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# 51 Properties of 125 Words: A Unit Analysis of Verbal Behavior

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Values for 125 words were obtained for 51 scales including measures of orthography, pronunciation, imagery, categorizability, association, number of attributes, age-of-acquisition, word frequency, goodness, emotionality, autobiographical memory, tachistoscopic recognition, reading latency, lexical decision, incidental and intentional recall, recall using a mnemonic pathway, paired-associate learning, and recognition. Six factors emerged: *Spelling and Sound, Imagery and Meaning, Word Frequency, Recall, Emotionality,* and *Goodness.* Implications for current methodology and theory are discussed, including the claims: that multivariate research is a necessary addition to the study of verbal behavior; that a unidimensional concept such as depth does not do justice to the complexity of recall; and that associative frequency, emotionality, and pronunciability are among the best predictors of our commonly used tasks.

In the 95 years that have passed since Ebbinghaus (1885) published *Memory,* psychologists interested in the processing of verbal materials have generated numerous experimental tasks and independent variables. Even a brief summary of those independent variables takes most text book writers at least one chapter (e.g., Hall, 1971, Chap. 3 and 4; Kausler, 1974, Chap. 2). The purpose of this research is not to add to these collections, but rather to organize them by investigating the empirical relations among them.

The most common methodological approach in experimental psychology is to take one dependent variable and to ask how one or two independent variables affect it. While this approach is necessary, it may not be sufficient when used in isolation. First, the relative degree of predictive power among variables can be used to make inferences about underlying processes beyond those made from just knowing whether the variables can have an effect at the .05 level. Such information cannot be provided by experiments which attempt to control the effects of all but one or two variables (Petrinovich, 1979).

Second, given the apparent success of so many controlled experiments, one must begin to wonder if all extraneous variables were really controlled. In fact, psychologists have now shown that so many variables affect some experimental tasks that

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controlling for all but one independent variable is virtually impossible. For example, consider actually demonstrating that imagery affects free recall while holding constant meaningfulness, concreteness, frequency, pronunciability, number of letters in the words, goodness, pleasantness, emotionality, associative difficulty, and at least a half dozen other independent variables that competent psychologists, in well designed experiments, have reported also affect free recall. Most of these variables correlate with imagery, making the job more difficult. Even worse, after holding constant or balancing all these variables, a list of words long enough to allow for generalization over stimuli (Clark, 1973) is still needed.

Third, all the independent variables that spring from the minds of psychologists may not be independent, but rather some may be tapping the same underlying cognitive processes. Similarly, the various tasks may have processes in common. A good deal could be learned both about the psychological processes used by subjects and the methods used by their experimenters by examining many tasks and variables together instead of in isolation. This is especially true if one wants to try to understand general cognitive processes, rather than the particular set of tasks psychologists have devised. Put simply, our a priori concepts need not map directly onto actual psychological processes. Considering many variables at once provides some opportunity to examine this problem.

This change in strategy is not without theoretical underpinnings. Instead of choosing one's pet theory, Broadbent (1973) suggests that experimenters try to divide the universe of possible theories into classes and then make observations that would be probable under some classes and improbable under others. A more modest goal is attempted here. A sample of variables is examined to see which variables form empirical classes. Because most of the variables in the sample are theoretically motivated, the theories themselves can be considered to form the same empirical classes as their respective variables. Given the state of verbal learning and verbal behavior just described, Broadbent's approach seems imperative as an addition to the more commonly used methods.

In order to perform such a multivariate study, a unit analysis was undertaken. Psychologists usually analyze their results in terms of subjects, not in terms of units. It is often useful to do both (Clark, 1973; Rubin, 1978b). Here, instead of just obtaining a mean value for each group, a set of values, one for each word, is obtained. This richer quantitative description allows for a much more detailed analysis (e.g., Rubin, 1978b). Many sets of values, or scales, are obtained for a set of words. These scales are correlated, with the correlations calculated over the words rather than over the subjects (Underwood, Boruch, & Malmi, 1978). The correlations are then interpreted directly or by means of factor analysis or multiple regression. Empirically similar attempts have been made by Frincke (1968), Paivio (1968), Underwood and Schulz (1960), and Wimer (1963). Since these studies, however, numerous tasks and independent variables have been added to our repertoire. It is for these variables that this study should be most informative.

## Method

### *Selection of Words and Variables*

Brown's (1976) catalog of scaled verbal material was searched systematically to find a sample of words scaled on as many variables as possible. The 125 words that occurred in both the 925 nouns rated by Paivio, Yuille, and Madigan (1968) and the 650 nouns rated by Brown and Ure (1969) were chosen. While the set of variables was chosen to span the range of dependent and independent variables that have been studied both classically and currently by psychologists, the effort required to obtain each variable was also considered.

*General Procedure*

Each subject participated in only one task. Wherever possible a standard procedure was used. Unless noted, only modifications necessitated by differences in the forms and items were made. For each variable every subject saw the 125 words in a different random order. If there were $2n$ subjects in an experiment, $n$ different random orders were generated and each was presented to one subject in the forward and one subject in the reverse order. All data were scored independently by two people to insure accuracy.

## THE VARIABLES

In order to make the positively evaluated direction of all variables the mathematically positive direction, variable names ending in an asterisk (*) have had all their values multiplied by $-1$. Thus reaction times and word length are reflected because shorter reaction times are considered better and because shorter words generally lead to better performance. Any negative correlations obtained are therefore contrary to expectations.

At the end of the description of each variable formed here, its reliability as measured by Cronbach's $\alpha$ (Cronbach, 1951) will be given.

*Spelling and Sound*

Manelis (1974) distinguishes between two types of variables: structural variables which depend on relations internal to strings of letters, regardless of whether they are words, and lexical variables which depend on the properties of words as wholes. By this definition all *Spelling and Sound* variables are at least in theory structural. The first five variables deal with orthography, the next five with pronunciation.

*Length in Letters*, First-, Second-, and Third-Order Approximation to English Using Letters (L*, FOA, SOA, TOA).* The shorter or more common spelling of a word the easier it should be to process in a host of psychological tasks. As high-frequency words are shorter and have more common spellings than low-frequency words (Landauer & Streeter, 1973), spelling patterns need to be measured if frequency effects are to be isolated. By using the concept of order of approximation to English (Miller & Selfridge, 1950), the 125 words used here can be scaled on how likely it is that they would occur in the process of randomly sampling letters. This method was chosen over several other measures of letter statistics (Travers & Olivier, 1978; Massaro, Venezky, & Taylor, 1979) because of its direct tie to information theory. In zero-order approximation all 27 characters (26 letters plus *blank*) are equally likely (i.e., $p = 1/27$), thus, the word *boy* would have a probability of being created equal to the probability of drawing a *blank*, then a *b*, then an *o*, then a *y*, then another *blank*, or $(1/27)^5$. In general the probability of a word is $(1/27)$ to the $(l + 2)$ power where $l$ is the length in letters. For first-order approximations, the five 1/27 values would be replaced by the letters' actual probabilities of occurrence in running text. For second-order approximation the probabilities of drawing: a *blank*, a *b* given the *blank*, an *o* given the *b*, a *y* given the *o*, and a *blank* given the *y* would be multiplied. For third order approximation the following probabilities would be multiplied: *blank*, *b* given *blank*, *o* given *blank b*, *y* given *bo*, and *blank* given *oy*. In order to convert the products of probabilities obtained in the zero through third-order approximations to an information measure the logarithm to the base 2 is taken. Zero-order approximation is a linear transformation of length in letters, allowing the simpler concept of *Length in Letters** to be used. The probabilities used in the calculations are from unpublished tables by Olivier (Note 1; Rubin, 1978a), which are based on the first 5 million characters of the corpus of the Kucera and Francis (1967) word count.

*Orthographic Distinctiveness* (OD*)* correlates with pronunciability and bigram frequency (Zechmeister, 1969) and is a predictor of free recall (Hunt & Elliot, 1980), recognition memory (Zechmeister, 1972), and verbal discrimination learning (Kausler, 1973). Judges rate how distinctive the spellings of words are using a 9-point scale. Zechmeister's detailed instructions were used except that one paragraph relating *OD** and memory was deleted so that judges would not rate words partly on memorability. The forms were typed in lower case on a Data Terminal Communications 300/S using a Diablo Elite 12 font. The judges were 24 Lawrence University undergraduate volunteers. $\alpha = .85$.

*Pronunciability** (*Pr**) ratings were obtained using Underwood and Schulz's (1960) 9-point rating scale procedure. The 36 judges were undergraduate volunteers enrolled at the University of Wisconsin Fox Valley Extension. $\alpha = .96$.

*Number of Phonemes**, *First-Order Approximation Using Phonemes*, *and Number of Syllables** (*Ph**, *FOPh*, *Syl**) are for sound what *Length in Letters** and the *Approximations Using Letters* are for spelling: simple statistical measures of the probability of components of words. As each syllable is a breath pulse (Rubin, 1974), the number of syllables should be a good measure of the time it takes to pronounce a word. Dewey's (1950, 1970) counts were used. With Funk and Wagnall's *Concise Standard Dictionary* (1915) and Dewey's (1970) Table 2, the same phonemic transcriptions that were made to form the counts were made for the 125 words used here. The values of *Ph** and *FOPh*, will vary only slightly depending on the transcription system used (e.g., $r = .95$ for *Ph** and the number of phonemes calculated from the *American Heritage Dictionary*, 1969). While the location of syllable boundaries in a word may vary across transcriptions, the number of syllables, and thus *Syl**, will not. FOPh is the $\log_2$ of the product of the probabilities of the individual phonemes, where the values are taken from Table 17 of Dewey (1950).

