Phoneme

Generation of the estimates of first phoneme (FP) and last phoneme similarity (LP) was the most complex of all of the measures. The initial step in this procedure was the accumulation of data on the similarity between phonemes in an easily quantifiable format. The work of Jakobson, Fant and Halle (1952) provides a widely accepted system for the classification of phonemes which was nominally scaled. Because of the nominal scaling measure used in this system, only dichotomous data for the estimates of phoneme similarity could have been generated. Fortunately a novel use of the multidimensional scaling technique dealing with the clustering of common phonemes appeared in Shepard's (1974) paper on the state of the art of multidimensional scaling. The procedure used in this dissertation to derive the measures of phoneme similarity is based on Shepard's original idea and extends it one step further.

The multidimensional scaling or M-D-SCAL technique generates a picture or spatial representation of the relationships among a set of objects O_1, O_2 ..., O_n. A complex mathematical procedure is used to produce this spatial representation from a matrix of proximity values for the objects O_1, O_2, O_3, ..., O_n. Schematically, a proximity matrix such as the one shown in Table 3 would have as entries in its cells some measure of the proximity between each object. The P_{ij}th cell of this matrix then contains some measure of the proximity between O_i and O_j.

Table 3

Proximity Matrix of O_1, O_2, O_3, ..., O_n Objects

	O_1	O_2	O_3 .... O_n
O_1	P_{11}	P_{12}	P_{13} .... P_{1n}
O_2		P_{22}	P_{23} .... P_{2n}
O_3			P_{33} .... P_{3n}
O_n			P_{nn}

The entries in this matrix may be correlation coefficients or as in the case of phonemes, the number of times O_i is confused or mistaken for O_j. This was essentially Shepard's idea, to use a matrix of confusion as an input to generate a spatial representation of the relationship among the phonemes formed by combining a consonant sound with a common vowel phoneme.

Miller and Nicely's (1961) paper in which they presented the confusion matrices for sixteen consonant phonemes under seventeen different conditions of background noise was one of the original sets of data used to derive the estimates used in this study. A second confusion matrix for vowel phonemes was obtained from the work of Fairbanks (1961).

These confusion matrices were analyzed by the M-D-SCAL technique (Shepard, 1962a, 1962b) which has been computerized by Kruskal and Carmone (1969). Prior to the analysis using Kruskal and Carmone's (1969) M-D-SCAL version 5M, the seventeen consonant confusion matrices were averaged. This procedure was unnecessary for the vowel phonemes because only a single matrix was presented.

Multidimensional analysis of the consonant phonemes produced a spatial representation of their groupings which is shown in Figure 1. The figure shows groupings of the consonants which are in close agreement with the distinctive feature analysis model of Jakobson, Fant and Halle (1952). A similar analysis for the vowels is shown in Figure 2. There is no consistent grouping pattern similar to that of the consonants.

The two dimensional solutions of the spatial relationships between the various phonemes is shown mainly for illustrative purposes because in the actual calculations of the inter-phoneme distances, a three dimensional solution was used. Using criteria originally outlined by Shepard (1962a, 1962b) and refined by Kruskal and Carmone (1969), it was determined that a three dimensional solution was the most accurate representation of the data on the phonemes and also the most meaningful and useful. A three dimensional solution is difficult to show graphically and instead, the inter-phoneme distances like the distances between the planets in the solar system is shown in Appendix F.

According to Subkoviak (1972), the geometric inter-phonemic distances are accurate correspondences of the judged similarity between them. The closer the objects, the more similar they are.

In example I, the first and last phonemes of a pair of words are compared using the derived measure.

Example I:

	FP	LP	
b a n k	|b|	|k|	
j o k e	|j|	|k|	(the final e is silent)

FP:	|b| versus |j|	1.329
LP:	|k| versus |k|	0.000 identical phonemes

This procedure was used to derive the inter-phoneme similarity estimates for all of the words used in this study and the derived values can be found in Appendix A. Because the phoneme information found in Miller and Nicely (1961) and Fairbanks (1961) was incomplete, there were no existing data points for some of the phonemes used in this study. Rather than discard the word pair because there was no information on one of the phonemes, the average inter-phoneme distance was substituted. When two phonemes, which had missing data were being compared, the maximum

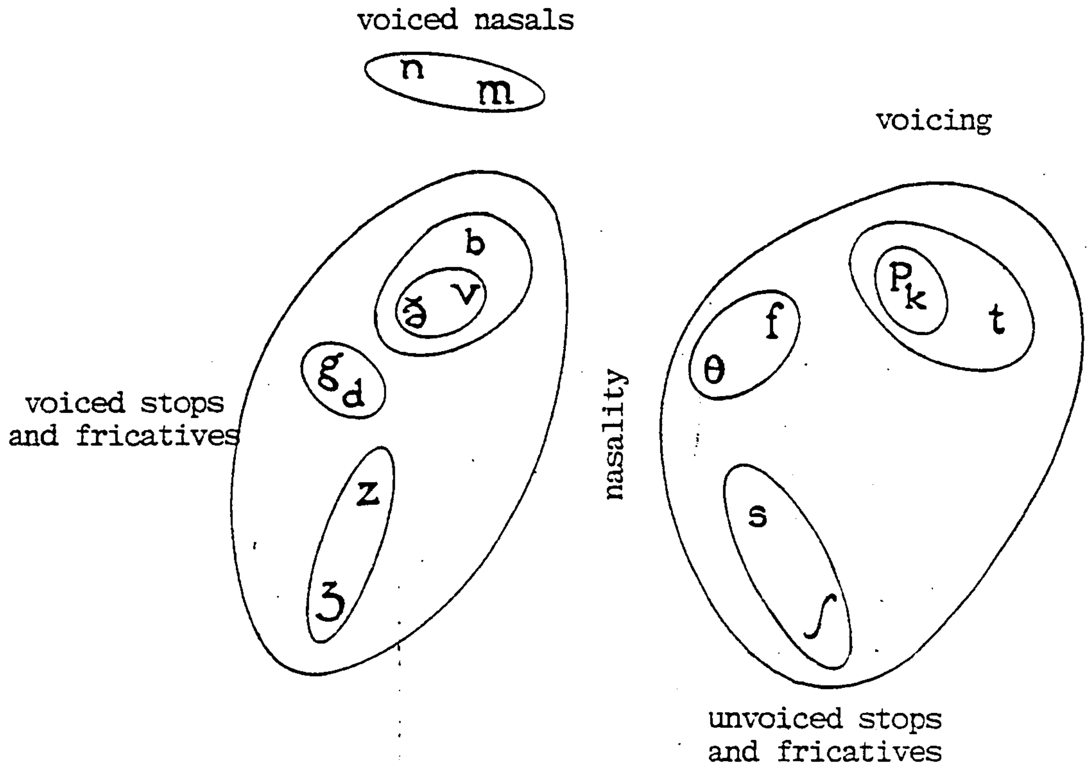


Figure 1. Two dimensional representation of 16 consonant phonemes in space.

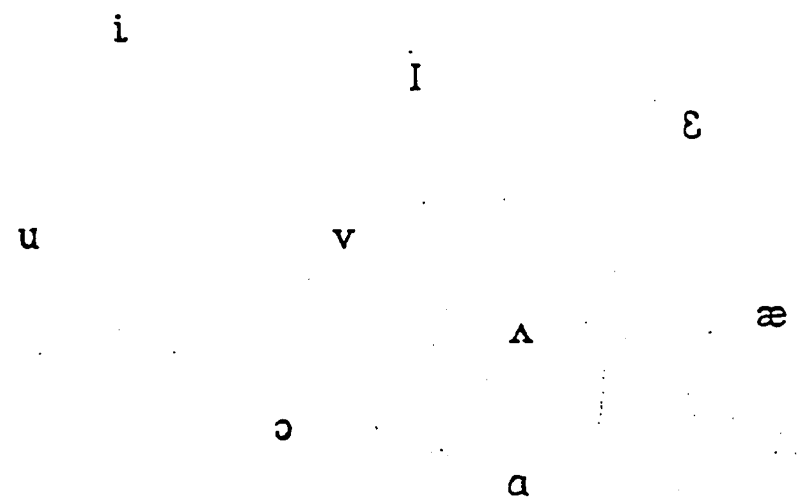


Figure 2. Two dimensional representation of nine vowel phonemes in space.

inter-phoneme distance was used. The use of the average and maximum interphoneme distances was justified on the basis that if there was any resultant bias due to these substitutions, the bias would have been against finding results in the experimenter's favor. The use of an average value tends to reduce the variation in the data and consequently lessens the ability of the linear regression model to capture the subject's strategy.

Meaning Similarity

Meaning similarity (M) was perhaps the weakest of the measures in terms of the procedures used to derive it. This measure was previously described in the review of literature dealing with semantic and syntactic features. Because of the lack of quantifiable data on the meaning similarity for the words used in this study, an instrument was constructed to obtain experimental data on the meaning similarity for the words used. The 276 word pairs were listed using a Likert 7-point scale format with zero indicating maximum dissimilarity and 6 maximum similarity. Alternate forms of the instrument were constructed. Form A tested the words according to procedures suggested by Ross (1939) and Form B reversed both the order of the list and the order of the pairs. Thus the last word in Form A became the first word in Form B and the word order of the pairs were also reversed. These precautions were instituted in order to counteract fatigue and positional effects. Form A was administered to five students and Form B to six students. Detailed instructions for the administration of this instrument are shown in Appendix B. Subjects who requested additional information regarding what the experimenter meant by the word "meaning" were told that they should impose whatever "meaning" they wished. A Pearson's r between the responses for both forms for 100 randomly selected items was calculated and a value of .66 was obtained. The index of meaningfulness was recorded as the sum of the responses across all subjects for each word pair. The values are recorded in Appendix A.

Subjects

All of the word similarity task instruments used in this study were group administered. Subjects were obtained from local elementary schools on a voluntary basis. The schools were located in high density low income areas and the standardized test scores of the students from these schools have consistently been below the average scores for the State of Hawaii.

Form CSA was administered to twelve first grade and twenty-two second grade students at Palolo elementary school and to twenty-five second grade students at Kauilani Elementary School. This form was also administered to thirty-five students in an undergraduate educational psychology class at the University of Hawaii.

Form CSB was administered to twenty-two first grade and sixteen second grade students at Palolo Elementary School and to twenty-eight third graders at Kauilani Elementary School.

The non-contextual form of the test consisting of NCA, NCB, NCC and NCD was administered to twenty-one third grade students at Kauilani Elementary School and twenty third grade students at Palolo Elementary School.

These subject pools did not include the less than 5 percent who submitted incompleted instruments. The subjects submitting incomplete books were found to be non-readers and were attending special classes.

Students in the elementary schools were also given the reading subtest of the Cooperative Primary Test (Educational Testing Services, 1967) prior to the administration of the word comparison task. None of the instruments administered was timed.

CHAPTER 5

RESULTS

Reliability

Reliability estimates of the instruments are subject to problems of bias because of the small number of subjects compared to the number of items in each of the various forms of the instrument. Kuder-Richardson 20 (K-R 20) reliability estimates were calculated for the adult group on Form CSA and a value of .96 was obtained. Another K-R 20 estimate for a third grade class at Palolo was also calculated and a value of .95 was obtained. These were the largest subject groups that could be used to provide any meaningful reliability estimates.

Prediction Equations

Using the stepwise regression technique, a multiple linear regression equation for each of the 200 subjects was calculated. Approximately 80 percent of these equations contained statistically significant beta weights with df = k, n-k-1, $p \leq 0.05$ (see Table 4). Using the criterion for practical significance as $R^2 \geq .25$, 43 percent of the equations attained practical significance. The cutoff of $R^2 \geq .25$ used to denote practical significance in this study corresponds to a multiple correlation coefficient of .50.

The equations for all nine groups tested are found in Appendix E. Table 4 contains a summary of the equations by grade levels in terms of the proportion of each group having significant beta weights for that feature. In interpreting the equations contained in the Appendices, two important points must be remembered: (a) only equations containing significant beta weights are listed; and (b) the direction (+ or -) of the beta weights is an important criterion in determining whether or not the equation listed is meaningful. The beta weights associated with first letter similarity (FL), last letter similarity (LL) and meaning (MG) should be positive while those associated with visual graphemic similarity (VG), first phoneme (FP), last phoneme (LP), ascending letters (A), and descending letters (D) should be negative. The differences in direction are a function of the coding system employed.

In order to illustrate how the equations are interpreted, subject #40 for grade 1, Palolo Elementary School, will be used as an example. The multiple linear regression equation for #40 is $\hat{Y} = .03\ VG + .42\ FL$ ($R^2 = 15$). All beta weights are standardized and consequently will be expressed in standardized units rather than the individual's actual response. The subject tends to indicate that the words increase in similarity when the first letters of the words being compared are identical (beta = .42). There are no other statistically significant strategies. A beta weight of .03 for visual graphemic similarity barely suggests that as the visual similarity of the words increase, this subject tends to indicate that the words do decrease in similarity. Because of the coding system employed in this study, the positive direction of the beta weight associated with visual similarity is the reverse of the measured relationship. Overall, the R^2 for this equation was 15 percent which is below the criterion of 25 percent set for practical significance.

The average R^2 value for each of the groups varied between 12-29 percent for the orally administered instruments for grades 1, 2 and 3 (see Table 4). For all of the groups tested, equations containing statistically significant beta weights were obtained for the majority of subjects in each group (see Table 4). The number of equations with $R^2 \geq 25$ percent was much less as can be seen in Table 4.

Examination of the correlation coefficients between R^2 and reading scores indicates that in the majority of subject groups, there was a significant positive correlation coefficient (see Table 4). There were large variations in the reading scores for the different groups. Table 5 contains the mean, median and standard deviations

Table 4

Summary Statistics Showing Proportion of Subjects Having Statistically Significant Prediction Equations

	Group	Test Form	No.	% Significant Equations $P \leq .05$	$R^2 \geq .25$	Average R^2	Correlation R^2 vs. Reading
A	Grade 1 Palolo	CSA	11	73	18	.12	.68
B	Grade 2 Palolo	CSB	22	64	32	.19	.52
C	Grade 2 Palolo	CSA	22	73	36	.23	.50
D	Grade 2 Palolo	CSB	16	94	50	.22	.65
E	Grade 2 Kaiulani	CSA	25	68	36	.23	.10
F	Grade 3 Likelike	CSB	28	100	54	.29	.61
G	Grade 3 Kaiulani	NC	21	90	29	.26	.13
H	Grade 3 Palolo	NC	20	95	65	.35	-.12
I	College	CSA	35	100	97	.54	—
	Total		200	80	43	.28	

of the reading scores for the various groups.