*Spelling to Sound* (*STS*) attempts to measure the ambiguity of English spelling facing a subject who is trying to go from a written to a spoken form of a word. It is $\log_2$ of the product of the probabilities of the graphemes of the written word yielding the appropriate phonemes. Dewey's (1970) Table 6 provides the individual probabilities of a grapheme–phoneme correspondence. For example, the grapheme *f* leads to phoneme /f/ with a probability of .605 and the phoneme /v/ with a probability of .395. The term grapheme is used here instead of letter because several letter combinations are grouped together to form one grapheme (e.g., *ay*, *ch*, *oo*). In deciding on grapheme boundaries, syllable boundaries and other inflectional forms of words were considered.

*Number of Rehearsals* (*Reh*) is the average number of times subjects rehearsed each word in the *Free Recall with Overt Rehearsal of Only the Word Showing* task to be described later. Thus, this measure provided an indication of how long it takes to say each word. The count was made from tape recordings of the sessions. $\alpha = .80$.

### *Imagery and Meaning*

*Imagery and Concreteness* (Paivio, 1971). *Imagery* (*I*) obtained from Paivio, Yuille, and Madigan (1968) is a 7-point rating scale ranging from words that arouse images only with great difficulty to words that arouse images most readily. The reliability of the full scale using the 925 nouns of Paivio et al. (1968) is .94.

There are two measures of concreteness. The first measure, *Concreteness* (*C*), was also obtained from Paivio et al., and is a modification of the measure of concreteness used by Spreen and Schulz (1966). The 7-point rating scale ranges from highly abstract concepts that cannot be experienced by the senses to highly concrete words which refer to objects, materials or persons. The reliability of the full scale using the 925 nouns of Paivio et al. is .94.

The second measure of concreteness,

*Concreteness'* ($C'$), was obtained from Brown and Ure (1969), who define concreteness stressing whether the word can be experienced by the senses. Brown and Ure obtained an intergroup correlation of .98 for a sample of 50 words. The slight change in directions used, the differences in subject population, and different words in which the 125 words common to both counts were embedded make the .95 correlation between $C$ and $C'$ a conservative measure of the reliability of the concreteness measure for the 125 words.

*Imagery Using a Mnemonic Pathway* (*IMn*) is a performance measure of actual imagery use. Subjects learned and used a mnemonic pathway as described later under the *Recall Using a Mnemonic Pathway* task. After completing their recalls, the subjects were asked to go back and indicate the strategy they used to recall each word. The choices included: direct imagery of the object indicated by the word, imagery of an object related to the word, and various associative methods. In only 0.7% of the cases did subjects fail to report a particular method. *IMn* is defined as the proportion of subjects who indicated that they used direct imagery of the referent of a word to recall the word. The measure is weighted by the effectiveness of the images generated as mnemonic cues: if a word was not recalled, the method used by the subject for that word was not recorded. $\alpha = .94$.

*Categorizability* (*Cat*) (Toglia & Battig, 1978) is a 7-point rating scale of how easy words are to categorize. It is placed here with the imagery variables not for any obvious conceptual reasons, but because Toglia and Battig report that categorizability correlates .905 with imagery and .887 with concreteness. Thirty-two Duke University undergraduate volunteers used Toglia and Battig's procedure. A correlation of .92 was obtained between the values obtained here and those of Toglia and Battig for the 90 words common to both scales. $\alpha = .97$.

*Meaningfulness* ($m$) values were obtained from Paivio et al. (1968), who, using a slight modification of Noble's (1952) production method, defined $m$ as the mean number of associations given by subjects in 30 seconds. The intergroup reliability calculated over 12 words by Paivio et al. is .94.

*Associative Difficulty** (*AD**) is a 7-point rating scale ranging from words which make one think of a large number of other words and ideas to words which leave the mind blank. The scale was obtained from Brown and Ure (1969) and has an intergroup correlation, calculated over a subset of 50 words, of .91. While it is conceptually similar to Noble, Stockwell, and Pryer's (1957) $m'$ rating scale and Toglia and Battig's (1978) rating scale of "meaningfulness," for the 90 words common to this count and Toglia and Battig's, the correlation is only .65. Thus, this scale must be interpreted with caution.

*Number of Attributes* (*NOA*) (Toglia & Battig, 1978) is a 7-point rating scale of how many different features or attributes the referent of a word contains. Thirty-four Duke University undergraduate volunteers rated *NOA* using Toglia and Battig's procedure. A correlation of .84 was obtained between the values obtained here and those of Toglia and Battig for the 90 words common to both scales. $\alpha = .89$.

*Associative Frequency* (*AF*) is the converse of *Meaningfulness*. Instead of measuring how many associates are given to a word, it measures the number of times a word is given as a first associate to a sample of stimulus words (Ervin, 1963; Howes, 1957). In particular *AF* is log of the number of times a word is given as an associate in the Palermo and Jenkins (1964) word association norms. Palermo and Jenkins obtained first associations to 200 stimulus words from 250 boys and 250 girls in grades 4, 5, 6, 7, 8, 10, and 12 and 500 male and 500 female undergraduates. If a word was given as an associate to a given stimulus word once in at least one grade–sex group but did not occur more than once in any other grade–sex group its exact frequency was not recorded in Palermo and Jenkins and was assumed to be 2. Seventeen of the one hundred twenty-five words used here did not appear at all in the response index and were assigned frequencies of 1.

While the *Number of Dictionary Meanings* (*Dict*) entered for a word (Britton, 1978) has its drawbacks (Kelly & Stone, 1975; Reder, Anderson, & Bjork, 1974) the measure correlates with frequency (Gilhooly & Gilhooly, 1979) and has been shown to have effects in recognition (Peterson & McGee, 1974) and in paired-associate learning even with frequency held constant (Saltz & Modigliani, 1967).

Following Peterson and McGee (1974) the number of meanings in *Webster's Third New International Dictionary of the English Language Unabridged* (1966) were counted. All entries for each word were used. The number of meanings at the lowest local level of the hierarchy were counted. Separate plural meanings and meanings combining the word with prefixes, suffixes or other words in idiomatic phrases were not counted. Where a word had separate meanings as a transitive and an intransitive verb which were the lowest local level of the hierarchy, the two meanings were counted even though the Dictionary did not number them separately.

*Date of Entry into the English Language** (*OED**) is the earliest year mentioned for each word in the *Oxford English Dictionary* (1933). The variable was motivated by the view that the longer a word has been in the language, the more time it has had to develop an elaborate network of meanings.

### Age-of-Acquisition

*Age-of-Acquisition** (*AOA**) (Carroll & White, 1973b) is a good predictor of several semantic memory tasks, but not of recall or recognition (Gilhooly & Gilhooly, 1979; Lyons, Teer, & Rubenstein, 1978). *AOA** is a 9-point scale on which one rates the age at which the word was probably first learned. Carroll and White's (1973a) instructions were used. Forty-two Lawrence University undergraduate volunteers performed the ratings. $\alpha = .99$.

### Word Frequency

Word frequency has been shown to have effects on nearly every psychological task on which it has been tested.

*Familiarity* (*F*) is the subjective scale corresponding to word frequency (Rubin, 1976). Here it is a 7-point rating of printed familiarity provided by Paivio (Note 2), similar to the one used by Paivio (1968).

*Kucera and Francis Frequency* (*KFF*) (Kucera & Francis, 1967) is based on a corpus of slightly over one million words of running text sampled from a wide variety of modern writing. Here, it provides one measure for written, adult word frequency as well as the corpus used in forming the *First-, Second-, and Third-Order Approximation to English Using Letters*. As with all other word counts used here, log of the word frequency is used.

*Thorndike–Lorge Frequency* (TLF) (Thorndike & Lorge, 1944) is included to allow comparison with other studies. Its use of AA and A for frequent words, and its combination of adult and juvenile books, however, makes it harder to interpret than the other counts listed. As is common practice, words listed as AA and A were given values of 100 and 50, respectively.

*Lorge Magazine Frequency* (*LMF*) is a component of the Thorndike and Lorge (1944) frequency count based on popular magazines sampled from 1927 to 1938. Thus, it is a good sample of what was commonly read at the time.

*Carroll, Davies, and Richman Frequency* (*CDRF*) is based on a corpus of over 5 million words of school books used by third to ninth graders in the United States (Carroll, Davies, & Richman, 1971). The one word not occurring in the count was assigned a frequency of 1.

*Rinsland Frequency* (*RF*) (Rinsland, 1945) is a count of the frequency of occurrence of words in the speech of first graders and the writing of second through eighth graders based on a corpus of over 6 million words. Rinsland only listed words which occurred three or more times in any one grade; the five words which were not listed were assigned frequencies of 1.

### *Goodness and Emotionality*

The dimensions of *Goodness* (Boucher & Osgood, 1969; Zajonc, 1968), and *Emotionality* (Rapaport, 1942), for which Brown and Ure (1969) provide the basis for five scales, are probably the most studied dimensions of connotative meaning (Osgood, Suci, & Tannenbaum, 1957).

*Goodness* (*G*) is a 7-point rating scale of how intensely good or bad a word's meaning is. It is very similar to the scale that loaded the highest on the evaluation factor of Osgood et al. (1957). Brown and Ure (1969) report an intergroup correlation of .98 for a sample of 50 words.