In order to find out if there were any differences in reading scores between subjects who had significant beta weights for first letter feature and those who did not have significant beta weights, a series of *t* tests were carried out for the various subject groups (Table 6). Subjects with significant beta weights for first letter feature were found to have higher reading scores for Grade 1 Palolo CSA (df = 9, $p \leq .05$) and Grade 3 Likelike CSB (df = 26, $p \leq .05$). A similar analysis was carried out contrasting the reading scores of subjects with statistically significant beta weights for last letter feature and those who did not. Subjects with significant beta weights for last letter feature were found to have higher reading scores for Grade 2 Palolo CSB (df = 20, $p \leq .05$). A similar analysis for meaningfulness feature was carried out. Subjects with statistically significant beta weights were found to have higher reading scores for Grade 2 Palolo CSA (df = 20, $p \leq .05$). No other significant differences were found. Because of the small number of subjects with significant beta weights for the remaining word features, no further *t* tests were performed.

Table 7 contains the proportion of each group by grade level whose beta weights for the various word features reached statistical significance. The features whose beta weights were most frequently statistically

Table 5

Summary Statistics of Reading Scores for Subject Groups

		Test Form	n	Reading Scores Mean	S.D.	Median
A	Grade 1 Palolo	CSA	11	16.3	11.4	12.0
B	Grade 2 Palolo	CSB	22	12.1	8.8	12.0
C	Grade 2 Palolo	CSA	22	18.4	10.4	17.5
D	Grade 2 Palolo	CSB	16	18.8	11.8	20.0
E	Grade 2 Kaiulani	CSA	25	20.0	5.4	21.0
F	Grade 3 Likelike	CSB	28	27.1	7.0	27.5
G	Grade 3 Kaiulani	NC	21	24.1	6.2	24.0
H	Grade 3 Palolo	NC	20	21.0	11.5	20.5
			165			

Table 6

Comparisons of Various Subject Groups Based on Reading Scores

		Test	FL			Non-FL				LL			Non-LL				MG			Non-MG			
		Form	n	Mean	S.D.	n	Mean	S.D.	t	n	Mean	S.D.	n	Mean	S.D.	t	n	Mean	S.D.	n	Mean	S.D.	t
A	Grade 1 Palolo	CSA	3	27.7	7.6	8	12.0	9.4	2.34*	2	22.0	10.0	9	15.0	11.24	1.78	2	22.5	14.84	9	14.89	11.74	.71
B	Grade 2 Palolo	CSB	3	20.0	.8	19	10.9	8.9	1.69	5	18.8	3.54	17	10.18	8.96	2.00*	4	18.75	9.00	18	10.67	8.60	1.61
C	Grade 2 Palolo	CSA	7	23.4	8.6	15	16.0	10.4	1.56	3	14.67	2.62	19	18.95	11.06	.64	11	23.18	8.69	11	13.55	10.61	2.21*
D	Grade 2 Palolo	CSB	2	30.0	1.0	14	17.2	11.8	1.43	6	24.17	6.44	10	13.8	12.03	1.82	6	21.67	14.25	10	17.1	11.26	.66
E	Grade 2 Kaiulani	CSA	8	19.1	4.9	17	20.4	5.5	.23	—	—	—	25	20.0	5.37	—	7	20.71	3.90	18	19.72	6.06	.38
F	Grade 3 Likelike	CSB	11	31.6	5.1	17	24.2	6.4	3.10*	8	27.75	8.60	20	26.80	6.15	.32	13	28.31	7.05	15	26.0	7.17	.83
G	Grade 3 Kaiulani	NC	3	20.3	5.9	18	24.8	6.1	1.11	2	19.50	4.50	19	24.63	6.18	1.09	11	24.45	7.10	10	23.8	5.85	.22
H	Grade 3 Palolo	NC	7	13.4	7.8	13	25.1	11.1	1.56	2	21.50	16.5	18	20.94	10.79	.06	12	28.08	21.64	8	16.13	6.38	1.44

*Significant at $p \leq .05$.

Table 7

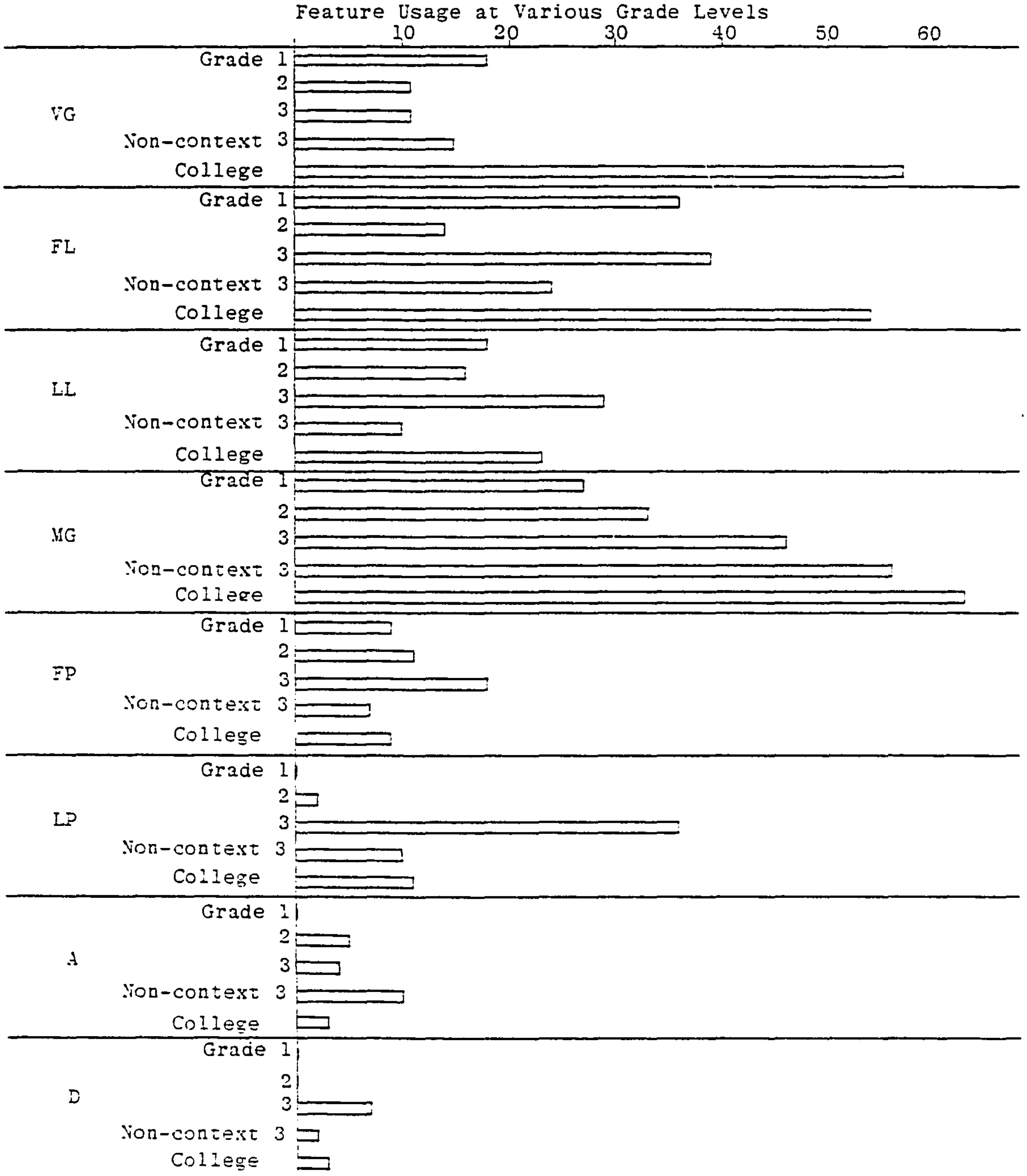
Proportion of Subjects in Each Grade Level with Statistically Significant Beta Weights for Each Word Feature

Group	N	Features							
		VG	FL	LL	MG	FP	LP	A	D
Oral Forms Grade 1	11	18	36	18	27	9	0	0	0
Oral Forms Grade 2	85	11	14	16	33	11	2	5	0
Oral Forms Grade 3	28	11	39	29	46	18	36	4	7
Non-Context Grade 3	41	15	24	10	56	7	10	10	2
Oral Forms College	35	57	54	23	63	9	11	3	3

significant were first letter (FL), last letter (LL), and meaning (MG). Except for the college students, visual graphemic (VG) was the least frequently occurring overall. The phonemic features, first phoneme (FP) and last phoneme (LP) occurred less frequently. Ascending letters (A) and descending letters (D) occurred a very small percentage of the time. Figure 3 is a graphic illustration of the data in Table 7.

Figure 3

Bar Graph Showing Relationship between Feature Usage at Various Grade Levels



CHAPTER 6

DISCUSSION AND CONCLUSIONS

It would appear that the stepwise regression technique can be used to analyze responses to a word comparison task. Multiple linear regression equations with statistically significant beta weights were derived from the responses of the majority of subjects. The more stringent criterion of $R^2 = .25$ resulted in 37 percent fewer equations attaining a level of practical significance. Before it is possible to ascribe any significance to these findings, it is necessary to investigate whether or not the fact that a significant beta weight was obtained is a valid indication that the method is accurately measuring an individual's strategy.

Any method of validating the results of this study must address itself to the question of whether or not the multiple linear regression equation obtained for an individual is an accurate representation of his word comparison strategy. The most direct but not necessarily the best method is to simply ask what kinds of features of the words were being utilized when the pairwise comparisons were being made. This would most certainly seem to provide the necessary validation since each individual might know what strategy he or she used. Unfortunately the understanding of the spoken or written word is a complex set of cognitive processes such as the abstraction of information, the ignoring of irrelevant information, and the reduction of uncertainty (Gibson and Levin, 1975) that it seems reasonable to assume that an elementary school student would not be able to verbalize them accurately. If, instead of asking for a description of the processes, one asked how a prescribed set of features were used it would be difficult to know if the information obtained is free from experimenter or instructional set bias. The ideal method would employ one or more unobtrusive measures in determining whether or not the derived multiple linear regression is an accurate representation of the individual's strategy. Because a direct inquiry method of validation was not feasible, this study employed an inferential strategy in assessing the validity of this study. In previously cited literature (Gibson and Levin, 1975; Marchbanks and Levin, 1965; Huey, 1908, Samuels, 1970; Dunn-Rankin, 1976; Anderson and Dearborn, 1952; Merikle and Coltheart, 1972; and Matsuda, 1971), it has been shown that the most frequently used cues in word recognition have been first letter, last letter, and word meaning. These features are also those whose significant beta weights occur most frequently in this study (see Figure 3). On this basis, it would appear that the procedure used in this study to capture an individual's word comparison strategy is in agreement with the results of other studies. It might be argued that these results were obtained because of some inherent biases in the instruments or subjects used.

There are various sources of bias that might have entered into the procedures which could have produced the results obtained. Some biases may be due to the sample while others are inherent in the instruments.

Possible Sample Biases

Because of the non-representativeness of the samples of subjects selected, it is possible that the results obtained were a function of the relatively low academic reading achievement level of the students comprising the samples. The average reading scores for the sample groups on Form 12 of the Cooperative Primary Test is 16.30 for grade 1, 17.20 on Form 23 for grade 2, and 25.14 on Form 23 for grade 3. These are lower scores than the national norms ($p \leq .05$) for the test. However, since there were only a few isolated differences between the reading scores of the students who had statistically significant beta weights for first letter, last letter and meaningfulness features, it seems reasonable to assume that usage of these cues is not necessarily a function of reading ability level. Only a few significant differences were found between groups for the various cues and there was no evident pattern in these differences (Table 6). The finding of substantially no difference in the type of strategy used and reading scores is based on very small numbers of subjects ($n < 5$) in some of the groups.

Based on the results of this study, it would appear that the type of feature used is invariant of the reading ability of the subject. Although it seems quite clear that certain types of strategies dominate more than others.

Possible Instrument Biases

The measurement of the features or unique characteristics of the words may have also provided a source of bias in the results.

Visual Graphemic (VG)

The mean VG for Form CSA was 23.37 and for Form CSB, 32.03 on a scale of zero to 100. These values indicate that the words contained letters that were relatively visually similar to each other and also contained about the same number of letters. Even though the words tended to be alike, VG was not the dominant cue used by elementary school subjects. The lack of dominance appears unrelated to whether or not the words are read to the student or they are read alone since the proportion of students having statistically significant beta weights for VG is approximately the same for the oral administration and the non-oral administration (see Table 7). An assumption was made that the sum of the letter similarities is equivalent to the total word similarities. Evidence for the rejection of this assumption is not within the scope of this study but is worth further investigation, since it is fundamental to the validity of this index. In addition, this is the only documented application of the Dunn-Rankin (1968) scale to measure the similarity of words. Although the scale was shown to by psychometrically sound in the original study, further experimentation is needed to find out if the results are replicable.

First Letter (FL) and Last Letter (LL)

Most of the words in this study did not have the same first letter. In light of this fact it is remarkable that the use of the first letter as a strategy was so dominant. The same is also true of the last letter feature. It could be argued that these results were due to the fact that these features were the only ones measured dichotomously and perhaps if the first letters had been measured using the Dunn-Rankin scale, these same results would not have been obtained. Because of the large expenditure of time required, that hypothesis was not tested. The decision to use a dichotomous measure was to have some common ground for comparison between the results of this study and those cited such as Marchbanks and Levin (1965); Huey (1908); Samuels (1970); and Anderson and Dearborn (1952).

Meaningfulness (MG)

This is the weakest of the measures and besides being based on a small scale study, makes the assumption that the meaningfulness attributed to words by adults and children is similar. In general, the words used in this study were not very similar in meaning (8.8 on a scale of 0-66). Meaningfulness is very idiosyncratic in children but despite the idiosyncratic nature, it seems reasonable to assume that the repertoire of meanings that a child associates with a word will be a subset of those an adult would associate with the same word. An example of this would be a young child's definition of familiar things such as a tricycle as being a bicycle with training wheels, or an egg carton as being a bird's nest. The meanings are unique but they still represent a subset of an adult's conception of the word. Gibson and Levin (1975) point out that the child's unique associations are due to the individual's unique experiences. But they also point out that while they may be unique, they may not necessarily be widely varying from the associations of an adult as the analogies tried to demonstrate. Examination of the Palermo and Jenkins (1964) word association norms for fourth grade through college not only indicates that adults tend to provide less idiosyncratic responses but also that the patterns of most frequent associations is relatively invariant of grade level. At best, we can say that a child's meaning may be similar to an adult's but we cannot be certain unless we ask the child. This study assumes that they are, and in doing so, may have introduced a bias in the results which would have tended to decrease the effect of meaning in the multiple linear regression equations for the elementary school subjects.

First Phoneme (FP) and Last Phoneme (LP)

A major drawback of the procedure is the substitution of the average interphonemic distance for pairs of phonemes where no data exist. This substitution tends to decrease the variance of the measures and could reduce any tendency towards statistical significance. Miller and Nicely (1961) and Fairbanks (1961) investigated approximately 60 percent of the phonemes that have been classified so far in the English language. The average interphonemic distance was substituted in approximately 33 percent of the FP comparisons and 11 percent of the LP comparisons. What effect this may have had on the overall results is unknown. An obvious improvement is the generation of data for the remainder of the phonemes to eliminate the need for the substitution of an average value. The transformation of the confusion matrices for consonants and vowels using a multidimensional scaling technique seems to be a valid procedure and should be retained in future studies.

Ascending Letter (A) and Descending Letter (D)

Examination of the mean values for (A) and (D) and their standard deviations indicates that there was a large variation in the differences between the words as evidenced by the size of the standard deviations when compared with the mean values (Tables 7 and 8). This was mainly due to the large percentage of word pairs exhibiting no ascending letter differences (34 percent) and no descending letter differences (74 percent). The resultant distributions of (A) and (D) values were bimodal. It is possible that this may have had some effect on the number of significant beta weights obtained for these features. Although it would be probably impossible to predict the effect on the linear model. In the case of the Grade 1 group, it would not decrease the number since no significant beta weights associated with ascendancy or descending letters were found (Table 7).

In general, the kinds of biases that might have arisen from the procedures used in deriving the feature indices would tend to decrease the ability of the procedure to successfully calculate a multiple linear regression equation with significant beta weights. Despite the possible

Table 8

Summary Feature Statistics of the Instruments

Word Feature	Form CSA Mean	Form CSA S.D.	Form CSB Mean	Form CSB S.D.	Form NCC Mean	Form NCC S.D.
Visual Graphemic (VG)	23.37	8.04	32.03	13.08	28.76	9.85
First Letter (FL)	.09	.29	.11	.32	.08	.27
Last Letter (LL)	.25	.44	.15	.36	.16	.37
Meaning (MG)	8.87	11.28	8.18	11.20	7.59	10.44
First Phoneme (FP)	1.17	.46	1.50	.98	1.40	.78
Last Phoneme (LP)	.61	.56	1.95	.88	1.51	.96
Ascenders (A)	.13	.11	.06	.06	.10	.09
Descenders (D)	.03	.05	.03	.06	.03	.05

presence of these biases, the procedure was at least moderately successful since between 18 percent to 65 percent of the multiple linear equations calculated had R^2 values $\geq .25$. The arbitrary "practical" significance level of $R^2 \geq .25$ is far more stringent than the standard test of significance for the multiple R being different from zero. If the standard test of significance was used, the multiple R required to reach significance (df = 66 $\leq .05$) is .24 which is equivalent to an R^2 of 0.06. This could have resulted in situations in which the multiple linear regression equation would have a statistically significant multiple R because of the large sample size but no statistically significant beta weights. Consequently a more stringent criterion was employed.

A stepwise technique was used to calculate the equations for this study. The technique is recommended (Kim and Kohout, 1975) in instances where no prior hypothesis regarding a hierarchy in the variables is known. Rather than assume that, for example, (FL) features would be the most dominant, the technique selects the variable with the highest partial coefficient as being the first to insert in the analysis. Christal (1976) has made the suggestion that in the case in which there is no clear hypothesis governing the order of inclusion of the variables in the analysis, then all possible combinations should be calculated and the most reasonable solution(s) accepted. If an attempt was made to calculate all possible combinations of variables, it approaches a formidable task since all possible combinations of eight variables taken eight at a time already exceeds 40,000. Clearly, this procedure is not feasible in a study of this scope even assuming one could logically eliminate 99 percent of the equations. It would still involve the calculation of hundreds of multiple linear regression equations for each subject. The task is not confined to the calculation but also to the evaluation of these resultant equations. The stepwise procedure seemed to be the most efficient besides having a rationale for its selection. Allowing a stepwise procedure to select the order of inclusion of the variables into the multiple linear equation lessens the ability to detect "suppressor" variables which may be disguising the true relationships between the variables. However, McNemar (1975) has noted that in general, suppressor variables are an uncommon feature of linear regression analysis. Consequently the stepwise procedure seems to be the most acceptable procedure for calculating the multiple linear equations for the individuals in this study.

The assumption has been made through this study that a linear relationship exists between the variables. There is no prior reason to believe that the linear solution is not the optimum solution. Use of a linear model has produced at least moderate success in calculating the prediction equation. It is possible that a polynomial solution may be more efficient in terms of increasing the R^2 values. How one would begin to interpret the results, however, might be difficult depending on the polynomial function that produces the most efficient solution. In terms of effort involved, the isolation of possible polynomial regression equations is not as formidable as the calculation of all possible combinations of variables. Nevertheless, it is still quite large because one would need to calculate polynomial solutions for different combinations of the variables. Unless there is some prior rationale for hypothesizing a non-linear solution to the regression equations, it does not seem reasonable to doubt that the linear solution is adequate.

The words used in this study because of their non-random selection could be a possible source of bias. Initially, certain biases were included in the words used in this study, such as the presence of homonyms, and visually similar words. A simple way of determining whether or not these factors are biasing the results of this study would be to select a truly random sample of words and perform an identical study on matched groups of individuals. If the results are similar, then it suggests that the procedure is invariant of the words used. Because two different forms of the oral instrument were used in this study, there was a possibility that this could have been tested, but it was found that the average reading scores of both groups (df = 83, $t = 2.4$, $p \leq .05$) were significantly different. In the beginning of the Discussion section, it was shown that the strategy used is probably invariant of the individual's reading ability. These comparisons were made between individuals within subject groups taking the same form of the instrument. In this case, the comparisons were made between individuals within subject groups taking different forms of the instrument.

Therefore if the groups being compared are different in reading ability, there may be an interaction between the effect of reading ability and the form of the instruments. A valid test of the comparability of the instrument cannot be made with the data from this study.

Because of the non-random sample groups used in this study, between group comparisons to show the possible existence of developmental trends are to be viewed with caution. A number of possible trends seem promising and should be further studied using more rigid experimental controls. There seems to be an increase in R^2 with age. This may be an indication that as the individual gains in confidence and experience with the language, a more consistent strategy emerges. There also seems to be a gradual increase in the importance of meaning as a strategy as age increases. Again, this may be due to the enrichment of the individual's repertoire of associations and word meanings or a closer alignment of his repertoire to that of the adult world. It should be noted that the increase in the frequency of usage of a particular strategy does not mean the same corresponding decrease in the frequency of usage of another. A more plausible explanation would be that the individual has increased his repertoire of strategies to use in deciphering words. These trends are speculative and can only be verified by other studies designed to specifically test for them.

No attempt was made to contrast the results obtained from the non-contextual forms of the instrument and the oral forms of the instrument. One of the major reasons for this is due to the fact that not enough subjects were obtained to respond to each of the non-contextual forms. At the risk of sounding repetitious, this is another factor which needs further investigation. All of the findings reported have used data from the oral forms unless otherwise specified.

There seems to be a significant relationship between reading ability as measured by a standardized reading test and the R^2 value calculated for the multiple linear regression equation for an individual. A hierarchical clustering procedure (Ward, 1963) was used to determine if there were any patterns in the various types of strategies used by individuals. There were almost as many strategies as there were individuals. Thus the instrument may be indicating that good readers may be consistently using one of many different kinds of strategies. An analysis reveals that individuals with relatively high reading abilities can only be characterized by the consistency with which they apply their reading strategy. Individuals with low reading ability do not have a consistent strategy. There is no "right way" but only the consistent application of a strategy which works best for an individual.

APPENDICES

APPENDIX A

LIST OF WORDS WITH MATRIX OF WORD FEATURE VALUES

APPENDIX A.

THIS IS THE COMPLETE LIST OF WORDS FOR THE WORD SIMILARITY TASK

VG = INDEX OF VISUAL GRAPHEMIC SIMILARITY
FL = INDEX OF FIRST LETTER SIMILARITY
LL = INDEX OF LAST LETTER SIMILARITY
MG = INDEX OF MEANING SIMILARITY
FP = INDEX OF FIRST PHONEME SIMILARITY
LP = INDEX OF LAST PHONEME SIMILARITY
A = INDEX OF ASCENDING LETTER SIMILARITY
D = INDEX OF DESCENDING LETTER SIMILARITY

	VG	FL	LL	MG	FP	LP	A	D
001TOAST-JOKE	027	00	00	011	01329	00304	0000	0111
002STACK-DOE	037	00	00	006	01403	02630	0125	0000
003ROWS-BANK	023	00	00	007	01329	01116	0250	0000
004TEA-GOATS	037	00	00	001	02193	02630	0000	0125
005DATE-FATE	006	00	01	013	01373	00000	0000	0000
006CHALK-COLORED	041	01	00	018	01329	01873	0167	0000
007COLONEL-ATE	048	00	00	005	02630	01329	0100	0000
008DIE-DYE	010	01	01	004	00000	00000	0000	0167
009BLACK-BARN	025	01	00	006	00000	01942	0222	0000
010FEAST-EIGHT	034	00	01	009	02630	00000	0000	0000
011ROSE-BARK	025	00	00	010	01329	01116	0250	0000
012TOAST-KERNEL	030	00	00	011	00304	01329	0000	0000
013JOKE-RISE	023	00	01	007	01329	01116	0250	0125
014STACK-BANK	025	00	01	009	01526	00000	0000	0000
015ROWS-GOATS	027	00	01	004	01329	00000	0000	0111
016TEA-FATE	031	00	00	002	00729	02630	0143	0000
017DATE-COLORED	038	00	00	004	01878	02086	0000	0000
018CHALK-ATE	039	00	00	002	02630	02630	0250	0000
019COLONEL-DYE	050	00	00	004	01878	02630	0100	0100
020DIE-BARN	032	00	00	005	00737	02630	0000	0000
021BLACK-EIGHT	022	00	00	006	02630	00304	0100	0100
022FEAST-BARK	025	00	00	007	01061	00304	0000	0000
023ROSE-KERNEL	036	00	00	009	01329	01329	0200	0000
024TOAST-RISE	032	00	00	015	01329	01114	0222	0000
025JOKE-DOE	032	00	01	003	01329	02630	0143	0000
026STACK-GOATS	027	00	00	004	01514	00304	0100	0100
027ROWS-FATE	018	00	00	005	01329	01114	0250	0000
028TEA-COLORED	049	00	00	015	00304	02630	0000	0000
029DATE-ATE	017	00	01	014	02530	00000	0143	0000
030CHALK-DYE	038	00	00	012	01329	02630	0250	0125
031COLONEL-EARN	039	00	00	004	01497	01329	0083	0000
032DIE-EIGHT	038	00	00	003	02630	02630	0125	0125
033BLACK-BARK	020	01	01	010	00000	00000	0111	0000
034FEAST-KERNEL	028	00	00	008	00506	01329	0000	0000
035TOAST-ROSE	025	00	00	008	01329	01114	0222	0000
036RISE-DOE	029	00	01	008	01329	02630	0143	0000
037JOKE-BANK	026	00	00	006	01329	00000	0000	0000
038STACK-FATE	030	00	00	007	00824	00304	0000	0000
039ROWS-COLORED	040	00	00	006	01329	01403	0091	0000
040TEA-ATE	028	00	00	015	02630	02630	0000	0000
041DATE-DYE	027	01	01	001	00000	02630	0143	0143
042CHALK-BARN	031	00	00	003	01329	01942	0222	0000
043COLONEL-EIGHT	032	00	00	002	02630	01329	0000	0083
044DIE-BARK	032	00	00	009	00737	02630	0143	0000