*Pleasantness* (*P*) is a 7-point rating scale of how intensely pleasant or unpleasant a word is. This scale was not used by Osgood et al. (1957) but is similar to others that loaded highly on their evaluation factor. Brown and Ure (1969) report an intergroup correlation of .99 for a sample of 50 words.

*Emotionality* (*E*) is a 7-point rating scale based on the intensity of emotional meaning, not on the kind of emotional meaning. Brown and Ure (1969) report intergroup correlations of .95 for a sample of 50 words.

*Emotional Goodness* (*EG*) was formed by taking the absolute distance from neutral of a word's goodness rating. The rationale for forming this scale comes from Brown and Ure's definition of emotionality as well as from the semantic differential's concept of degree of polarization (Jenkins, 1960). Empirical support comes from Brown and Ure's (1969) observations of a marked curvilinear relation between *E* and *G*, and between *E* and *P*. The definition is $EG = |G - 4|$, where 4 is neutral on a 7-point scale. Thus, the measure is identical to Jenkins' (1960) $D_4$ measure calculated over the single evaluative dimension.

*Emotional Pleasantness* (*EP*) was formed in the same way as *EG* by substituting *P* for *G*.

### *Autobiographical Memory*

*Age of Episode* and *Number of Episodes* (*AOE, NOE*) are derived from a recent study of Crovitz and Schiffman (1974) which revived a method dating back to Galton (Crovitz, 1970). To quote Crovitz and Schiffman: "It would be desirable to expose by listing, the full store of episodic memory. Such a list should include the age of each memory as referred to the present" (p. 517). The technique used to sample from this store was to provide 48 Duke University undergraduate volunteers with a set of stimulus words and have them provide the first episode associated with each word. The subjects were then asked to go back and date their episodes. The average log seconds is reported for each word as *AOE*. One word, *context*, cued episodes for only 14 subjects. The geometric mean age of these 14 memories was 17 minutes, whereas the remaining 124 words had a range from 16 hours to 154 days. To avoid having this one outlier, which is based on so little data, inflate the correlations, the value for *context* was considered as missing for *AOE*. $\alpha = .91$.

As subjects were requested to go to the next word if an episode did not come to mind within 10 to 15 seconds, this task is the only one for which there were considerable missing data. Thus, a second variable was constructed. The *Number of Episodes* is the percentage of subjects providing a dated episode for each word: that is, *NOA* is the ease with which words cue episodes. $\alpha = .84$.

### *Timed Tasks*

The following three variables use log seconds instead of seconds in all calculations because the distributions of the raw data were skewed with occasional long times. As with all tasks using slides for stimuli, the words appeared white on a no-additional-light background. The typeface was lowercase Universe from an IBM Magnetic Tape Selectric Composer.

*Tachistoscopic Recognition Threshold** (*TS**) instructions, which included five practice slides, introduced the 30 Lawrence University undergraduate volunteers to the ascending method of limits procedure (Postman & Adis-Castro; 1957). The series of ascending tachistoscope exposures increased by a factor of 1.2 from 5 milliseconds. Exposures of the same word were 3 seconds apart and stopped when the subject reported the correct word. The experimenter, slide projector, tachistoscope shutter, and timer were in one room; the subject and screen were in another, fully lit, room. The words appeared approximately 10 cm high on a screen 1.6 m from the subjects. The ratio of the illumination of the word to the background screen was 1 to 1.26. $\alpha = .90$.

*Reading Latency** (*RL**) or as it is sometimes called, naming or pronunciation latency, is the time it takes a subject to begin naming a visually presented stimulus. *RL** has been used to investigate people's access to their lexical memory, often in comparison to a lexical decision task.

The procedure used was a simplified version of Frederiksen and Kroll's (1976). The subject initiated a trial by pressing a foot switch. After 850 milliseconds a timer started and a shutter opened projecting a word approximately 10 cm high between two white tape lines on a screen placed 2.4 m in front of the subject. The onset of the subject's voice pronouncing the word triggered a Lafayette Voice Response Time Control which stopped the timer and closed the shutter. Words mispronounced were considered as missing data. One artifact might have been that different initial sounds take different times to trigger the voice key, however, this does not appear to be a serious problem (Forster & Chambers, 1973). Thirty Lawrence University undergraduate volunteers took part in the experiment. $\alpha = .92$.

*Lexical Decision** (*LD**) is response latency to judge whether a string of letters is a word. The physical set up was identical to that of the *TS** experiment except that the display was brighter. The subject initiated a trial by pressing a foot switch. After 500 milliseconds, a timer started and a shutter opened projecting a string of letters between two white tape lines on a screen. The subject's pressing of a "yes" or "no" button on a hand-held console stopped the timer and closed the shutter. Only "yes" responses to words were recorded. Ten practice trials followed the instructions. Thirty-six Lawrence University undergraduate volunteers took part in the experiment.

The nonword foils were constructed by randomly selecting 62 words not used here from the list of 925 nouns of Paivio et al. (1968). One letter of each word was selected at random and changed by a naive judge to produce a string of letters which followed English orthography, was easily pronounceable, and did not appear in the *Oxford English Dictionary* (1933). Thus, the foils insured that subjects could not use strategies based purely on spelling or pronunciation (Shulman & Davidson, 1977). $\alpha = .91$.

### *Recall*

All recall tasks were scored for exact words only: spelling and number changes were accepted but not synonyms. The variables reported are the percentages of subjects recalling each word.

*Free Recall with Overt Rehearsal* (*FROR*) was adapted from a study by Rundus and Atkinson (1970). Seven lists of 18 words were shown to 36 Lawrence University undergraduate volunteers at a rate of one word every 5 seconds. Lists were generated randomly with the restriction that each word appear exactly twice in each serial position. Subjects were instructed to rehearse out loud during the presentation of the lists and were provided with a practice list. The only major change in Rundus and Atkinson's procedure was that subjects counted backwards by 3's for 30 seconds after the last word was presented before writing down their recalls. $\alpha = .71$.

*Free Recall with Overt Rehearsal of Only the Word Showing* (*FRI*) is identical in procedure to *FROR* except that subjects were instructed to rehearse only the word being shown. $\alpha = .71$.

*Free Recall: Fast Presentation* (FRFP) was modeled after Underwood and Freund (1970). Thirty Lawrence University undergraduates volunteered. All 125 words were presented as a single list on a memory drum at the rate of one word per second. Each subject was asked to "try to remember as many words as you can," but not informed as to the type of recall task that would follow. After counting backwards by 3's for 30 seconds, subjects were asked to write down all the words they could. In informal questioning following the session most subjects indicated they expected a written or oral free recall test. $\alpha = .74$.

*Free Recall following Lexical Decision* (FRLD). At the end of the *Lexical Decision* task subjects were asked to recall as many words as they could. $\alpha = .83$.

*Free Recall from Paired-Associate Stimulus* and *Free Recall from Paired-Associate Response* (*FRPS, FRPR*) are from a surprise free recall which followed the paired-associate task to be described below. Stimulus and response words were scored separately to form the two variables. $\alpha = .57$; $\alpha = .52$.

*Free Recall Grouped* (*FRG*) is the combination of the data from the six recall tasks just described, just as if all 214 subjects took part in the same experiment. It was formed because the six recall tasks individually had fairly low reliabilities (in the .5 to .8 range) as is common with recall tasks using about 30 subjects to obtain an estimate for each word (Christian, Bickley, Tarka, & Clayton, 1978; Paivio, 1968), yet had intercorrelations almost as high as their reliabilities. By combining the data from all 214 subjects it is possible to raise the reliability, as measured by Cronbach's $\alpha$ (Cronbach, 1951), to .92. This reliability is as high as one would expect from applying the Spearman–Brown Prophecy Formula (Walker & Lev, 1953) to the reliabilities of the individual free recall tasks which make up *FRG*. Thus, while there may be some differences between the recalls from the various free recall tasks, the accuracy of the values from the current study is such that a general index of free recall is useful for analyses using correlational techniques. *FRG* is such an index of free recall averaged over situations.

*Free Recall from Christian, Bickley, Tarka, and Clayton* (*FRC*) is from a published table (Christian et al., 1978) which provides values for 121 of the 125 words used here. The task was an immediate free recall of lists, 25 words long, presented at a rate of 6 seconds per word. The first five and last five words were unscored buffer items. Recalls from 32 subjects go into the recall estimate of each word yielding a reliability for the whole list of .57.

*Recall Using a Mnemonic Pathway* (*RMn*) is the percentage of subjects who recalled each word on a mnemonic pathway. As a class requirement, 34 Lawrence University undergraduates read a description of the use of mnemonic pathways (Bower, 1970) and learned a 42 location pathway around campus with the aid of three slide presentations, and a map and list of the loci.

Each word was presented visually for 10 seconds. In order to present all 125 words plus one dummy word the 42 loci pathway was used three times. The presentation of each 42 word list was followed by a 7-minute recall period and a 1-minute rest period. Words were scored as correct only if they appeared with the proper loci. $\alpha = .67$.

*Paired-Associate Stimulus and Response* (*PAS, PAR*) was modeled after Paivio (1965, 1968). While the extensive literature (Goss & Nodine, 1965) cannot be reviewed here, one effect, that of the facilitative effect of high stimulus imagery (Paivio, 1965, 1968; Wicker & Thorelli, 1978), should be noted.

The 125 words plus one dummy word were randomly divided into three lists of 21 pairs. A subject saw the first list of 21 pairs on a memory drum at the rate of one pair every 4 seconds. After the 21st pair a row of asterisks signaled the subject to prepare to write on a response sheet. The 21 stimulus words then appeared in a new random order at a rate of one every 4 seconds. Two more trials of the same 21 pairs in different random orders followed. This procedure was then repeated for the remaining two lists of 21 pairs. The next subject had the identical lists with identical pairs except that stimulus and response words were switched. The words were then randomized for the next two subjects with the restriction that the set of 42 words used in the first list were now used in the last list and vice versa. After each set of four subjects a total randomization occurred.

The dependent variable was the number of trials on which the subjects recalled the proper response member of the pair. Each two successive subjects were combined to form one "subject" so that each of the 125 words appeared as both a stimulus and a response word once. The data were scored on the basis of their stimulus members to form *PAS* and on the basis of their response members to form *PAR*. Seventy-six Lawrence University undergraduate volunteers took part in the experiment yielding 38 "subjects" for the statistical analysis. Instructions, including a two-trial, five-pair practice list, preceded the task. $\alpha = .79$; $\alpha = .59$.

*Recognition* (*Recg*) is the percentage of subjects who recognized each word in a forced choice, five-item, multiple-choice task following the *Free Recall: Fast Presentation*. The 500 foils needed were drawn randomly from the 800 of 925 nouns of Paivio et al. (1968) not used here. After completing their free recall subjects were seated at a memory drum set at a 4-second exposure, and instructed to indicate the words that they had seen earlier, marking one and only one word per trial. $\alpha = .61$.

## Results

Norms of the 34 previously unpublished scales are published (Rubin, in press). A computer-readable form is available from the author.

### Correlations

Correlations among all of the 51 variables in the study are presented in Table 1, with leading decimal points omitted. A brief examination of the table reveals that with the exception of the correlations between the imagery and emotionality variables, nearly all the correlations are positive. While most correlations are moderate, it is not the case that everything correlates with everything else. Many of the high correlations fall in clusters near the main diagonal indicating that the conceptual categories used to organize the variables are present in the data.

### Methodological Issues

*Outliers* that were more than 3 SD from the mean were removed and the correlations of Table 1 recalculated. Only one correlation changed by more than .20.

*Nonlinearities* were searched for by examining a sample of key variables (one from each factor on the factor analysis to be presented) crossed with all the other variables. Clear nonmonotonic functions were apparent on the plots *Goodness* and *Pleasantness* with the three emotionality variables and to a much lesser extent in the plots of *Imagery* and *Associative Difficulty** with the emotionality variables and *Number of Attributes* and *Recognition* with *Goodness* and *Pleasantness*. While no unexpected nonmonotonic functions were observed, improvements in many correlations would probably occur if models more complex than a linear relation were introduced.

*Limits on the use of inferential statistics.* Detailed post hoc analyses are hindered by the study's professed neutrality. Given $(51 \times 50)/2$, or 1275, correlation coefficients at least one or two should be interesting. While aimlessly searching Table 1 may provide a good source of hypotheses, pilot data, and evidence to be used in addition to other studies, correlations chosen because of their extreme value instead of some a priori interest are the ones most likely to show regression to the mean, and therefore are the ones most in need of replication. Theoretically motivated investigations, however, could make use of Table 1 without this problem because only a small subset of correlations would be relevant, and these only in specific predictions.

The correlations reported in Table 1 are calculated over words and not over subjects. They are therefore not independent observations, although they are often treated as such by experimenters who use correlations over units as well as by experimenters who calculate quasi-$F$ ratios from a combination of $F_1$ and $F_2$ (Clark, 1973). Because of the lack of independence, most analyses will be descriptive rather than inferential. If the observations were considered to be independent, the .05 and .001 levels for the correlations would be .18 and .29, respectively. Approximately half of the 1275 correlations are significant beyond the .001 level, while only one would be expected to be "by chance."

*Range effects.* Even though the variables here exhibit a reasonable spread of values, they may not be representative of the total possible range. Consider the following example. Howes (1957) demonstrated statistically that the correlation between *Associative Frequency* and frequency approaches 1.00 although the actual observed correlation is modest. This is because available frequency counts deal with only "common" words, that is, words with frequencies of at least one per million. "Rare" words occurring once per billion, or less, are left out of frequency counts, most rating scales and most psychology experiments. Thus, the range of words dealt with is severely reduced, and all correlations may be underestimated. This problem will plague this as well as almost all other studies. As the frequency of the words investigated are typical of those that make up more than 99% of English words (Rubin, 1974), this problem may not be that serious a hindrance in predicting most behavior. Range effects, however, also need to be considered for almost all other scales studied. The problem, however, is not unique to correlational studies; it is equally important, though less obvious, in the more standard experimental approach.

### *A Factor Analysis*

The principal-factor, orthogonal, varimax procedure used by previous researchers in this area (Fringke, 1968; Paivio, 1968; Wimer, 1963) was chosen to reduce the 51 × 51 correlation matrix to an interpretable summary. The results obtained make sense in terms of the matrix itself and hierarchical clustering analyses performed on the same data. The claim that is being made for this analysis is that variables that load on the same factor are related. In a hierarchical clustering solution they would cluster together. In a multidimensional scaling solution they would be near one another. The factor analysis presented here is flawed (Carroll, 1978). The six factors presented here emerge when these flaws are corrected by removing variables so that no correlation .85 or higher remains, by removing all variables that were formed by summing other variables, and by removing all variables that were not logically independent of other variables formed from the same experimental task. A seventh factor with an eigenvalue greater than one (1.17 compared to 18.43, 6.57, 5.49, 3.34, 2.34, and 1.72 for the first six factors) is not presented because it failed to appear when the correct analysis was performed.

Table 2 presents the surprisingly simple factor solution. The numbers in the table are the correlations (with decimals not printed) among the variables and the factors. Correlations, or loadings, greater than $.10^{1/2}$ have been bordered with vertical lines to draw attention to those loadings that account for greater than 10% of the variable's variance. Examining these vertical lines it can be seen that the factors are quite clean with many variables loading on only one factor. With the exception of factors 1 and 3, there is little overlap for most variables. The 51 variables collapse into six factors: *Spelling and Sound, Imagery and Meaning,*

TABLE 1A

| | | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| LENGTH IN LETTERS* | 1 | 95 | 89 | 83 | 65 | 84 | 90 | 88 | 72 | 41 | 65 | 23 | 18 | 19 | 28 | 21 | 25 | 1 |
| 1ST ORDER LETTERS | 2 | | 89 | 81 | 70 | 80 | 87 | 89 | 74 | 39 | 66 | 28 | 20 | 19 | 27 | 21 | 25 | 2 |
| 2ND ORDER LETTERS | 3 | | | 87 | 74 | 78 | 78 | 80 | 64 | 40 | 65 | 18 | 12 | 13 | 22 | 14 | 16 | 3 |
| 3RD ORDER LETTERS | 4 | | | | 71 | 77 | 72 | 74 | 61 | 42 | 60 | 19 | 12 | 12 | 24 | 17 | 16 | 4 |
| ORTHOGRAPHIC DIST. | 5 | | | | | 70 | 55 | 59 | 58 | 37 | 46 | 07 | 05 | 02 | 13 | 34 | 02 | 5 |
| PRONOUNCIABILITY* | 6 | | | | | | 80 | 80 | 76 | 48 | 63 | 43 | 31 | 30 | 41 | 33 | 34 | 6 |
| # OF PHONEMES* | 7 | | | | | | | 95 | 79 | 45 | 71 | 36 | 23 | 23 | 30 | 23 | 32 | 7 |
| 1ST ORDER PHONEMES | 8 | | | | | | | | 77 | 55 | 73 | 38 | 27 | 25 | 32 | 26 | 31 | 8 |
| # OF SYLLABLES* | 9 | | | | | | | | | 48 | 61 | 36 | 27 | 26 | 32 | 24 | 25 | 9 |
| SPELLING TO SOUND | 10 | | | | | | | | | | 43 | 25 | 25 | 19 | 20 | 20 | 20 | 10 |
| # OF REHEARSALS | 11 | | | | | | | | | | | 42 | 34 | 35 | 38 | 33 | 29 | 11 |
| IMAGERY | 12 | | | | | | | | | | | | 88 | 88 | 89 | 89 | 73 | 12 |
| CONCRETENESS | 13 | | | | | | | | | | | | | 95 | 91 | 91 | 67 | 13 |
| CONCRETENESS' | 14 | | | | | | | | | | | | | | 89 | 92 | 68 | 14 |
| IMAGERY ON PATHWAY | 15 | | | | | | | | | | | | | | | 89 | 63 | 15 |
| CATEGORIZABILITY | 16 | | | | | | | | | | | | | | | | 67 | 16 |
| MEANINGFULNESS | 17 | | | | | | | | | | | | | | | | | 17 |

| | | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 | 31 | 32 | 33 | 34 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| LENGTH IN LETTERS* | 1 | 35 | 00 | 53 | 37 | 46 | 52 | 39 | 30 | 46 | 45 | 46 | 49 | 14 | 18 | 06 | -02 | 08 | 1 |
| 1ST ORDER LETTERS | 2 | 31 | -01 | 51 | 37 | 49 | 48 | 37 | 32 | 45 | 44 | 46 | 49 | 09 | 15 | 03 | -01 | 06 | 2 |
| 2ND ORDER LETTERS | 3 | 25 | 05 | 52 | 39 | 49 | 48 | 45 | 41 | 48 | 51 | 57 | 53 | 10 | 14 | 01 | -01 | 01 | 3 |
| 3RD ORDER LETTERS | 4 | 27 | 05 | 53 | 51 | 52 | 50 | 48 | 46 | 51 | 52 | 54 | 52 | 12 | 16 | 00 | -02 | -01 | 4 |
| ORTHOGRAPHIC DIST. | 5 | 26 | 15 | 56 | 44 | 52 | 49 | 50 | 47 | 51 | 57 | 52 | 53 | 10 | 12 | 03 | -03 | -01 | 5 |
| PRONOUNCIABILITY* | 6 | 51 | 02 | 71 | 49 | 67 | 74 | 59 | 38 | 64 | 62 | 67 | 69 | 24 | 19 | 01 | -01 | 05 | 6 |
| # OF PHONEMES* | 7 | 37 | 00 | 54 | 37 | 54 | 56 | 36 | 27 | 51 | 45 | 45 | 50 | 12 | 19 | 08 | 08 | 17 | 7 |
| 1ST ORDER PHONEMES | 8 | 36 | -01 | 51 | 39 | 52 | 55 | 35 | 28 | 50 | 46 | 47 | 53 | 09 | 17 | 00 | 04 | 11 | 8 |
| # OF SYLLABLES* | 9 | 35 | -05 | 55 | 37 | 62 | 52 | 34 | 21 | 44 | 39 | 42 | 47 | 11 | 16 | 07 | 06 | 13 | 9 |
| SPELLING TO SOUND | 10 | 25 | -08 | 25 | 31 | 33 | 39 | 13 | 07 | 23 | 21 | 29 | 36 | 12 | 18 | -22 | -19 | -11 | 10 |
| # OF REHEARSALS | 11 | 46 | 04 | 54 | 34 | 42 | 58 | 38 | 28 | 55 | 53 | 53 | 61 | 17 | 21 | 00 | 05 | 07 | 11 |
| IMAGERY | 12 | 62 | -05 | 49 | 23 | 22 | 59 | 26 | 02 | 26 | 23 | 37 | 52 | 26 | 32 | -12 | -03 | 09 | 12 |
| CONCRETENESS | 13 | 42 | -19 | 40 | 18 | 12 | 50 | 15 | -03 | 14 | 10 | 33 | 46 | 18 | 24 | -41 | -24 | -13 | 13 |
| CONCRETENESS' | 14 | 42 | -12 | 41 | 11 | 11 | 50 | 21 | -01 | 18 | 13 | 34 | 47 | 19 | 24 | -35 | -17 | -10 | 14 |
| IMAGERY ON PATHWAY | 15 | 47 | -15 | 50 | 29 | 18 | 58 | 29 | 06 | 24 | 22 | 41 | 53 | 17 | 22 | -30 | -18 | -09 | 15 |
| CATEGORIZABILITY | 16 | 47 | -16 | 42 | 15 | 11 | 53 | 22 | -03 | 19 | 14 | 33 | 48 | 20 | 25 | -34 | -21 | -10 | 16 |
| MEANINGFULNESS | 17 | 45 | 01 | 42 | 16 | 23 | 45 | 22 | 11 | 23 | 14 | 37 | 42 | 25 | 28 | -20 | -08 | 02 | 17 |
| ASSOC. DIFFICULTY* | 18 | | 31 | 63 | 20 | 33 | 64 | 55 | 33 | 48 | 53 | 50 | 60 | 62 | 67 | 26 | 34 | 40 | 18 |
| # OF ATTRIBUTES | 19 | | | 70 | -10 | 09 | 05 | 33 | 45 | 33 | 37 | 28 | 21 | 34 | 31 | 51 | 44 | 33 | 19 |
| ASSOCIATIVE FREQ. | 20 | | | | 39 | 53 | 80 | 71 | 55 | 71 | 73 | 74 | 80 | 30 | 33 | 07 | 11 | 17 | 20 |
| # OF DICT MEANINGS | 21 | | | | | 42 | 44 | 38 | 43 | 45 | 50 | 54 | 49 | 13 | 15 | -16 | -20 | -18 | 21 |
| DATE OF ENTRY* | 22 | | | | | | 51 | 40 | 32 | 50 | 46 | 41 | 43 | 12 | 13 | 12 | 11 | 08 | 22 |
| AGE-OF-ACQUISITION* | 23 | | | | | | | 64 | 40 | 61 | 65 | 69 | 81 | 32 | 35 | -05 | 01 | 09 | 23 |
| FAMILIARITY | 24 | | | | | | | | 74 | 75 | 81 | 75 | 74 | 39 | 34 | 04 | 05 | 02 | 24 |
| K-F FREQUENCY | 25 | | | | | | | | | 70 | 81 | 79 | 65 | 34 | 30 | 09 | -01 | -10 | 25 |
| T-L FREQUENCY | 26 | | | | | | | | | | 87 | 77 | 78 | 36 | 35 | 11 | 02 | -01 | 26 |
| LORGE FREQUENCY | 27 | | | | | | | | | | | 80 | 83 | 40 | 37 | 16 | 07 | 03 | 27 |
| C-O-R FREQUENCY | 28 | | | | | | | | | | | | 89 | 40 | 41 | -12 | -15 | -14 | 28 |
| RINSLAND FREQUENCY | 29 | | | | | | | | | | | | | 42 | 42 | -08 | -08 | -05 | 29 |
| GOODNESS | 30 | | | | | | | | | | | | | | 95 | 04 | 21 | 08 | 30 |
| PLEASANTNESS | 31 | | | | | | | | | | | | | | | 02 | 20 | 18 | 31 |
| EMOTIONALITY | 32 | | | | | | | | | | | | | | | | 69 | 65 | 32 |
| EMOTIONAL GOODNESS | 33 | | | | | | | | | | | | | | | | | 86 | 33 |
| EMOTIONAL PLEASANT | 34 | | | | | | | | | | | | | | | | | | 34 |