045BLACK-KERNEL	027	00	00	003	01497	02630	0091	0000
046FEAST-ROSE	027	00	00	008	01329	01114	0222	0000
047TOAST-DOE	035	00	00	008	02086	02630	0125	0000
048RISE-BANK	030	00	00	009	01329	01116	0250	0000
049JOKE-GOATS	030	00	00	001	01329	01116	0111	0000
050STACK-COLORED	035	00	00	004	01116	01878	0000	0000
051ROWS-ATE	030	00	00	010	02630	01114	0143	0000
052TEA-DYE	023	00	00	014	02085	01403	0000	0167
053DATE-BARN	014	00	00	005	00737	02244	0125	0000
054CHALK-EIGHT	017	00	00	001	02630	00304	0100	0100
055COLONEL-BARK	041	00	00	003	01497	01329	0000	0000
056DIE-KERNEL	046	00	00	004	01878	02630	0111	0000
057BLACK-ROSE	031	00	00	005	01329	01116	0222	0000
058TOAST-FEAST	006	00	01	019	00729	00000	0000	0000
059DOE-BANK	027	00	00	005	00737	02630	0143	0000
060RISE-GOATS	036	00	00	005	01329	00000	0111	0000
061JOKE-FATE	013	00	01	007	01329	00304	0000	0000
062STACK-ATE	034	00	00	008	02630	00304	0125	0000
063ROWS-DYE	027	00	00	001	01329	02630	0143	0143
064TEA-BARN	031	00	00	001	01771	02630	0000	0000
065DATE-EIGHT	034	00	00	005	02630	00000	0000	0111
066CHALK-BARK	021	00	01	001	01329	00000	0111	0000
067COLONEL-KERNEL	025	00	01	001	00000	00000	0000	0000
068DIE-ROSE	032	00	01	008	01329	02630	0143	0000
069BLACK-FEAST	020	00	00	005	01061	00304	0100	0000
070TOAST-BANK	024	00	00	004	01771	00304	0000	0000
071DOE-GOATS	043	00	00	007	00000	00000	0000	0125
072RISE-FATE	021	00	01	007	01329	01114	0250	0000
073JOKE-COLORED	035	00	00	007	01329	01878	0091	0091
074STACK-DYE	042	00	00	002	01403	02630	0125	0125
075ROWS-BARN	024	00	00	004	01329	02257	0125	0000
076TEA-EIGHT	042	00	00	004	02630	02630	0125	0125
077DATE-BARK	016	00	00	004	00737	00304	0000	0000
078CHALK-KERNEL	029	00	00	002	01329	01329	0091	0000
079COLONEL-ROSE	039	00	00	005	01329	01329	0182	0000
080DIE-FEAST	041	00	00	008	01373	02630	0125	0000
081TOAST-BLACK	019	00	00	011	01771	00304	0100	0000
082BANK-GOATS	028	00	00	006	00777	01116	0111	0111
083DOE-FATE	033	00	01	003	01373	02630	0143	0000
084RISE-COLORED	043	00	00	003	01329	01403	0091	0000
085JOKE-ATE	024	00	01	003	02630	00304	0143	0143
086STACK-BARN	028	00	00	009	01526	01942	0111	0000
087ROWS-EIGHT	032	00	00	005	02630	01114	0222	0111
088TEA-BARK	031	00	00	002	01771	02630	0143	0000
089DATE-KERNEL	036	00	00	002	01878	01329	0000	0000
090CHALK-ROSE	037	00	00	002	01329	02630	0333	0000
091COLONEL-FEAST	031	00	00	009	00506	01329	0000	0000
092DIE-BLACK	031	00	00	014	00737	02630	0250	0000
093TOAST-GOATS	020	00	00	005	02193	01114	0100	0100
094BANK-FATE	024	00	00	004	01061	00304	0000	0000
095DOE-COLORED	050	00	00	006	01878	02630	0100	0000
096RISE-ATE	030	00	01	011	02630	02630	0143	0000
097JOKE-DYE	026	00	01	003	01329	02630	0143	0143
098STACK-EIGHT	019	00	00	004	02630	00304	0000	0100
099ROWS-BARK	026	00	00	004	01329	01116	0250	0000
100TEA-KERNEL	043	00	00	007	00304	02630	0111	0000
101DATE-ROSE	020	00	01	004	01329	01114	0250	0000
102CHALK-FEAST	025	00	00	002	01329	00304	0100	0000
103COLONEL-BLACK	034	00	00	005	01497	01329	0333	0000

104TOAST-DIE	041	00	00	004	02086	02630	0125	0000
105GOATS-FATE	024	00	00	002	01477	01114	0111	0111
106BANK-COLORED	042	00	00	003	01497	01878	0000	0000
107DOE-ATE	022	00	01	014	02630	02630	0000	0000
108RISE-DYE	030	00	01	006	01329	02630	0000	0143
109JOKE-BARN	022	00	00	006	01329	01942	0125	0125
110STACK-BARK	022	00	01	006	01526	00000	0000	0000
111ROWS-KERNEL	037	00	00	005	01329	01329	0200	0000
112TEA-ROSE	031	00	00	006	01329	02630	0143	0000
113DATE-FEAST	026	00	00	013	01373	00000	0000	0000
114CHALK-BLACK	015	00	01	006	01329	00000	0000	0000
115COLONEL-DIE	049	00	00	009	01878	02630	0100	0000
116TOAST-FATE	028	00	00	004	00729	00000	0000	0000
117GOATS-COLORED	034	00	00	007	01981	01403	0083	0083
118BANK-ATE	035	00	00	007	02630	02630	0143	0000
119DOE-DYE	014	00	01	004	00000	01403	0000	0167
120RISE-BARN	027	00	00	007	01329	02257	0125	0000
121JOKE-EIGHT	026	00	00	004	02630	00304	0000	0111
122STACK-KERNEL	023	00	00	001	01116	01329	0000	0000
123ROWS-ROSE	013	01	00	007	00000	00000	0000	0000
124TEA-FEAST	029	00	00	019	00729	02630	0125	0000
125DATE-BLACK	031	00	00	007	00737	00304	0111	0000
126CHALK-DIE	041	00	00	003	01329	02630	0250	0000
127TOAST-COLONEL	029	00	00	008	00304	01329	0000	0000
128FATE-COLORED	036	00	00	006	00506	02086	0000	0000
129GOATS-ATE	030	00	00	013	02630	01114	0000	0125
130BANK-DYE	032	00	00	003	00737	02630	0143	0143
131DOE-BARN	026	00	00	003	00737	02630	0000	0000
132RISE-EIGHT	030	00	00	009	02630	01114	0222	0111
133JOKE-BARK	025	00	00	008	01329	00000	0000	0125
134STACK-ROSE	031	00	00	008	01329	01116	0222	0000
135ROWS-FEAST	026	00	00	007	01329	01114	0222	0000
136TEA-BLACK	034	00	00	016	01771	02630	0250	0000
137DATE-DIE	025	01	00	007	00000	02630	0143	0000
138CHALK-COLONEL	033	01	00	003	01329	01329	0083	0000
139TOAST-COLORED	029	00	00	007	00304	02086	0000	0000
140FATE-ATE	017	00	01	003	02630	00000	0143	0000
141GOATS-DYE	037	00	00	002	00113	02630	0000	0000
142BANK-BARN	012	01	00	008	00000	01942	0125	0000
143DOE-EIGHT	045	00	00	007	02630	02630	0125	0125
144RISE-BARK	029	00	00	006	01329	01116	0250	0000
145JOKE-KERNEL	037	00	00	006	01329	01329	0000	0100
146STACK-FEAST	021	00	00	008	00834	00304	0000	0000
147ROWS-BLACK	034	00	00	003	01329	01116	0333	0000
148TEA-DIE	022	00	00	004	02086	01403	0000	0000
149DATE-COLONEL	039	00	00	002	01878	01329	0000	0000
150TOAST-CHALK	025	00	00	004	01329	00304	0100	0000
151COLORED-ATE	047	00	00	003	02630	02630	0100	0000
152FATE-DYE	027	00	01	004	01370	02630	0143	0143
153GOATS-BARN	024	00	00	018	00777	02257	0000	0111
154BANK-EIGHT	030	00	00	010	02630	00304	0000	0111
155DOE-BARK	026	00	00	005	00737	02630	0143	0000
156RISE-KERNEL	034	00	00	008	01329	01329	0200	0000
157JOKE-ROSE	015	00	01	005	01329	01116	0250	0125
158STACK-BLACK	014	00	01	003	01526	00000	0100	0000
159ROWS-DIE	030	00	00	006	01329	02630	0143	0000
160TEA-COLONEL	048	00	00	006	00304	02630	0100	0000
161DATE-CHALK	026	00	00	004	01329	00304	0111	0000
162TOAST-ATE	030	00	00	019	02630	00000	0125	0000

163COLORED-DYE	049	00	00	033	01878	02630	0100	0000
164FATE-BARN	017	00	00	003	01061	02244	0125	0000
165GOATS-EIGHT	025	00	00	005	02630	01114	0100	0000
166BANK-BARK	006	01	01	002	00000	00000	0000	0000
167DOE-KERNEL	046	00	00	006	01878	02630	0111	0000
168RISE-ROSE	012	01	01	029	00000	00000	0000	0000
169JOKE-FEAST	030	00	00	014	01329	00304	0000	0111
170STACK-DIE	041	00	00	005	01403	02630	0125	0000
171ROWS-COLONEL	039	00	00	006	01329	01329	0182	0000
172TEA-CHALK	042	00	00	003	01329	02630	0250	0000
173TOAST-DATE	030	00	00	010	02086	00000	0000	0000
174ATE-DYE	014	00	01	004	02630	02630	0000	0167
175COLORED-BARN	038	00	00	010	01497	01402	0091	0000
176FATE-EIGHT	032	00	00	003	02630	00000	0000	0111
177GOATS-BARK	027	00	00	003	00777	01116	0111	0111
178BANK-KERNEL	036	00	00	004	01497	01329	0000	0000
179DOE-ROSE	029	00	01	007	01329	02630	0143	0000
180RISE-FEAST	031	00	00	010	01329	01114	0222	0000
181JOKE-BLACK	031	00	00	007	01329	00000	0111	0111
182STACK-COLONEL	035	00	00	002	01116	01329	0000	0000
183ROWS-CHALK	033	00	00	005	01329	01116	0333	0000
184TEA-DATE	035	00	00	013	02086	02630	0143	0000
185TOAST-DYE	041	00	00	002	02086	02630	0125	0125
186ATE-BARN	028	00	00	010	02630	02630	0000	0000
187COLORED-EIGHT	034	00	00	003	02630	02086	0000	0083
188FATE-BARK	020	00	00	003	01061	00304	0000	0000
189GOATS-KERNEL	028	00	00	009	01981	01329	0091	0091
190BANK-ROSE	028	00	00	007	01329	01116	0250	0000
191DOE-FEAST	036	00	00	006	01373	02630	0125	0000
192RISE-BLACK	026	00	00	001	01329	01116	0333	0000
193JOKE-DIE	028	00	01	004	01329	02630	0143	0143
194STACK-CHALK	014	00	01	002	01329	00000	0100	0000
195ROWS-DATE	022	00	00	002	01329	01114	0250	0000
196TOAST-TEA	029	01	00	013	00000	02630	0125	0000
197DYE-BARN	032	00	00	002	00737	02630	0000	0143
198ATE-EIGHT	037	00	00	007	00000	00000	0125	0125
199COLORED-BARK	040	00	00	009	01497	01878	0000	0000
200FATE-KERNEL	034	00	00	003	00506	02630	0000	0000
201GOATS-ROSE	030	00	00	004	01329	00000	0111	0111
202BANK-FEAST	029	00	00	002	01061	00304	0000	0000
203DOE-BLACK	035	00	00	001	00737	02630	0250	0000
204RISE-DIE	029	00	01	003	01329	02630	0143	0000
205JOKE-COLONEL	035	00	00	008	01329	01329	0000	0091
206STACK-DATE	032	00	00	004	01403	00304	0000	0000
207ROWS-TEA	032	00	00	002	01329	02630	0143	0000
208TOAST-BARN	025	00	00	003	01771	02244	0111	0000
209DYE-EIGHT	044	00	00	004	02630	02630	0125	0000
210ATE-BARK	031	00	00	004	02630	02630	0143	0000
211COLORED-KERNEL	030	00	00	008	00000	01329	0000	0000
212FATE-ROSE	017	00	01	005	01329	01114	0250	0000
213GOATS-FEAST	021	00	00	011	01477	01114	0100	0100
214BANK-BLACK	022	01	01	004	00000	00000	0111	0000
215DOE-DIE	014	01	01	004	00000	01403	0000	0000
216RISE-COLONEL	043	00	00	012	01329	01329	0182	0000
217JOKE-CHALK	029	00	00	002	01329	00000	0111	0111
218STACK-TEA	034	00	00	004	01114	02630	0125	0000
219TOAST-ROWS	026	00	00	007	01329	01114	0222	0000
220BARN-EIGHT	035	00	00	003	02630	01771	0111	0111
221DYE-BARK	032	00	00	011	00737	02630	0143	0000

222ATE-KERNEL	046	00	00	015	02630	02630	0111	0000
223COLORED-ROSE	038	00	00	023	01329	01403	0182	0000
224FATE-FEAST	027	01	00	005	00000	00000	0000	0000
225GOATS-BLACK	026	00	00	008	00777	01116	0200	0100
226BANK-DIE	032	00	00	003	00737	02630	0143	0000
227DOE-COLONEL	050	00	00	004	01878	02630	0100	0000
228RISE-CHALK	033	00	00	001	01329	01116	0333	0000
229JOKE-DATE	015	00	01	009	01329	00304	0000	0125
230STACK-ROSE	035	00	00	020	01329	01116	0222	0000
231TOAST-EIGHT	026	00	01	011	02630	00000	0000	0100
232BARN-BARK	011	01	00	010	00000	01942	0125	0000
233DYE-KERNEL	047	00	00	005	01878	02630	0111	0111
234ATE-ROSE	028	00	01	006	02630	01114	0143	0000
235COLORED-FEAST	033	00	00	003	00506	02086	0000	0000
236FATE-BLACK	029	00	00	009	01051	00304	0111	0000
237GOATS-DIE	037	00	00	006	00113	02630	0000	0000
238BANK-COLONEL	040	00	00	008	01497	01329	0000	0000
239DOE-CHALK	042	00	00	004	01329	02630	0250	0000
240RISE-DATE	025	00	01	005	01329	01114	0125	0000
241JOKE-TEA	031	00	00	007	01329	02630	0143	0143
242TOAST-STACK	020	00	00	011	01114	00304	0000	0000
243EIGHT-BARK	031	00	00	002	02630	00304	0000	0111
244BARN-KERNEL	029	00	00	007	01497	01329	0100	0000
245DYE-ROSE	032	00	01	015	01329	02630	0143	0143
246ATE-FEAST	042	00	00	038	02630	00000	0125	0000
247COLORED-BLACK	031	00	00	042	01497	01878	0083	0000
248FATE-DIE	025	00	01	030	01373	02630	0143	0000
249GOATS-COLONEL	036	00	00	008	01981	01329	0083	0083
250BANK-CHALK	023	00	01	006	01329	00000	0111	0000
251DOE-DATE	029	01	01	002	00000	02630	0143	0000
252RISE-TEA	025	00	00	010	01329	02630	0143	0000
253JOKE-ROWS	017	00	00	008	01329	01116	0250	0125
254TOAST-BARK	022	00	00	008	01771	00304	0000	0000
255EIGHT-KERNEL	027	00	00	004	02630	01329	0000	0091
256BARN-ROSE	023	00	00	007	01329	02630	0125	0000
257DYE-FEAST	040	00	00	002	01373	02630	0125	0000
258ATE-BLACK	037	00	00	003	02630	00304	0250	0000
259COLORED-DIE	048	00	00	008	01878	02630	0000	0000
260FATE-COLONEL	037	00	00	004	00506	01329	0000	0000
261GOATS-CHALK	020	00	00	004	01329	01116	0200	0100
262BANK-DATE	020	00	00	003	00737	00304	0000	0000
263DOE-TEA	017	00	00	007	02086	01403	0000	0000
264RISE-ROWS	022	01	00	014	00000	00000	0000	0000
265JOKE-STACK	021	00	00	002	01329	00000	0000	0111
266BARK-KERNEL	034	00	00	010	01497	01329	0000	0000
267EIGHT-ROSE	036	00	00	006	02630	01114	0222	0111
268BARN-FEAST	031	00	00	008	01060	02244	0111	0000
269DYE-BLACK	036	00	00	014	00737	02630	0250	0125
270ATE-DIE	012	00	01	007	02630	02630	0000	0000
271COLORED-COLONEL	007	01	00	007	00000	01329	0000	0000
272FATE-CHALK	027	00	00	001	01329	00304	0111	0000
273GOATS-DATE	019	00	00	002	00113	01114	0111	0111
274BANK-TEA	034	00	00	004	01771	02630	0143	0000
275DOE-ROWS	035	00	00	004	01329	02630	0143	0000
276RISE-STACK	023	00	00	021	01329	01116	0222	0000
888TOY-TOY	000	01	01	066	00000	00000	0000	0000
999MILK-MILK	000	01	01	066	00000	00000	0000	0000

APPENDIX B

WORD MEANING SIMILARITY TASK

11/6/75: S.C-C.