TABLE 1B

| | | 35 | 36 | 37 | 38 | 39 | 40 | 41 | 42 | 43 | 44 | 45 | 46 | 47 | 48 | 49 | 50 | 51 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| LENGTH IN LETTERS* | 1 | 15 | 23 | 68 | 60 | 70 | 17 | 08 | 19 | 31 | 19 | 18 | 22 | 39 | 23 | 23 | 42 | 20 | 1 |
| 1ST ORDER LETTERS | 2 | 16 | 22 | 57 | 57 | 65 | 13 | 05 | 15 | 27 | 19 | 17 | 19 | 34 | 17 | 20 | 41 | 19 | 2 |
| 2ND ORDER LETTERS | 3 | 06 | 19 | 56 | 56 | 68 | 11 | 11 | 15 | 23 | 20 | 16 | 19 | 33 | 17 | 18 | 39 | 13 | 3 |
| 3RD ORDER LETTERS | 4 | 03 | 15 | 55 | 54 | 73 | 11 | 07 | 14 | 20 | 17 | 14 | 17 | 33 | 19 | 17 | 42 | 07 | 4 |
| ORTHOGRAPHIC DIST. | 5 | -03 | 16 | 39 | 48 | 61 | -01 | 02 | 13 | 13 | 24 | 11 | 12 | 25 | 13 | 02 | 35 | 07 | 5 |
| PRONOUNCIABILITY* | 6 | 17 | 35 | 64 | 68 | 80 | 11 | 10 | 18 | 26 | 22 | 22 | 22 | 47 | 33 | 28 | 47 | 15 | 6 |
| # OF PHONEMES* | 7 | 24 | 26 | 63 | 58 | 67 | 15 | 07 | 17 | 29 | 16 | 15 | 20 | 39 | 20 | 25 | 40 | 19 | 7 |
| 1ST ORDER PHONEMES | 8 | 23 | 25 | 59 | 54 | 65 | 14 | 08 | 11 | 23 | 13 | 13 | 17 | 37 | 19 | 27 | 41 | 12 | 8 |
| # OF SYLLABLES* | 9 | 26 | 16 | 43 | 55 | 56 | 14 | 07 | 16 | 28 | 12 | 19 | 19 | 40 | 12 | 22 | 37 | 17 | 9 |
| SPELLING TO SOUND | 10 | 18 | 05 | 25 | 19 | 36 | -02 | -02 | -01 | 04 | -02 | -05 | -02 | 18 | -01 | 18 | 20 | -08 | 10 |
| # OF REHEARSALS | 11 | 18 | 28 | 53 | 61 | 61 | 10 | 07 | 14 | 17 | 14 | 08 | 14 | 44 | 20 | 33 | 44 | 17 | 11 |
| IMAGERY | 12 | 47 | 45 | 37 | 37 | 27 | 44 | 31 | 29 | 29 | 28 | 35 | 40 | 55 | 62 | 67 | 42 | 23 | 12 |
| CONCRETENESS | 13 | 37 | 29 | 23 | 26 | 15 | 28 | 19 | 12 | 16 | 18 | 20 | 24 | 41 | 52 | 62 | 25 | 02 | 13 |
| CONCRETENESS' | 14 | 39 | 33 | 23 | 29 | 19 | 33 | 24 | 17 | 21 | 21 | 24 | 29 | 44 | 52 | 59 | 26 | 11 | 14 |
| IMAGERY ON PATHWAY | 15 | 34 | 33 | 36 | 35 | 27 | 42 | 26 | 23 | 26 | 30 | 31 | 37 | 51 | 66 | 62 | 35 | 13 | 15 |
| CATEGORIZABILITY | 16 | 40 | 38 | 27 | 27 | 19 | 34 | 20 | 19 | 21 | 27 | 31 | 31 | 43 | 58 | 65 | 29 | 12 | 16 |
| MEANINGFULNESS | 17 | 49 | 46 | 35 | 34 | 26 | 29 | 18 | 12 | 16 | 20 | 27 | 25 | 37 | 49 | 47 | 21 | 12 | 17 |
| ASSOC. DIFFICULTY* | 18 | 24 | 55 | 43 | 53 | 50 | 32 | 33 | 35 | 33 | 33 | 37 | 41 | 57 | 44 | 35 | 54 | 47 | 18 |
| # OF ATTRIBUTES | 19 | 05 | 17 | 19 | 22 | 27 | 20 | 28 | 25 | 10 | 25 | 19 | 26 | 19 | -02 | -09 | 27 | 32 | 19 |
| ASSOCIATIVE FREQ. | 20 | 22 | 50 | 52 | 62 | 69 | 30 | 30 | 33 | 35 | 42 | 43 | 43 | 60 | 48 | 27 | 58 | 28 | 20 |
| # OF DICT MEANINGS | 21 | -02 | 13 | 23 | 26 | 44 | -04 | -10 | 05 | 00 | 07 | 10 | 01 | 13 | 22 | 14 | 27 | -08 | 21 |
| DATE OF ENTRY* | 22 | 17 | 26 | 25 | 41 | 55 | 06 | 08 | 18 | 19 | 21 | 26 | 19 | 33 | 08 | 17 | 37 | 14 | 22 |
| AGE-OF-ACQUISITION* | 23 | 29 | 50 | 53 | 63 | 68 | 20 | 21 | 28 | 27 | 30 | 27 | 30 | 53 | 50 | 35 | 52 | 23 | 23 |
| FAMILIARITY | 24 | -01 | 48 | 41 | 55 | 68 | 14 | 20 | 26 | 28 | 32 | 30 | 30 | 39 | 37 | 11 | 50 | 25 | 24 |
| K-F FREQUENCY | 25 | -05 | 23 | 33 | 45 | 56 | 08 | 14 | 18 | 15 | 29 | 26 | 22 | 27 | 20 | -01 | 43 | 09 | 25 |
| T-L FREQUENCY | 26 | 06 | 37 | 47 | 58 | 72 | 12 | 15 | 19 | 17 | 28 | 27 | 23 | 38 | 26 | 11 | 53 | 15 | 26 |
| LORGE FREQUENCY | 27 | -02 | 36 | 45 | 60 | 70 | 15 | 24 | 28 | 26 | 33 | 29 | 31 | 41 | 29 | 10 | 57 | 20 | 27 |
| C-O-R FREQUENCY | 28 | 10 | 30 | 49 | 60 | 67 | 14 | 18 | 20 | 23 | 34 | 31 | 28 | 44 | 38 | 22 | 49 | 09 | 28 |
| RINSLAND FREQUENCY | 29 | 18 | 46 | 55 | 63 | 67 | 22 | 27 | 26 | 30 | 35 | 32 | 34 | 55 | 47 | 36 | 59 | 17 | 29 |
| GOODNESS | 30 | -09 | 19 | 23 | 31 | 30 | 16 | 28 | 22 | 20 | 21 | 20 | 26 | 33 | 19 | 16 | 22 | 30 | 30 |
| PLEASANTNESS | 31 | -03 | 19 | 23 | 30 | 30 | 15 | 29 | 21 | 22 | 23 | 22 | 27 | 32 | 20 | 15 | 21 | 29 | 31 |
| EMOTIONALITY | 32 | 14 | 18 | 15 | 22 | 11 | 29 | 29 | 37 | 25 | 23 | 29 | 34 | 24 | -02 | -12 | 34 | 47 | 32 |
| EMOTIONAL GOODNESS | 33 | 07 | 23 | 06 | 16 | 07 | 31 | 34 | 26 | 18 | 15 | 22 | 30 | 23 | -04 | -09 | 29 | 44 | 33 |
| EMOTIONAL PLEASANT | 34 | 23 | 30 | 10 | 11 | 03 | 34 | 37 | 30 | 25 | 22 | 30 | 36 | 25 | 04 | -07 | 27 | 42 | 34 |
| AGE OF EPISODE | 35 | | 55 | 31 | 14 | 14 | 23 | 08 | 12 | 12 | 15 | 21 | 19 | 24 | 33 | 38 | 21 | 05 | 35 |
| # OF EPISODES | 36 | | | 39 | 30 | 38 | 18 | 14 | 18 | 15 | 21 | 33 | 24 | 35 | 44 | 34 | 47 | 28 | 36 |
| TSCOPE THRESHOLD* | 37 | | | | 65 | 64 | 27 | 18 | 30 | 36 | 29 | 25 | 33 | 53 | 43 | 30 | 45 | 28 | 37 |
| READING LATENCY* | 38 | | | | | 72 | 17 | 17 | 27 | 30 | 32 | 20 | 28 | 57 | 33 | 28 | 47 | 26 | 38 |
| LEXICAL DECISION* | 39 | | | | | | 08 | 10 | 18 | 21 | 24 | 18 | 20 | 41 | 25 | 21 | 50 | 22 | 39 |
| FREE RECALL OVERT | 40 | | | | | | | 67 | 59 | 56 | 57 | 60 | 82 | 58 | 49 | 34 | 47 | 49 | 40 |
| FREE RECALL ONE | 41 | | | | | | | | 58 | 61 | 61 | 56 | 83 | 58 | 31 | 31 | 43 | 42 | 41 |
| FREE RECALL FAST | 42 | | | | | | | | | 79 | 64 | 60 | 83 | 54 | 33 | 23 | 44 | 64 | 42 |
| FREE RECALL L.O. | 43 | | | | | | | | | | 61 | 60 | 84 | 54 | 35 | 32 | 48 | 58 | 43 |
| FREE RECALL P-A:S | 44 | | | | | | | | | | | 67 | 82 | 53 | 36 | 21 | 45 | 39 | 44 |
| FREE RECALL P-A:R | 45 | | | | | | | | | | | | 81 | 54 | 35 | 27 | 53 | 43 | 45 |
| FREE RECALL GROUP | 46 | | | | | | | | | | | | | 67 | 45 | 35 | 57 | 59 | 46 |
| FREE RECALL CBTC | 47 | | | | | | | | | | | | | | 48 | 48 | 59 | 45 | 47 |
| RECALL ON PATHWAY | 48 | | | | | | | | | | | | | | | 51 | 42 | 26 | 48 |
| PAIRED-ASSOC. S | 49 | | | | | | | | | | | | | | | | 45 | 11 | 49 |
| PAIRED-ASSOC. R | 50 | | | | | | | | | | | | | | | | | 42 | 50 |
| RECOGNITION | 51 | | | | | | | | | | | | | | | | | | 51 |

TABLE 2

| VARIABLES | FACTORS 1 | 2 | 3 | 4 | 5 | 6 | |
|---|---|---|---|---|---|---|---|
| LENGTH IN LETTERS* | 93 | 08 | 11 | 14 | 12 | 07 | 90 |
| 1ST ORDER LETTERS | 92 | 09 | 11 | 11 | 03 | -02 | 98 |
| 2ND ORDER LETTERS | 87 | -22 | 23 | 12 | -07 | -02 | 93 |
| 3RD ORDER LETTERS | 92 | -01 | 30 | 09 | -20 | -01 | 79 |
| ORTHOGRAPHIC DIST. | 67 | -11 | 41 | 06 | -18 | -03 | 64 |
| PRONOUNCIABILITY* | 82 | 23 | 34 | 07 | 03 | 07 | 87 |
| # OF PHONEMES* | 91 | 16 | 10 | 07 | 12 | 07 | 88 |
| 1ST ORDER PHONEMES | 92 | 19 | 10 | 04 | 04 | 01 | 89 |
| # OF SYLLABLES* | 81 | 19 | 08 | 08 | 17 | 02 | 70 |
| SPELLING TO SOUND | 53 | 19 | 02 | -11 | -15 | 15 | 37 |
| # OF REHEARSALS | 69 | 28 | 24 | 30 | 08 | 09 | 62 |
| IMAGERY | 20 | 93 | 07 | 21 | 05 | 12 | 92 |
| CONCRETENESS | 12 | 91 | 01 | 08 | -21 | 12 | 91 |
| CONCRETENESS* | 10 | 90 | 04 | 13 | -15 | 11 | 97 |
| IMAGERY ON PATHWAY | 18 | 86 | 12 | 22 | -18 | 04 | 87 |
| CATEGORIZABILITY | 10 | 91 | 06 | 15 | -16 | 09 | 90 |
| MEANINGFULNESS | 15 | 73 | 12 | 06 | 05 | 09 | 59 |
| ASSOC. DIFFICULTY* | 24 | 65 | 37 | 20 | 41 | 46 | 81 |
| # OF ATTRIBUTES | -08 | -19 | 40 | 20 | 44 | 22 | 49 |
| ASSOCIATIVE FREQ. | 44 | 35 | 61 | 25 | 13 | 05 | 77 |
| # OF DICT MEANINGS | 38 | 10 | 43 | -06 | -24 | 00 | 40 |
| DATE OF ENTRY* | 54 | 07 | 31 | 08 | 11 | -04 | 42 |
| AGE-OF-ACQUISITION* | 47 | 49 | 52 | 11 | 07 | 10 | 75 |
| FAMILIARITY | 27 | 11 | 90 | 16 | 05 | 15 | 77 |
| K-F FREQUENCY | 19 | -13 | 85 | 14 | -05 | 09 | 80 |
| T-L FREQUENCY | 40 | 09 | 77 | 08 | 06 | 11 | 78 |
| LORGE FREQUENCY | 36 | 01 | 84 | 17 | 05 | 14 | 89 |
| C-O-R FREQUENCY | 36 | 23 | 78 | 13 | -16 | 17 | 87 |
| KINSLAND FREQUENCY | 40 | 39 | 71 | 16 | -05 | 16 | 98 |
| GOODNESS | 04 | 12 | 29 | 15 | 09 | 88 | 91 |
| PLEASANTNESS | 10 | 17 | 24 | 14 | 11 | 89 | 91 |
| EMOTIONALITY | 02 | -30 | 06 | 38 | 74 | -07 | 77 |
| EMOTIONAL GOODNESS | 01 | -16 | -06 | 24 | 82 | 17 | 79 |
| EMOTIONAL PLEASANT | 07 | -03 | -13 | 27 | 82 | 07 | 78 |
| AGE OF EPISODE | 11 | 55 | -02 | 02 | 36 | -28 | 53 |
| # OF EPISODES | 10 | 48 | 39 | 03 | 48 | -11 | 64 |
| TSCOPE THRESHOLD* | 59 | 24 | 28 | 22 | 16 | 01 | 52 |
| READING LATENCY* | 55 | 21 | 42 | 16 | 17 | 13 | 59 |
| LEXICAL DECISION* | 65 | 10 | 56 | 05 | 12 | 09 | 77 |
| FREE RECALL OVERT | 03 | 29 | -03 | 77 | 17 | -01 | 71 |
| FREE RECALL ONE | -03 | 14 | 05 | 79 | 14 | 18 | 69 |
| FREE RECALL FAST | 08 | 06 | 10 | 83 | 13 | 06 | 73 |
| FREE RECALL L.D. | 20 | 09 | 02 | 84 | 03 | 06 | 76 |
| FREE RECALL P-A:S | 06 | 12 | 25 | 78 | 01 | -01 | 68 |
| FREE RECALL P-A:R | 03 | 20 | 22 | 74 | 13 | -06 | 66 |
| FREE RECALL GROUP | 07 | 12 | 12 | 96 | 12 | 05 | 99 |
| FREE RECALL CBTC | 30 | 39 | 22 | 56 | 18 | 12 | 65 |
| RECALL ON PATHWAY | 05 | 59 | 27 | 34 | 01 | -05 | 55 |
| PAIRED-ASSOC. S | 16 | 66 | -01 | 24 | -05 | 00 | 52 |
| PAIRED-ASSOC. R | 32 | 24 | 41 | 45 | 27 | -04 | 60 |
| RECOGNITION | 10 | 04 | 04 | 57 | 39 | 19 | 52 |

*Word Frequency, Recall, Emotionality,* and *Goodness.* Thus, the factor analysis agrees with the standard conceptual breakdown used in presenting the variables. The six factors account for 74% of the common variance.

Factor 1, *Spelling and Sound,* has its highest loadings from variables that were or could be formed without regard to whether the strings of letters scaled were words (Manelis, 1974). As might be expected from previous work (e.g., Landauer & Streeter, 1973), the *Word Frequency* variables have moderate loadings on Factor 1. Somewhat less expected, the *Timed Tasks* all have their highest loadings on Factor 1.

Factor 2, *Imagery and Meaning,* consists of variables that measure some aspect of a word's semantic representation. *Recall Using a Mnemonic Pathway and Paired-Associate Stimulus* load highest on this factor, as might be expected from their high correlations with *Imagery,* but the other recall variables did not. Replicating Paivio (1968), the imagery and associative variables do not separate into two factors.

Factor 3 has high loadings from the *Word Frequency* variables and moderate loadings from some of the *Spelling and Sound* variables. Factor 3 also has nearly as high loadings as Factor 1 from *Reading Latency** and *Lexical Decision**, but not from *Tachistoscopic Recognition Threshold**. The lack of a higher correlation between *Tachistoscopic Recognition Threshold** and the *Word Frequency* variables may be due in part to the use of lower as opposed to uppercase letters. This change from the usual procedure probably emphasized the structural aspects of the words (D. Howes, personal communication).

Factor 4 has its highest loadings from the free recall variables with more moderate loadings from the other *Recall* tasks. Thus the *Recall* variables, with the exception of those depending on imagery, form a group independent of the numerous variables invented to correlate with them.

Factor 5 has high loadings from the emotionality variables and moderate loadings from the *Autobiographical Memory* variables. Factor 6 has high loadings from *Goodness* and *Pleasantness.* These two factors are similar to the degree of polarization and evaluative factors of the semantic differential.

*AD*, AF, AOA*, RF, NOE,* and *PAR* load on more than two factors. These variables cannot be explained in terms of a single factor, but need either some combination of factors or a different conceptual framework. With the exception of these variables, the 51 variables sampled here form six categories, or factors, with the property that correlations among the variables loading on the same factor are generally high while correlations among the variables loading on different factors are generally low. These six factors provide a way of viewing the variables studied by cognitive psychologists and should help in the design and interpretation of controlled experiments. For example, assume that an experiment is being designed to test the effects of *Length in Letters**, a variable which loads highly on Factor 1. Then, it will be easier to choose words to control for variables that load on Factors, 2, 3, 4, 5, and 6, than those that load on Factor 1, and if one variable from Factor 2, 3, 4, 5, or 6 is controlled for it is likely that the range of the other variables loading on that factor will be severely reduced. Similarly if proper controls are not taken almost any variable loading highly on Factor 1 could probably account for the effects observed and these variables should also be considered in interpreting the results.

Considering the variety among the samples of variables used in factor analytic studies, there is considerable agreement in results. Four of Paivio's (1968) six factors are similar to the present Factors 2, 3, 4, and 5. His remaining two factors, *Specificity* and *Associative Variety*, are based on variables not included in the present study. Three of Wimer's (1963) five factors overlap with the present Factors 2, 3, and 6. Her *Associative Similarity* and *Potency* factors are based on variables not included in the present study. Comparisons with Frincke's (1968) study are difficult. His two factors do not account for his eleven variables as indicated by the observation that 5 of his 11 variables have communalities of .35 or less while only two have communalities over .70.

### *Multiple Regressions*

In performing multiple regressions all variables up to the *Autobiographical Memory* variables were considered as independent variables. Table 3 displays the multiple regressions. Given the low reliability of the individual free recall variables only *Free Recall Grouped* is presented. In order to minimize multicollinearity problems, the multiple regressions are based on the 22 independent variables left when variables that correlate .85 or more with other independent variables are excluded. The values of these regressions are displayed under the "MR all" column in Table 3. The regression equations resulting from the restriction that each variable, when it is added, must have a Beta weight significantly different from zero, $p < .05$, under the liberal assumption that the words are independent, are displayed in Table 3. The last column of the table shows the reliability of each dependent variable as calculated by Cronbach's $\alpha$ (Cronbach, 1951).

In general, the multiple regression predictions are quite good, accounting for most

TABLE 3
MULTIPLE REGRESSIONS

| Dependent variable | Independent variables[a] 1 | 2 | 3 | 4 | 5 | 6 | M.R. shown[b] | M.R. all[c] | $\alpha$[d] |
|---|---|---|---|---|---|---|---|---|---|
| Age of Episode | .40*m* | +.26*E* | −.27*G* | +.28*I* | | | .62 | .69 | .91 |
| Number of Episodes | .43*AD** | +.33*M* | +.52*F* | −.34*CDRF* | −.22*G* | | .70 | .75 | .84 |
| Tscope Threshold* | .63*L** | +.06*AD** | +.18*NOA* | −.22*OED** | +.27*AOA** | | .76 | .80 | .90 |
| Naming Latency* | .46*Pr** | +.27*Reh* | +.19*E* | +.32*CDRF* | −.15*STS* | −.16*Dict* | .80 | .82 | .92 |
| Lexical Decision* | .61*Pr** | +21*KFF* | +.16*NOA* | +.16*Reh* | | | .87 | .89 | .91 |
| Free Recall Group | .32*AF* | +.36*E* | +.36*I* | −.18*Reh* | | | .62 | .71 | .92 |
| Recall on Pathway | .61*I* | ÷.24*F* | −.19*STS* | | | | .68 | .76 | .67 |
| Paired-Assoc. S | .67*I* | | | | | | .67 | .71 | .75 |
| Paired-Assoc. R | .17*AF* | +.31*E* | +.30*I* | +.33*LMF* | | | .72 | .77 | .57 |
| Recognition | .39*E* | +.32*AD** | | | | | .56 | .68 | .61 |

[a] $\beta$ weights given.
[b] Multiple regression of variables shown.
[c] Multiple regression using 22 independent variables.
[d] Cronbach's $\alpha$ for dependent variables.

of the reliable variance, and in the case of *Paired-Associate Response*, even more. Free recall, the dependent variable which has attracted the most attention, has the worst predictions, but this may be due in part to the grouping of several procedures to produce one measure.