WORD MEANING SIMILARITY TASK

In the following task you are asked to compare pairs of words in terms of the amount of meaning that they have in common. In other words you should indicate the degree of similarity that exists between the pairs of words according to how much meaning they have in common.

The degree of similarity in meaning is indicated by checking the appropriate scale score as shown below in the following examples.

EXAMPLES

WORD PAIRS	DEGREE OF MEANING SIMILARITY						
	0	1	2	3	4	5	6
black — white	X						

A score of 0 indicates that you believe that "black" and "white" are maximally dissimilar.

	0	1	2	3	4	5	6
strong-- hard						X	

A score of 4 indicates that you believe that there is a fair amount of similarity in meaning between the two words.

PLEASE DO EVERY PAIR. WORK AS QUICKLY AS POSSIBLE

Thank you for your kind cooperation.

WORD PAIRS	DEGREE OF MEANING SIMILARITY 0	1	2	3	4	5	6	
1. stack -- rise	___	___	___	___	___	___	___	1.
2. rows -- doe	___	___	___	___	___	___	___	2.
3. tea -- bank	___	___	___	___	___	___	___	3.
4. date -- goats	___	___	___	___	___	___	___	4.
5. chalk -- fate	___	___	___	___	___	___	___	5.
6. colonel - colored	___	___	___	___	___	___	___	6.
7. die -- ate	___	___	___	___	___	___	___	7.
8. black -- dye	___	___	___	___	___	___	___	8.
9. feast -- barn	___	___	___	___	___	___	___	9.
10. rose -- eight	___	___	___	___	___	___	___	10.
11. kernel -- bark	___	___	___	___	___	___	___	11.
12. stack -- joke	___	___	___	___	___	___	___	12.
13. rows -- rise	___	___	___	___	___	___	___	13.
14. tea -- doe	___	___	___	___	___	___	___	14.
15. date -- bank	___	___	___	___	___	___	___	15.
16. chalk -- goats	___	___	___	___	___	___	___	16.
17. colonel - fate	___	___	___	___	___	___	___	17.
18. die -- colored	___	___	___	___	___	___	___	18.
19. black -- ate	___	___	___	___	___	___	___	19.
20. feast -- dye	___	___	___	___	___	___	___	20.
21. rose -- barn	___	___	___	___	___	___	___	21.
22. kernel -- eight	___	___	___	___	___	___	___	22.
23. bark -- toast	___	___	___	___	___	___	___	23.
24. rows -- joke	___	___	___	___	___	___	___	24.
25. tea -- rise	___	___	___	___	___	___	___	25.
26. date -- doe	___	___	___	___	___	___	___	26.
27. chalk -- bank	___	___	___	___	___	___	___	27.
28. colonel - goats	___	___	___	___	___	___	___	28.
29. die -- fate	___	___	___	___	___	___	___	29.
30. black -- colored	___	___	___	___	___	___	___	30.
31. feast -- ate	___	___	___	___	___	___	___	31.
32. rose -- dye	___	___	___	___	___	___	___	32.
33. kernel -- barn	___	___	___	___	___	___	___	33.
34. bark -- eight	___	___	___	___	___	___	___	34.
35. stack -- toast	___	___	___	___	___	___	___	35.

	WORD PAIRS	DEGREE OF MEANING SIMILARITY 0	1	2	3	4	5	6	
36.	tea -- joke	___	___	___	___	___	___	___	36.
37.	date -- rise	___	___	___	___	___	___	___	37.
38.	chalk -- doe	___	___	___	___	___	___	___	38.
39.	colonel - bank	___	___	___	___	___	___	___	39.
40.	die -- goats	___	___	___	___	___	___	___	40.
41.	black -- fate	___	___	___	___	___	___	___	41.
42.	feast -- colored	___	___	___	___	___	___	___	42.
43.	rose -- ate	___	___	___	___	___	___	___	43.
44.	kernel -- dye	___	___	___	___	___	___	___	44.
45.	bark -- barn	___	___	___	___	___	___	___	45.
46.	eight -- toast	___	___	___	___	___	___	___	46.
47.	rows -- stack	___	___	___	___	___	___	___	47.
48.	date -- joke	___	___	___	___	___	___	___	48.
49.	chalk -- rise	___	___	___	___	___	___	___	49.
50.	colonel - doe	___	___	___	___	___	___	___	50.
51.	die -- bank	___	___	___	___	___	___	___	51.
52.	black -- goats	___	___	___	___	___	___	___	52.
53.	feast -- fate	___	___	___	___	___	___	___	53.
54.	rose -- colored	___	___	___	___	___	___	___	54.
55.	kernel -- ate	___	___	___	___	___	___	___	55.
56.	bark -- dye	___	___	___	___	___	___	___	56.
57.	eight -- barn	___	___	___	___	___	___	___	57.
58.	rows -- toast	___	___	___	___	___	___	___	58.
59.	tea -- stack	___	___	___	___	___	___	___	59.
60.	chalk -- joke	___	___	___	___	___	___	___	60.
61.	colonel - rise	___	___	___	___	___	___	___	61.
62.	die -- doe	___	___	___	___	___	___	___	62.
63.	black -- bank	___	___	___	___	___	___	___	63.
64.	feast -- goats	___	___	___	___	___	___	___	64.
65.	rose -- fate	___	___	___	___	___	___	___	65.
66.	kernel -- colored	___	___	___	___	___	___	___	66.
67.	bark -- ate	___	___	___	___	___	___	___	67.
68.	eight -- dye	___	___	___	___	___	___	___	68.
69.	barn -- toast	___	___	___	___	___	___	___	69.
70.	tea -- rows	___	___	___	___	___	___	___	70.

	WORD PAIRS	DEGREE OF MEANING SIMILARITY 0	1	2	3	4	5	6	
71.	date — stack								71.
72.	colonel - joke								72.
73.	die — rise								73.
74.	black — doe								74.
75.	feast — bank								75.
76.	rose — goats								76.
77.	kernel — fate								77.
78.	bark — colored								78.
79.	eight — ate								79.
80	barn — dye								80.
81.	tea — toast								81.
82.	date — rows								82.
83.	chalk — stack								83.
84.	die — joke								84.
85.	black — rise								85.
86.	feast — doe								86.
87.	rose — bank								87.
88.	kernel — goats								88.
89.	bark — fate								89.
90.	eight — colored								90.
91.	barn — ate								91.
92.	dye — toast								92.
93.	date — tea								93.
94.	chalk — rows								94.
95.	colonel— stack								95.
96.	black — joke								96.
97.	feast — rise								97.
98.	rose — doe								98.
99.	kernel — bank								99.
100.	bark — goats								100.
101.	eight — fate								101.
102.	barn — colored								102.
103.	dye — ate								103.
104.	date — toast								104.
105.	chalk — tea								105.

WORD PAIRS	DEGREE OF MEANING SIMILARITY 0	1	2	3	4	5	6	
106. colonel - rows	___	___	___	___	___	___	___	106.
107. die -- stack	___	___	___	___	___	___	___	107.
108. feast -- joke	___	___	___	___	___	___	___	108.
109. rose -- rise	___	___	___	___	___	___	___	109.
110. kernel -- doe	___	___	___	___	___	___	___	110.
111. bark -- bank	___	___	___	___	___	___	___	111.
112. eight -- goats	___	___	___	___	___	___	___	112.
113. barn -- fate	___	___	___	___	___	___	___	113.
114. dye -- colored	___	___	___	___	___	___	___	114.
115. ate -- toast	___	___	___	___	___	___	___	115.
116. chalk -- date	___	___	___	___	___	___	___	116.
117. colonel - tea	___	___	___	___	___	___	___	117.
118. die -- rows	___	___	___	___	___	___	___	118.
119. black -- stack	___	___	___	___	___	___	___	119.
120. rose -- joke	___	___	___	___	___	___	___	120.
121. kernel -- rise	___	___	___	___	___	___	___	121.
122. bark -- doe	___	___	___	___	___	___	___	122.
123. eight -- bank	___	___	___	___	___	___	___	123.
124. barn -- goats	___	___	___	___	___	___	___	124.
125. bark -- date	___	___	___	___	___	___	___	125.
126. eight -- tea	___	___	___	___	___	___	___	126.
127. barn -- rows	___	___	___	___	___	___	___	127.
128. dye -- stack	___	___	___	___	___	___	___	128.
129. colored - joke	___	___	___	___	___	___	___	129.
130. fate -- rise	___	___	___	___	___	___	___	130.
131. goats -- doe	___	___	___	___	___	___	___	131.
132. bank -- toast	___	___	___	___	___	___	___	132.
133. feast -- black	___	___	___	___	___	___	___	133.
134. rose -- die	___	___	___	___	___	___	___	134.
135. kernel -- colonel	___	___	___	___	___	___	___	135.
136. bark -- chalk	___	___	___	___	___	___	___	136.
137. eight -- date	___	___	___	___	___	___	___	137.
138. barn -- tea	___	___	___	___	___	___	___	138.
139. dye -- rows	___	___	___	___	___	___	___	139.
140. ate -- stack	___	___	___	___	___	___	___	140.

	WORD PAIRS	DEGREE OF MEANING SIMILARITY 0	1	2	3	4	5	6	
141.	fate — joke	___	___	___	___	___	___	___	141.
142.	goats — rise	___	___	___	___	___	___	___	142.
143.	bank — doe	___	___	___	___	___	___	___	143.
144.	feast — toast	___	___	___	___	___	___	___	144.
145.	rose -- black	___	___	___	___	___	___	___	145.
146.	kernel — die	___	___	___	___	___	___	___	146.
147.	bark -- colonel	___	___	___	___	___	___	___	147.
148.	eight — chalk	___	___	___	___	___	___	___	148.
149.	barn -- date	___	___	___	___	___	___	___	149.
150.	dye — tea	___	___	___	___	___	___	___	150.
151.	colonel - toast	___	___	___	___	___	___	___	151.
152.	die — chalk	___	___	___	___	___	___	___	152.
153.	black — date	___	___	___	___	___	___	___	153.
154.	feast — tea	___	___	___	___	___	___	___	154.
155.	rose — rows	___	___	___	___	___	___	___	155.
156.	kernel — stack	___	___	___	___	___	___	___	156.
157.	eight — joke	___	___	___	___	___	___	___	157.
158.	barn — rise	___	___	___	___	___	___	___	158.
159.	dye — doe	___	___	___	___	___	___	___	159.
160.	ate — bank	___	___	___	___	___	___	___	160.
161.	colored - goats	___	___	___	___	___	___	___	161.
162.	fate — toast	___	___	___	___	___	___	___	162.
163.	die — colonel	___	___	___	___	___	___	___	163.
164.	black — chalk	___	___	___	___	___	___	___	164.
165.	feast — date	___	___	___	___	___	___	___	165.
166.	rose — tea	___	___	___	___	___	___	___	166.
167.	kernel — rows	___	___	___	___	___	___	___	167.
168.	bark — stack	___	___	___	___	___	___	___	168.
169.	barn — joke	___	___	___	___	___	___	___	169.
170.	dye — rise	___	___	___	___	___	___	___	170.
171.	ate — doe	___	___	___	___	___	___	___	171.
172.	colored - bank	___	___	___	___	___	___	___	172.
173.	fate -- goats	___	___	___	___	___	___	___	173.
174.	die — toast	___	___	___	___	___	___	___	174.
175.	black — colonel	___	___	___	___	___	___	___	175.

	WORD PAIRS	0	1	2	3	4	5	6	
176.	dye -- fate	___	___	___	___	___	___	___	176.
177.	ate -- colored	___	___	___	___	___	___	___	177.
178.	chalk -- toast	___	___	___	___	___	___	___	178.
179.	colonel - date	___	___	___	___	___	___	___	179.
180.	die -- tea	___	___	___	___	___	___	___	180.
181.	black -- rows	___	___	___	___	___	___	___	181.
182.	feast -- stack	___	___	___	___	___	___	___	182.
183.	kernel -- joke	___	___	___	___	___	___	___	183.
184.	bark -- rise	___	___	___	___	___	___	___	184.
185.	eight -- doe	___	___	___	___	___	___	___	185.
186.	barn -- bank	___	___	___	___	___	___	___	186.
187.	dye -- goats	___	___	___	___	___	___	___	187.
188.	ate -- fate	___	___	___	___	___	___	___	188.
189.	colored - toast	___	___	___	___	___	___	___	189.
190.	colonel - chalk	___	___	___	___	___	___	___	190.
191.	die -- date	___	___	___	___	___	___	___	191.
192.	black -- tea	___	___	___	___	___	___	___	192.
193.	feast -- rows	___	___	___	___	___	___	___	193.
194.	rose -- stack	___	___	___	___	___	___	___	194.
195.	bark -- joke	___	___	___	___	___	___	___	195.
196.	eight -- rise	___	___	___	___	___	___	___	196.
197.	barn -- doe	___	___	___	___	___	___	___	197.
198.	dye -- bank	___	___	___	___	___	___	___	198.
199.	ate -- goats	___	___	___	___	___	___	___	199.
200.	colored - fate	___	___	___	___	___	___	___	200.
201.	feast -- chalk	___	___	___	___	___	___	___	201.
202.	rose -- date	___	___	___	___	___	___	___	202.
203.	kernel -- tea	___	___	___	___	___	___	___	203.
204.	bark -- rows	___	___	___	___	___	___	___	204.
205.	eight -- stack	___	___	___	___	___	___	___	205.
206.	dye -- joke	___	___	___	___	___	___	___	206.
207.	ate -- rise	___	___	___	___	___	___	___	207.
208.	colored - doe	___	___	___	___	___	___	___	208.
209.	fate -- bank	___	___	___	___	___	___	___	209.
210.	goats -- toast	___	___	___	___	___	___	___	210.