The independent variables that produce the greatest predictive power for the various dependent variables are not necessarily the ones most cognitive psychologists would have guessed. Thus being so stupid as not to limit study to theoretically relevant variables may not have been so stupid. *Associative Frequency, Emotionality*, and *Pronunciability** are the three major surprises. *Associative Frequency*, a variable that does not rely on subject's intuitions for its formation, is the best single predictor of *Free Recall Grouped* and *Paired-Associate Response*. This may be viewed as an associative spew hypothesis or any of the other models applied to frequency, but here it is the frequency with which a word is given as an associate. In terms of network models of memory the fact that *Associative Frequency* and *Meaningfulness* are not empirically more similar suggests that the links going to a node are not equal to the links going from a node (i.e., the links are not symmetrical). Of methodological interest is the observation that once *Associative Frequency* is thought to be important, post hoc explanations for its importance are fairly easy to find. *Emotionality* appears in the multiple regressions of all three *Recall* tasks that do not depend highly on *Imagery*. While emotions and memory have seen little attention in the recent literature, emotionality as defined here as an extreme value on a scale may be seeing a revival in the form of distinctiveness (Helson, 1964; Hunt & Elliot, 1980; Murdock, 1960). *Emotionality* as the best predictor of *Recognition* is especially noteworthy, but requires replication in an experiment also showing the more standard inverse relation of recognition and frequency. *Pronunciability** as the best predictor of *Reading Latency** and *Lexical Decision** also deserves added attention. While these results need replication, the present findings indicate that the theory driven, one variable at a time approach to verbal learning may have missed some interesting observations.

The dominance of *Imagery* over Concreteness as a predictor of *Recall* variables is, however, not unusual. In spite of the two variables' high correlation, similar findings are noted by Christian et al. (1979), Frincke (1968), and Paivio (1968).

### *Free Recall and the Depth of Processing Approach*

Some words are easier to remember than others in a range of free recall tasks, as indicated by the high intercorrelations among the free recall variables. The limits of such invariance, however, are reached if imagery is involved in a recall task, as is claimed for *Recall Using a Mnemonic Pathway* or Paired-Associate Stimulus. If more subjects were tested in each recall condition, differences between these tasks may have been detected. Nonetheless, as a first approximation the invariance uncovered is useful in itself as well as a base from which to note deviations.

These arguments can be stated in terms of the processing during encoding which is emphasized by the depth of processing approach (Craik & Lockhart, 1972). If encoding involves imagery, the encoding affects which words are recalled. If not, over the range of the free recall tasks used here, the encoding task affects only the amount of recall. To account for both how many and which units are recalled, both the material and the processing must be considered.

That the properties of words as well as the type of encoding affect recall is not a novel finding. It can be interpreted as: evidence that lifelong habits of processing information semantically cannot be completely overcome by instruction (Postman & Kruesi, 1977); as support for a functionalist approach to the study of memory (Jacoby, Bartz, & Evans, 1978); as an argument for the need to emphasize both structure and process (Hunt & Elliot, 1980); or as the fact that the properties of words will in part determine what processing a word will be able to support in an encoding situation (Craik, personal communication). The point to be stressed here is that psychologists must distinguish between how much is recalled and what is recalled. Very different perspectives can follow from these different views of the data. The unit analysis used here provides an extremely rich source of information which cannot be ignored. (For an expansion of this distinction between how much and what recalled, and an extension to prose see Rubin, 1978b.)

This study also argues against any unidimensional explanation of why some words or tasks produce higher recall, be that explanation depth, elaboration, or distinctiveness. *Pronunciability**, *Imagery*, *Familiarity*, *Emotionality*, and *Goodness*, to name a few, do not fall on a straight line. Words and tasks vary in numerous ways. Unidimensional metaphors while useful ways to force us to broaden our theorizing, in the end do not do justice to the complexity of the behaviors involved. While depth of processing need not be considered as a unidimensional concept, in practice it usually is.

### *Some Recently Introduced Variables: Age-of-Acquisition and Autobiographical Memory*

One claimed goal of this study is to provide experimenters, who are studying new procedures or explanatory principles, a way to obtain a good deal of information simply by obtaining relevant values for 125 words. This section provides a test of that claim.

Most *Age-of-Acquisition** (*AOA**) studies consider the confounding effects of word frequency. Examining variables in this study, however, it would appear that *Pronunciability**( *Pr**) and *Associative Frequency* (*AF*) are *AOA**'s most serious competitors. *Pr** correlates .74 with *AOA** and is the best single predictor of *Reading Latency**, a variable which comes from a task similar to the picture-naming latency commonly used in *AOA** studies (Carroll & White, 1973a, 1973b; Gilhooly & Gilhooly, 1979). *AF* correlates .80 with *AOA** and is one of the best predictors of free recall. One must be cautious in noting the superior performance of *Pr** and *AF* because they were chosen for their extreme correlations and thus are likely to show some regression to the mean in future studies. Nonetheless, faced with these high correlations it becomes easy to see, post hoc, why such correlations could exist and also easy to write scripts explaining *AOA** effects in terms of *Pr** or *AF* and vice versa. The notion that words learned early in life come to mind easiest is especially appealing. Thus, the shotgun approach used here does suggest variables which should be studied and/or controlled for in future work with *AOA** and suggests many variables which could most likely be ignored.

*Age of Episode* has had relatively little study with respect to the property of the word prompts (Robinson, 1976, Fitzgerald, Note 3; Neisser, Note 4). *Age of Episode* was included in the study in order to obtain pilot data for future studies by the author. Because there exists little theory, the choice of independent variables will rely on the pilot work performed here. In this way a tedious series of experiments examining which of the many possible variables played the major role in determining *Age of Episode* can be avoided.

## Discussion

A sample of 51 variables from the verbal learning and verbal behavior literature was examined in an attempt at a theoretically neutral, comprehensive study. Both the method used and the results obtained have implications for cognitive psychology.

The method used should make several points obvious. First, it has become extremely difficult to use a standard analysis of variance experimental design to show that an independent variable is solely responsible for effects observed in a dependent variable. While for certain variables clever methods of control exist, in most cases the sheer number of demonstrated confounding factors usually prohibits a truly controlled study. Second, knowing that certain variables predict more or less than other variables can be much more useful than knowing that certain variables have an effect when those other variables are controlled. This, of course, is not true where the simple demonstration of an effect disproves a theory, but such demonstrations are not the usual case. Third, the correlational unit analysis performed here provides a wealth of information with respect to the effort invested, and fourth, that information can provide a perspective different from that of the more standard experimental approach. Knowing which words are easy to see or learn can be as useful and important as knowing how many words are seen or learned. Finally, it is difficult to see how the interrelationships among the various variables we have created and demonstrated effective can be understood without some form of large multivariate study.

The results of the study indicate that the variables that were sampled here clustered into six main groups. While there may be interesting differences among the variables in any one group, the overall organization is surprisingly simple. The empirical structure observed lends support to many of the conceptual structures of cognitive psychology, while providing novel information about many variables. Using the approach suggested by Broadbent (1973), the universe of theories has been divided into classes empirically as well as conceptually.

One of the six main groups, *Recall*, deserves special attention. In general, this study demonstrated that: (1) a word that is recalled in one free recall situation will tend to be recalled in a wide range of free recall situations, (2) current theories are not especially good at indicating which words will be recalled, and (3) unlike many of the other changes in encoding used here, the use of imagery does have drastic effects on what is recalled.

Combined with an earlier study (Rubin, 1978) it appears that, for both prose and isolated words, which units are recalled in free recall is quite stable over many changes in procedure even though large changes in how many units are recalled can be observed; whatever makes a unit memorable in one situation tends to make it memorable in many others. Unfortunately, for both prose and isolated words psychologists have not been especially successful at discovering what it is that makes a unit memorable, although almost all their theories seem to be somewhat successful. In contrast to free recall, we are much more successful in predicting values for individual words in *Reading Latency**, *Lexical Decision**, *Tachistoscopic Recognition Threshold**, *Recall Using a Mnemonic Pathway*, and *Paired Associate Stimulus*.

Before suggesting possible uses for this study, its main limitations should be emphasized. The sample of words used here was not selected randomly from English speech or text, but was taken to be the words common to two other counts. This is a serious fault, but one shared by all the common norms and therefore the words sampled from them. Even if the sample were random, it would only be one sample. While comparisons with other studies indicated that the results are representative, any one correlation could be off due to the sampling of words. Especially where the correlations are searched haphazardly for noteworthy values, further experimentation is suggested to support the original finding.

The values obtained here can serve as a good first test of additional variables for which a large literature does not exist. If a researcher can obtain a set of 125 values for a new variable, one value for each word in this study, then that researcher could know the extent to which each of 51 other variables are related to it. Changes in the new variable could be made to maximize its desired properties before it was tested further.

If more than one variable is added to the 51 collected here, the possibilities expand. Differences on a task between a clinical and a control population, or among samples of different ages or imagery ability could be probed with the variables already available. Similarly variables derived from different ways of calculating orthographic regularity, or from using upper or lowercase letters or other procedural changes could be studied. The extent to which the added variables have the same values also has theoretical interest as a measure of generalizability of results over conditions. Besides the correlational analysis, comparisons of the means of the variables calculated over all words or over specific subsets of words could be made. Even without adding a new variable a by unit ($F_2$) analysis of variance can be calculated as a pilot study before proceeding with an actual experiment (Christian et al., 1978).

In short, the values obtained here can be used to provide a good deal of initial information about a variable, or variables, with a minimum expenditure of effort.

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