DEGREE OF MEANING SIMILARITY

WORD PAIRS	DEGREE OF MEANING SIMILARITY 0	1	2	3	4	5	6	
211. black — die	___	___	___	___	___	___	___	211.
212. feast — colonel	___	___	___	___	___	___	___	212.
213. rose — chalk	___	___	___	___	___	___	___	213.
214. kernel -- date	___	___	___	___	___	___	___	214.
215. bark — tea	___	___	___	___	___	___	___	215.
216. eight -- rows	___	___	___	___	___	___	___	216.
217. barn -- stack	___	___	___	___	___	___	___	217.
218. ate — joke	___	___	___	___	___	___	___	218.
219. colored - rise	___	___	___	___	___	___	___	219.
220. fate — doe	___	___	___	___	___	___	___	220.
221. goats — bank	___	___	___	___	___	___	___	221.
222. black — toast	___	___	___	___	___	___	___	222.
223. feast — die	___	___	___	___	___	___	___	223.
224. rose — colonel	___	___	___	___	___	___	___	224.
225. kernel — chalk	___	___	___	___	___	___	___	225.
226. ate — rows	___	___	___	___	___	___	___	226.
227. colored - stack	___	___	___	___	___	___	___	227.
228. goats — joke	___	___	___	___	___	___	___	228.
229. bank — rise	___	___	___	___	___	___	___	229.
230. doe -- toast	___	___	___	___	___	___	___	230.
231. rose — feast	___	___	___	___	___	___	___	231.
232. kernel — black	___	___	___	___	___	___	___	232.
233. bark — die	___	___	___	___	___	___	___	233.
234. eight — colonel	___	___	___	___	___	___	___	234.
235. barn — chalk	___	___	___	___	___	___	___	235.
236. dye — date	___	___	___	___	___	___	___	236.
237. ate — tea	___	___	___	___	___	___	___	237.
238. colored - rows	___	___	___	___	___	___	___	238.
239. fate — stack	___	___	___	___	___	___	___	239.
240. bank — joke	___	___	___	___	___	___	___	240.
241. doe -- rise	___	___	___	___	___	___	___	241.
242. rose — toast	___	___	___	___	___	___	___	242.
243. kernel — feast	___	___	___	___	___	___	___	243.
244. bark — black	___	___	___	___	___	___	___	244.
245. eight — die	___	___	___	___	___	___	___	245.

	WORD PAIRS	DEGREE OF MEANING SIMILARITY 0	1	2	3	4	5	6	
246.	barn -- colonel	___	___	___	___	___	___	___	246.
247.	dye -- chalk	___	___	___	___	___	___	___	247.
248.	ate -- date	___	___	___	___	___	___	___	248.
249.	colored - tea	___	___	___	___	___	___	___	249.
250.	fate -- rows	___	___	___	___	___	___	___	250.
251.	stack -- goats	___	___	___	___	___	___	___	251.
252.	doe -- joke	___	___	___	___	___	___	___	252.
253.	rise -- toast	___	___	___	___	___	___	___	253.
254.	kernel -- rose	___	___	___	___	___	___	___	254.
255.	bark -- feast	___	___	___	___	___	___	___	255.
256.	eight -- black	___	___	___	___	___	___	___	256.
257.	barn -- die	___	___	___	___	___	___	___	257.
258.	dye -- colonel	___	___	___	___	___	___	___	258.
259.	ate -- chalk	___	___	___	___	___	___	___	259.
260.	colored - date	___	___	___	___	___	___	___	260.
261.	fate -- tea	___	___	___	___	___	___	___	261.
262.	goats -- rows	___	___	___	___	___	___	___	262.
263.	bank -- stack	___	___	___	___	___	___	___	263.
264.	rise -- joke	___	___	___	___	___	___	___	264.
265.	kernel -- toast	___	___	___	___	___	___	___	265.
266.	bark -- rose	___	___	___	___	___	___	___	266.
267.	eight -- feast	___	___	___	___	___	___	___	267.
268.	barn -- black	___	___	___	___	___	___	___	268.
269.	dye -- die	___	___	___	___	___	___	___	269.
270.	ate -- colonel	___	___	___	___	___	___	___	270.
271.	colored - chalk	___	___	___	___	___	___	___	271.
272.	fate -- date	___	___	___	___	___	___	___	272.
273.	goats -- tea	___	___	___	___	___	___	___	273.
274.	bank -- rows	___	___	___	___	___	___	___	274.
275.	doe -- stack	___	___	___	___	___	___	___	275.
276.	joke -- toast	___	___	___	___	___	___	___	276.

APPENDIX C

WORD SIMILARITY TASK—FORMS CS-A AND B

Directions for Administering Word Similarity Task (WST)

Forms CT (Parts A, B, C, and D) and CS (Parts A and B)

This is an attempt to find out how much similarity exists between words. It is of paramount importance that you read every word clearly and pronounce it correctly.

As you read the instructions, pause after each one to see that the children are "with you". It is essential that a child mark a response to every item on the test.

Give the children enough time to do each item. Do not help them with any of their responses. <u>There are no right or wrong responses</u>.

As you give the test, caution children if necessary, not to say the words aloud or to look to see what other children are doing.

INSTRUCTIONS TO CHILDREN. Write your name in the space.

We are going to find out how you feel about some words. I will read some words to you and you will mark circles to show how much alike you think some of these words are. Sometimes it will be easy, and sometimes it will not be so easy. There are no right answers. We only want to find out how you feel about these words.

Now let's begin. Look at the first page. Look at the first box marked A. The words on the left are a red <u>car</u>. 'Car' has a line under it. The words on the right are, 'a white <u>car</u>'. 'Car' has a line under it. Look in the right hand side of the box. There is a row of circles. If you mark the first circle it means that you do <u>not</u> think that the words <u>car</u> and <u>car</u> are like each other. If you mark 2 circles it means that you think that there is only a small amount of likeness between the two underlined words. The 3 circles mean that you think that the words are somewhat alike. The 4 circles mean that you feel that the words are very much alike. The 5 circles mean that the words are very, very, much alike.

Our two words are <u>car</u> and <u>car</u>. Notice 5 circles have been marked because <u>car</u> and <u>car</u> are very, very much alike. In fact they are the same. Do you see how this works?

Let's look at Box B. The words on the left are 'happy <u>face</u>' and 'big <u>fish</u>'. The words to compare are '<u>face</u>' and '<u>fish</u>'. How much alike do you think '<u>face</u>' and '<u>fish</u>' are? Put a mark on the circles you think best tells how much alike they are. (After about 10 seconds ask, 'Who has finished this one?' Show your hands. If they haven't all finished give another 5 seconds then ask again. Pick one child in the back and one child in the front and ask each to tell you which set of circles they marked. Comment 'That's good' after each one.)

Does everyone know what to do? (Proctors should check to make sure everyone marked circles in Box B.)

O.K. Let's do one last one before we begin. Look at Box C. The words are 'baseball bat' and 'bad cat'. Compare 'bat' and 'bad' and mark your circles. (After 8-10 seconds ask) Did everyone mark their circles?

O.K. Let's begin. Turn the page. Ready? The first words are

(Read, the first phrase on the left.

Say: a pretty rose and black crayons

Compare rose and black.

Continue until all items are read from the form.)

To begin the test look at the copy of the test.

WORD SIMILARITY TASK (WST) May 1976

NAME ______________________________

SCHOOL ______________________________

BOX A.

a red car	a white car	0	00	000	0000	00000

BOX B.

happy face	big fish	0	00	000	0000	00000

BOX C.

baseball bat	bad cat	0	00	000	0000	00000

a pretty rose	rows of soldiers	0	00	000	0000	00000
stack of blocks	light brown toast	0	00	000	0000	00000
chalk for writing	milk from goats	0	00	000	0000	00000
black crayons	luau feast	0	00	000	0000	00000
a good joke	a dried date	0	00	000	0000	00000
a happy fate	a pretty rose	0	00	000	0000	00000
rise up	rows of soldiers	0	00	000	0000	00000
milk from goats	stack of blocks	0	00	000	0000	00000
luau feast	chalk for writing	0	00	000	0000	00000
a dried date	black crayons	0	00	000	0000	00000
a happy fate	a good joke	0	00	000	0000	00000
a pretty rose	rise up	0	00	000	0000	00000

a big toy	a pretty toy	0	00	000	0000	00000
rows of soldiers	light brown toast	0	00	000	0000	00000
stack of blocks	luau feast	0	00	000	0000	00000
chalk for writing	a dried date	0	00	000	0000	00000
black crayons	a happy fate	0	00	000	0000	00000
a good joke	a pretty rose	0	00	000	0000	00000
light brown toast	rise up	0	00	000	0000	00000
milk from goats	rows of soldiers	0	00	000	0000	00000
a dried date	stack of blocks	0	00	000	0000	00000
a happy fate	chalk for writing	0	00	000	0000	00000
a good joke	black crayons	0	00	000	0000	00000
a pretty rose	light brown toast	0	00	000	0000	00000
rise up	milk from goats	0	00	000	0000	00000

rows of soldiers	luau feast	0	00	000	0000	00000
stack of blocks	a happy fate	0	00	000	0000	00000
chalk for writing	a good joke	0	00	000	0000	00000
black crayons	a pretty rose	0	00	000	0000	00000
milk from goats	light brown toast	0	00	000	0000	00000
luau feast	rise up	0	00	000	0000	00000
a dried date	rows of soldiers	0	00	000	0000	00000
a good joke	stack of blocks	0	00	000	0000	00000
black crayons	chalk for writing	0	00	000	0000	00000
a pretty rose	milk from goats	0	00	000	0000	00000
light brown toast	luau feast	0	00	000	0000	00000
rise up	a dried date	0	00	000	0000	00000

rows of soldiers	stack of blocks	0	00	000	0000	00000
a dried date	a happy fate	0	00	000	0000	00000
luau feast	a good joke	0	00	000	0000	00000
milk from goats	black crayons	0	00	000	0000	00000
light brown toast	chalk for writing	0	00	000	0000	00000
rise up	stack of blocks	0	00	000	0000	00000

rows of soldiers	a happy fate	0	00	000	0000	00000
stack of blocks	black crayons	0	00	000	0000	00000
chalk for writing	a pretty rose	0	00	000	0000	00000
luau feast	milk from goats	0	00	000	0000	00000
a dried date	light brown toast	0	00	000	0000	00000
a happy fate	rise up	0	00	000	0000	00000
a good joke	rows of soldiers	0	00	000	0000	00000
chalk for writing	stack of blocks	0	00	000	0000	00000
a pretty rose	luau feast	0	00	000	0000	00000
milk from goats	a dried date	0	00	000	0000	00000
light brown toast	a happy fate	0	00	000	0000	00000
rise up	a good joke	0	00	000	0000	00000

a glass of milk	milk from cows	0	00	000	0000	00000
rows of soldiers	black crayons	0	00	000	0000	00000
stack of blocks	a pretty rose	0	00	000	0000	00000
a dried date	luau feast	0	00	000	0000	00000
chalk for writing	milk from goats	0	00	000	0000	00000
a good joke	light brown toast	0	00	000	0000	00000
black crayons	rise up	0	00	000	0000	00000
chalk for writing	rows of soldiers	0	00	000	0000	00000
a pretty rose	a dried date	0	00	000	0000	00000
luau feast	a happy fate	0	00	000	0000	00000
milk from goats	a good joke	0	00	000	0000	00000
light brown toast	black crayons	0	00	000	0000	00000
rise up	chalk for writing	0	00	000	0000	00000

WORD SIMILARITY TASK (WST) May 1976

NAME ____

SCHOOL ____

BOX A.

a red car	a white car	0	00	000	0000	00000

BOX B.

happy face	big fish	0	00	000	0000	00000

BOX C.

baseball bat	bad cat	0	00	000	0000	00000

money in a bank	dogs bark loudly	0	00	000	0000	00000
doe a female deer	I ate lunch	0	00	000	0000	00000
to dye easter eggs	eight kittens	0	00	000	0000	00000
sick animals die	Japanese tea	0	00	000	0000	00000
colored blocks	the army colonel	0	00	000	0000	00000
kernel of corn	money in a bank	0	00	000	0000	00000
cows in the barn	dogs bark loudly	0	00	000	0000	00000
eight kittens	doe a female deer	0	00	000	0000	00000
Japanese tea	to dye easter eggs	0	00	000	0000	00000
the army colonel	sick animals die	0	00	000	0000	00000
kernel of corn	colored blocks	0	00	000	0000	00000
money in a bank	cows in the barn	0	00	000	0000	00000

a big <u>toy</u>	a pretty <u>toy</u>	0	00	000	0000	00000
dogs <u>bark</u> loudly	I <u>ate</u> lunch	0	00	000	0000	00000
<u>doe</u> a female deer	Japanese <u>tea</u>	0	00	000	0000	00000
to <u>dye</u> easter eggs	the army <u>colonel</u>	0	00	000	0000	00000
sick animals <u>die</u>	<u>kernel</u> of corn	0	00	000	0000	00000
<u>colored</u> blocks	money in a <u>bank</u>	0	00	000	0000	00000
I <u>ate</u> lunch	cows in the <u>barn</u>	0	00	000	0000	00000
<u>eight</u> kittens	dogs <u>bark</u> loudly	0	00	000	0000	00000
the army <u>colonel</u>	<u>doe</u> a female deer	0	00	000	0000	00000
<u>kernel</u> of corn	to <u>dye</u> easter eggs	0	00	000	0000	00000
<u>colored</u> blocks	sick animals <u>die</u>	0	00	000	0000	00000
money in the <u>bank</u>	I <u>ate</u> lunch	0	00	000	0000	00000
cows in the <u>barn</u>	<u>eight</u> kittens	0	00	000	0000	00000

dogs bark loudly	Japanese tea	0	00	000	0000	00000
doe a female deer	kernel of corn	0	00	000	0000	00000
to dye easter eggs	colored blocks	0	00	000	0000	00000
sick animals die	money in the bank	0	00	000	0000	00000
eight kittens	I ate lunch	0	00	000	0000	00000
Japanese tea	cows in the barn	0	00	000	0000	00000
the army colonel	dogs bark loudly	0	00	000	0000	00000
colored blocks	doe a female deer	0	00	000	0000	00000
sick animals die	to dye easter eggs	0	00	000	0000	00000
money in the bank	eight kittens	0	00	000	0000	00000
I ate lunch	Japanese tea	0	00	000	0000	00000

cows in the barn	the army colonel	0	00	000	0000	00000
dogs bark loudly	kernel of corn	0	00	000	0000	00000
doe a female deer	sick animals die	0	00	000	0000	00000
to dye easter eggs	money in the bank	0	00	000	0000	00000
Japanese tea	eight kittens	0	00	000	0000	00000
the army colonel	I ate lunch	0	00	000	0000	00000
kernel of corn	cows in the barn	0	00	000	0000	00000
colored blocks	dogs bark loudly	0	00	000	0000	00000
to dye easter eggs	doe a female deer	0	00	000	0000	00000
money in the bank	Japanese tea	0	00	000	0000	00000
eight kittens	the army colonel	0	00	000	0000	00000
I ate lunch	kernel of corn	0	00	000	0000	00000

a glass of milk	milk from cows	0	00	000	0000	00000
cows in the barn	colored blocks	0	00	000	0000	00000
dogs bark loudly	sick animals die	0	00	000	0000	00000
doe a female deer	money in the bank	0	00	000	0000	00000
the army colonel	Japanese tea	0	00	000	0000	00000
kernel of corn	eight kittens	0	00	000	0000	00000
colored blocks	I ate lunch	0	00	000	0000	00000
sick animals die	cows in the barn	0	00	000	0000	00000
to dye easter eggs	dogs bark loudly	0	00	000	0000	00000
money in the bank	the army colonel	0	00	000	0000	00000
Japanese tea	kernel of corn	0	00	000	0000	00000
eight kittens	colored blocks	0	00	000	0000	00000
I ate lunch	sick animals die	0	00	000	0000	00000

cows in the barn	to dye easter eggs	0	00	000	0000	00000
dogs bark loudly	doe a female deer	0	00	000	0000	00000
the army colonel	kernel of corn	0	00	000	0000	00000
Japanese tea	colored blocks	0	00	000	0000	00000
eight kittens	sick animals die	0	00	000	0000	00000
I ate lunch	to dye easter eggs	0	00	000	0000	00000
cows in the barn	doe a female deer	0	00	000	0000	00000

APPENDIX D

WORD SIMILARITY TASK—
FORMS NC-A, B, C AND D

Directions for Administering Word Similarity Task (WST)

Form NC (Parts A, B, C, and D)

This is an attempt to find out how much similarity exists between words.

As you read the instructions, pause after each one to see that the children are "with you." It is essential that a child mark a response to every item on the test.

Give the children enough time to do each item. Do not help them with any of the responses. There are no right or wrong responses.

As you give the test, caution children if necessary, not to say the words aloud or look to see what other children are doing.

INSTRUCTIONS TO CHILDREN

We are going to find out how you feel about some words. You will mark circles to show me how much alike you think some of these words are. Sometimes it will be easy, and sometimes it will not be so easy. There are no right answers. We only want to find out how you feel about these words.

Now let's begin. Look at the first page. Look at the first box marked A. The two words are car and car. Look at the right hand side of the box. There is a row of circles. If you mark the first circle it means that you do not think that the words car and car are like each other. If you mark the 2 circles it means that you think that there is only a small amount of likeness between the two words. The 3 circles mean that you feel that the words are very much alike. The 5 circles mean that the words are very, very much alike.

Notice that the 5 circles have been marked, because car and car are very, very much alike. In fact they are the same.

Do you see how this works?

Let's look at Box B. The words on the left are 'face' and 'fish'. How much alike do you think 'face' and 'fish' are? Put a mark on the circles you think best tells how much you feel they are alike. (After 10 seconds ask, 'Who has finished this one?' Show your hands. If they haven't all finished give another 5 seconds then ask again. Pick one child in the back and one child in the front and ask each to tell you which set of circles they marked. Comment 'That's good' after each one.)

Does everyone know what to do? (Proctors should check to make sure everyone marked circles in Box B.)

O.K. Let's do one last one before we begin. Look at Box C. The words are '<u>bat</u>' and '<u>bad</u>'. Compare '<u>bat</u>' and '<u>bad</u>' and mark your circles. (After 8-10 seconds ask) Did everyone mark their circles?

O.K. Let's begin. Turn the page.

Ready. Begin.

WORD SIMILARITY TASK (WST) May 1976

NAME____

SCHOOL____

BOX A.

car	car	0	00	000	0000	00000

BOX B.

face	fish	0	00	000	0000	00000

BOX C.

bat	bad	0	00	000	0000	00000

NCA 1

rise	stack	0	00	000	0000	00000
rows	doe	0	00	000	0000	00000
tea	bank	0	00	000	0000	00000
date	goats	0	00	000	0000	00000
chalk	fate	0	00	000	0000	00000
colonel	colored	0	00	000	0000	00000
die	ate	0	00	000	0000	00000
black	dye	0	00	000	0000	00000
feast	barn	0	00	000	0000	00000
rose	kittens	0	00	000	0000	00000
kernel	bark	0	00	000	0000	00000
stack	joke	0	00	000	0000	00000
toy	toy	0	00	000	0000	00000
rows	rise	0	00	000	0000	00000
tea	doe	0	00	000	0000	00000
date	bank	0	00	000	0000	00000
chalk	goats	0	00	000	0000	00000

NCA 2

colonel	fate	0	00	000	0000	00000
die	colored	0	00	000	0000	00000
black	ate	0	00	000	0000	00000
feast	dye	0	00	000	0000	00000
rose	barn	0	00	000	0000	00000
kernel	eight	0	00	000	0000	00000
bark	toast	0	00	000	0000	00000
rows	joke	0	00	000	0000	00000
tea	rise	0	00	000	0000	00000
date	doe	0	00	000	0000	00000
chalk	bank	0	00	000	0000	00000
colonel	goats	0	00	000	0000	00000
die	fate	0	00	000	0000	00000
black	colored	0	00	000	0000	00000
feast	ate	0	00	000	0000	00000
rose	dye	0	00	000	0000	00000
kernel	barn	0	00	000	0000	00000

NCA 3

bark	eight	0	00	000	0000	00000
stack	toast	0	00	000	0000	00000
tea	joke	0	00	000	0000	00000
date	rise	0	00	000	0000	00000
chalk	doe	0	00	000	0000	00000
colonel	bank	0	00	000	0000	00000
die	goats	0	00	000	0000	00000
black	fate	0	00	000	0000	00000
feast	colored	0	00	000	0000	00000
rose	ate	0	00	000	0000	00000
kernel	dye	0	00	000	0000	00000
bark	barn	0	00	000	0000	00000
eight	toast	0	00	000	0000	00000
rows	stack	0	00	000	0000	00000
date	joke	0	00	000	0000	00000
milk	milk	0	00	000	0000	00000
chalk	rise	0	00	000	0000	00000

NCA 4

colonel	doe	0	00	000	0000	00000
die	bank	0	00	000	0000	00000
black	goats	0	00	000	0000	00000
feast	fate	0	00	000	0000	00000
rose	colored	0	00	000	0000	00000
kernel	ate	0	00	000	0000	00000
bark	dye	0	00	000	0000	00000
eight	barn	0	00	000	0000	00000
rows	toast	0	00	000	0000	00000
tea	stack	0	00	000	0000	00000
chalk	joke	0	00	000	0000	00000
colonel	rise	0	00	000	0000	00000
die	doe	0	00	000	0000	00000
black	bank	0	00	000	0000	00000
feast	goats	0	00	000	0000	00000
rose	fate	0	00	000	0000	00000
kernel	colored	0	00	000	0000	00000

NCA 5

bark	ate	0	00	000	0000	00000
eight	dye	0	00	000	0000	00000
barn	toast	0	00	000	0000	00000
tea	rows	0	00	000	0000	00000
date	stack	0	00	000	0000	00000
colonel	joke	0	00	000	0000	00000

WORD SIMILARITY TASK (WST) May 1976

NAME____

SCHOOL______________________________________

BOX A.

car	car	0	00	000	0000	00000

BOX B.

face	fish	0	00	000	0000	00000

BOX C.

bat	bad	0	00	000	0000	00000

NCB 1

die	rise	0	00	000	0000	00000
black	doe	0	00	000	0000	00000
feast	bank	0	00	000	0000	00000
rose	goats	0	00	000	0000	00000
kernel	fate	0	00	000	0000	00000
bark	colored	0	00	000	0000	00000
eight	ate	0	00	000	0000	00000
barn	dye	0	00	000	0000	00000
tea	toast	0	00	000	0000	00000
date	rows	0	00	000	0000	00000
chalk	stack	0	00	000	0000	00000
die	joke	0	00	000	0000	00000
toy	toy	0	00	000	0000	00000
black	rise	0	00	000	0000	00000
feast	doe	0	00	000	0000	00000
rose	bank	0	00	000	0000	00000
kernel	goats	0	00	000	0000	00000

NCB 2

bark	fate	0	00	000	0000	00000
eight	colored	0	00	000	0000	00000
barn	ate	0	00	000	0000	00000
dye	toast	0	00	000	0000	00000
date	tea	0	00	000	0000	00000
chalk	rows	0	00	000	0000	00000
colonel	stack	0	00	000	0000	00000
black	joke	0	00	000	0000	00000
feast	rise	0	00	000	0000	00000
rose	doe	0	00	000	0000	00000
kernel	bank	0	00	000	0000	00000
bark	goats	0	00	000	0000	00000
eight	fate	0	00	000	0000	00000
barn	colored	0	00	000	0000	00000
dye	ate	0	00	000	0000	00000
date	toast	0	00	000	0000	00000
chalk	tea	0	00	000	0000	00000

NCB 3

colonel	rows	0	00	000	0000	00000
die	stack	0	00	000	0000	00000
feast	joke	0	00	000	0000	00000
rose	rise	0	00	000	0000	00000
kernel	doe	0	00	000	0000	00000
bark	bank	0	00	000	0000	00000
eight	goats	0	00	000	0000	00000
barn	fate	0	00	000	0000	00000
dye	colored	0	00	000	0000	00000
ate	toast	0	00	000	0000	00000
chalk	date	0	00	000	0000	00000
colonel	tea	0	00	000	0000	00000
die	rows	0	00	000	0000	00000
black	stack	0	00	000	0000	00000
rose	joke	0	00	000	0000	00000
milk	milk	0	00	000	0000	00000
kernel	rise	0	00	000	0000	00000

NCB 4

bark	doe	0	00	000	0000	00000
eight	bank	0	00	000	0000	00000
barn	goats	0	00	000	0000	00000
bark	date	0	00	000	0000	00000
eight	tea	0	00	000	0000	00000
barn	rows	0	00	000	0000	00000
dye	stack	0	00	000	0000	00000
colored	joke	0	00	000	0000	00000
fate	rise	0	00	000	0000	00000
goats	doe	0	00	000	0000	00000
bank	toast	0	00	000	0000	00000
feast	black	0	00	000	0000	00000
rose	die	0	00	000	0000	00000
kernel	colonel	0	00	000	0000	00000
bark	chalk	0	00	000	0000	00000
eight	date	0	00	000	0000	00000
barn	tea	0	00	000	0000	00000

NCB 5

dve	rows	0	00	000	0000	00000
ate	stack	0	00	000	0000	00000
fate	joke	0	00	000	0000	00000
goats	rise	0	00	000	0000	00000
bank	doe	0	00	000	0000	00000
feast	toast	0	00	000	0000	00000

WORD SIMILARITY TASK (WST) May 1976

NAME____

SCHOOL____

BOX A.

<u>car</u>	<u>car</u>	0	00	000	0000	00000

BOX B.

<u>face</u>	<u>fish</u>	0	00	000	0000	00000

BOX C.

<u>bat</u>	<u>bad</u>	0	00	000	0000	00000

NCC 1

rose	black	0	00	000	0000	00000
kernel	die	0	00	000	0000	00000
bark	colonel	0	00	000	0000	00000
eight	chalk	0	00	000	0000	00000
barn	date	0	00	000	0000	00000
dye	tea	0	00	000	0000	00000
colonel	toast	0	00	000	0000	00000
die	chalk	0	00	000	0000	00000
black	date	0	00	000	0000	00000
feast	tea	0	00	000	0000	00000
rose	rows	0	00	000	0000	00000
kernel	stack	0	00	000	0000	00000
toy	toy	0	00	000	0000	00000
eight	joke	0	00	000	0000	00000
barn	rise	0	00	000	0000	00000
dye	doe	0	00	000	0000	00000
ate	bank	0	00	000	0000	00000

NCC 2

colored	goats	0	00	000	0000	00000
fate	toast	0	00	000	0000	00000
die	colonel	0	00	000	0000	00000
black	chalk	0	00	000	0000	00000
feast	date	0	00	000	0000	00000
rose	tea	0	00	000	0000	00000
kernel	rows	0	00	000	0000	00000
bark	stack	0	00	000	0000	00000
barn	joke	0	00	000	0000	00000
dve	rise	0	00	000	0000	00000
ate	doe	0	00	000	0000	00000
colored	bank	0	00	000	0000	00000
fate	goats	0	00	000	0000	00000
die	toast	0	00	000	0000	00000
black	colonel	0	00	000	0000	00000
dve	fate	0	00	000	0000	00000
ate	colored	0	00	000	0000	00000

NCC 3

chalk	toast	0	00	000	0000	00000
colonel	date	0	00	000	0000	00000
die	tea	0	00	000	0000	00000
black	rows	0	00	000	0000	00000
feast	stack	0	00	000	0000	00000
kernel	joke	0	00	000	0000	00000
bark	rise	0	00	000	0000	00000
eight	doe	0	00	000	0000	00000
barn	bank	0	00	000	0000	00000
dye	goats	0	00	000	0000	00000
ate	fate	0	00	000	0000	00000
colored	toast	0	00	000	0000	00000
colonel	chalk	0	00	000	0000	00000
die	date	0	00	000	0000	00000
black	tea	0	00	000	0000	00000
milk	milk	0	00	000	0000	00000
feast	rows	0	00	000	0000	00000

NCC 4

rose	stack	0	00	000	0000	00000
bark	joke	0	00	000	0000	00000
eight	rise	0	00	000	0000	00000
barn	doe	0	00	000	0000	00000
dye	bank	0	00	000	0000	00000
ate	goats	0	00	000	0000	00000
colored	fate	0	00	000	0000	00000
feast	chalk	0	00	000	0000	00000
rose	date	0	00	000	0000	00000
kernel	tea	0	00	000	0000	00000
bark	rows	0	00	000	0000	00000
eight	stack	0	00	000	0000	00000
dye	joke	0	00	000	0000	00000
ate	rise	0	00	000	0000	00000
colored	doe	0	00	000	0000	00000
fate	bank	0	00	000	0000	00000
goats	toast	0	00	000	0000	00000

NCC 5

<u>black</u>	<u>die</u>	0	00	000	0000	00000
<u>feast</u>	<u>colonel</u>	0	00	000	0000	00000
<u>rose</u>	<u>chalk</u>	0	00	000	0000	00000
<u>kernel</u>	<u>date</u>	0	00	000	0000	00000
<u>bark</u>	<u>tea</u>	0	00	000	0000	00000
<u>eight</u>	<u>rows</u>	0	00	000	0000	00000

WORD SIMILARITY TASK (WST) May 1976

NAME____

SCHOOL______________________________________

BOX A.

car	car	0	00	000	0000	00000

BOX B.

face	fish	0	00	000	0000	00000

BOX C.

bat	bad	0	00	000	0000	00000

NCD 1

barn	stack	0	00	000	0000	00000
ate	joke	0	00	000	0000	00000
colored	rise	0	00	000	0000	00000
fate	doe	0	00	000	0000	00000
goats	bank	0	00	000	0000	00000
black	toast	0	00	000	0000	00000
feast	die	0	00	000	0000	00000
rose	colonel	0	00	000	0000	00000
kernel	chalk	0	00	000	0000	00000
ate	rows	0	00	000	0000	00000
colored	stack	0	00	000	0000	00000
goats	joke	0	00	000	0000	00000
toy	toy	0	00	000	0000	00000
bank	rise	0	00	000	0000	00000
doe	toast	0	00	000	0000	00000
rose	feast	0	00	000	0000	00000
kernel	black	0	00	000	0000	00000

NCD 2

bark	die	0	00	000	0000	00000
eight	colonel	0	00	000	0000	00000
barn	chalk	0	00	000	0000	00000
dye	date	0	00	000	0000	00000
ate	tea	0	00	000	0000	00000
colored	rows	0	00	000	0000	00000
fate	stack	0	00	000	0000	00000
bank	joke	0	00	000	0000	00000
doe	rise	0	00	000	0000	00000
rose	toast	0	00	000	0000	00000
kernel	feast	0	00	000	0000	00000
bark	black	0	00	000	0000	00000
eight	die	0	00	000	0000	00000
barn	colonel	0	00	000	0000	00000
dye	chalk	0	00	000	0000	00000
ate	date	0	00	000	0000	00000
colored	tea	0	00	000	0000	00000

NCD 3

fate	rows	0	00	000	0000	00000
stack	goats	0	00	000	0000	00000
doe	joke	0	00	000	0000	00000
rise	toast	0	00	000	0000	00000
kernel	rose	0	00	000	0000	00000
bark	feast	0	00	000	0000	00000
eight	black	0	00	000	0000	00000
barn	die	0	00	000	0000	00000
dye	colonel	0	00	000	0000	00000
ate	chalk	0	00	000	0000	00000
colored	date	0	00	000	0000	00000
fate	tea	0	00	000	0000	00000
goats	rows	0	00	000	0000	00000
bank	stack	0	00	000	0000	00000
rise	joke	0	00	000	0000	00000
milk	milk	0	00	000	0000	00000
kernel	toast	0	00	000	0000	00000

NCD 4

bark	rose	0	00	000	0000	00000
eight	feast	0	00	000	0000	00000
barn	black	0	00	000	0000	00000
dye	die	0	00	000	0000	00000
ate	colonel	0	00	000	0000	00000
colored	chalk	0	00	000	0000	00000
fate	date	0	00	000	0000	00000
goats	tea	0	00	000	0000	00000
bank	rows	0	00	000	0000	00000
doe	stack	0	00	000	0000	00000
joke	toast	0	00	000	0000	00000

APPENDIX E

PREDICTION EQUATIONS FOR ALL SUBJECTS

Table 9

Prediction Equations for Palolo
Grade 1 Form CSA (n=11)

ID	VG	FL	LL	MG	FP	LP	A	D	R^2	Reading Score
40	.03	.42							.15	17
50	-.25			-.35	-.31				.14	2
51				.28					.08	33
52									—	5
53	.40		.37	.18					.10	12
54	-.23	.52							.43	34
55		.41	.24						.26	32
56			-.33						.11	20
57									—	10
79			-.26						.07	6
80									—	8

Table 10

Prediction Equations for Palolo
Grade 2 Form CSB (n=22)

ID	VG	FL	LL	MG	FP	LP	A	D	R^2	Reading Score
2			.50				.28		.29	24
74		.38	.19	.60					.87	20
163				-.28					.09	2
178									—	10
179			.26		-.41	-.39			.65	13
180					-.28				.08	11
181		.44	.19		-.29				.58	19
182									—	13
183			.31						.08	18
184			-.31						.08	3
185				.53			-.24		.37	22
186									—	4
187	-.34			.36					.33	27
188								.27	.10	0
189									—	0
190									—	3
191									—	1
192									—	9
193									—	14
194	.33								.11	27
195	.33			.32					.16	6
196		.32			-.28				.28	21

Table 11

Prediction Equations for Palolo
Grade 2 Form CSA (n=22)

ID	VG	FL	LL	MG	FP	LP	A	D	R^2	Reading Score
18			.90						.10	17
19	.32	.27		.45					.34	5
20									—	4
22		.42							.18	22
23									—	1
24	−.27			.48					.44	25
25	−.19	.54		.53	.27				.82	31
26B		.41		.31					.42	30
27					−.24				.09	13
28			.38	.29					.16	16
26A									—	38
30									—	16
31				.35			.33		.16	18
32									—	13
33									—	14
34	−.29					.26			.11	0
35	.48		.37						.13	11
36				.28				.31	.15	19
37	−.25			.65					.65	35
38	−.24	.39		.39					.74	19
39		.49		.29		.50			.30	30
40		.27		.34					.30	27

Table 12

Prediction Equations for Palolo
Grade 2 Form LSB (n=16)

ID	VG	FL	LL	MG	FP	LP	A	D	R^2	Reading Score
138A				.36					.13	31
138B			.32	.51		-.21			.51	34
139									—	8
141					-.33	-.44			.40	35
142		-.42				-.42			.19	1
144		-.36	.30						.11	15
145	.31								.10	3
146		.49	.30			-.26	.18		.64	29
148				.27					.07	4
149				.50				.25	.27	3
151		.58		.19	-.24	-.20	.11	.13	.86	31
152							-.40		.16	13
153			.40						.16	19
165				.24			-.23	.41	.27	27
167			.34			-.25			.25	27
168	-.50		.31						.56	21

Table 13

Prediction Equations for Kaiulani
Grade 2 Form CSA (n=25)

ID	VG	FL	LL	MG	FP	LP	A	D	R^2	Reading Score
337									—	12
338				.50					.25	25
339									—	21
340									—	21
341		.54	-.27		.47				.16	20
342				.89					.79	22
343				.43			-.30		.36	26
344									—	24
345	-.16	.47		.36					.73	19
346		.25					-.37		.27	13
347		.44							.19	13
348									—	13
349									—	27
350							-.29		.09	12
351				.89					.78	18
352		.81			.36				.32	24
353				.27					.07	15
354		-.57	-.42						.58	26
355					-.28				.08	21
356	-.27	.44		.31					.57	20
357									—	21
358									—	30
359		.28							.08	16
360					-.24				.06	13
363		.23						.31	.13	28

Table 14

Prediction Equations for Likelike
Grade 3 Form CSB (n=28)

ID	VG	FL	LL	MG	FP	LP	A	D	R^2	Reading Score
42	-.29								8	16
43			-.30	.33				.24	.15	24
44			-.29	.19		-.29		-.36	.22	14
45			.32						.11	13
85		.41		.20		.11			.52	33
86			.25	.47	-.18	-.21			.63	34
87					-.29		-.24		.15	28
88		.51							.26	30
89	-.50							-.24	.29	23
90		.41				-.33			.41	41
91		.38		-.33		.34			.19	27
92		.53							.29	34
98		.36		.28		-.33			.58	32
99				.29					.08	26
100		.32	.32						.30	31
101				.28		-.29			.15	32
102		.25	.35	.34				.21	.58	40
103			.34	.23		-.50	.23		.55	32
104		.28							.08	26
105		.51			-.31				.53	24
106		.33				-.30			.29	29
107					-.24	-.31			.21	28
108			.29						.08	17
109			.30						.09	23
150	-.25			.37					.26	18
160			.36	.25		-.59	.27		.68	32
161				.35	-.22	-.24			.34	26
169				.31					.10	25

Table 15

Prediction Equations for Kaiulani
Grade 3 Non-Context Form NC (n=21)

ID	VG	FL	LL	MG	FP	LP	A	D	R^2	Reading Score
317								.23	.08	29
319						-.27		.27	.14	22
330				.33	-.33				.18	23
329				.37					.14	16
328				.65					.42	31
327				-.28		-.43			.19	26
325				.42					.18	33
324	-.47								.22	33
323		-.26		.43			-.33		.29	23
322	-.40								.16	29
321				.45					.21	18
318									—	20
314									—	16
308							-.31	-.31	.19	22
331		.33	.40	.36					.73	24
312				.31				.23	.18	31
311								.24	.06	26
310		.40		.48					.65	12
309		.30		.64			.16		.70	25
305			.27						.08	15
307				.79	-.15				.71	33

Table 16

Prediction Equations for Palolo
Grade 3 Non-Context Form NC (n=20)

ID	VG	FL	LL	MG	FP	LP	A	D	R^2	Reading Score
159		.41				-.22			.27	14
63		.23		.39					.27	19
62	-.23			.28					.18	28
158			.31	.38					.31	38
65		-.29					-.30		.14	14
64		.34				-.34			.28	25
60		.61							.37	19
59				.83					.68	37
58									—	20
69				.74	-.18			.26	.66	22
68	-.29	.28		.26					.45	1
67		.82	.21						.77	5
162				.35					.12	31
77	-.31			.30					.29	14
76		.44							.19	11
75	-.41								.16	21
73				.84		.19	-.16		.70	2
72				.59					.34	29
71				.74					.55	45
70				.41					.17	25

Table 17

Prediction Equations for College Students
Form CSA (n=35)

ID	VG	FL	LL	MG	FP	LP	A	D	R^2
1			.28	.39					.30
2	-.49	.49							.69
3	-.41	.34							.41
4	-.55	.54	.17		.26			-.17	.80
5	-.29	.27		.33					.55
6				.85					.72
7	-.29	.42				-.28			.58
8		.29		.33					.32
9				.89					.79
10	-.40			.36					.45
11				.56			.25		.31
12	-.27			.28		-.36			.47
13				.84					.71
14	-.38	.43				-.18			.61
15	-.46	.50			.34				.39
16		.55							.11
17	-.55		.21	.20					.67
18	-.28	.31		.37					.66
19		.44	.34						.37
20	-.36	.59			.34				.37
21	-.28	.22		.42					.62
22	-.26			.53				-.22	.59
23	-.17	.53		.37					.83
24			.33	.44		-.21			.52
25		.49	.37				-.20		.58
26		.44		.35					.51
27				.77					.59
28	-.66		.24						.70
29	-.26	.49		.23					.67
30	-.66								.44
31		.44	.30						.33
32	-.24	.33		.27					.49
33	-.31			.51					.54
34				.69					.48
35				.85					.72

APPENDIX F

INTERPHONEMIC DISTANCES FOR CONSONANTS AND VOWELS

Table 18

Interphonemic Distances for Millers and Nicely's (1961)
Consonant Data Using a Three-Dimensional MD-SCAL Solution

	p	t	k	f	θ	s	ʃ	b	d	g	υ	ð	z	ʒ	m
p															
t	.45														
k	.15	.30													
f	.49	.73	.51												
θ	.70	.88	.70	.21											
s	1.20	1.11	1.12	.83	.68										
ʃ	1.62	1.40	1.51	1.35	1.22	.56									
b	1.40	1.77	1.50	1.06	1.01	1.53	2.07								
d	1.83	2.09	1.88	1.37	1.21	1.40	1.86	.74							
g	1.93	2.19	1.98	1.48	1.32	1.51	1.96	.78	.11						
υ	1.41	1.73	1.48	1.01	.91	1.34	1.88	.25	.53	.59					
ð	1.57	1.88	1.64	1.15	1.03	1.40	1.92	.36	.38	.43	.17				
z	1.98	2.14	1.99	1.49	1.29	1.23	1.58	1.17	.49	.54	.93	.82			
ʒ	2.35	2.45	2.34	1.87	1.65	1.43	1.63	1.62	.92	.93	1.39	1.27	.45		
m	1.52	1.97	1.66	1.39	1.44	2.07	2.63	.69	1.40	1.42	.93	1.03	1.86	2.31	
n	1.81	2.24	1.94	1.64	1.66	2.26	2.81	.77	1.40	1.39	1.01	1.07	1.88	2.32	.30

Table 19

Interphonemic Distances for Fairbank's (1961) Vowel Data Using a Three Dimensional MD-SCAL Solution

	i	I	ɛ	æ	ʌ	ɑ	ɔ	ʊ
i								
I	1.03							
ɛ	1.96	.94						
æ	2.55	1.58	.82					
ʌ	1.92	1.14	.95	.83				
ɑ	2.44	1.80	1.60	1.14	.70			
ɔ	1.89	1.59	1.84	1.73	.94	.82		
ʊ	1.29	.77	1.20	1.44	.67	1.16	.82	
u	1.00	1.43	2.19	2.49	1.69	1.94	1.18	1.06

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