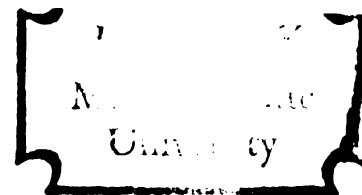


GENERALIZATION OF THE PAIRED-ASSOCIATE
MODEL TO DEFINITION LEARNING

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This is to certify that the
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ABSTRACT

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by Salah Abdul-Moniem Hotar

The Problem

Verbal learning psychologists are primarily concerned with studying the basic mechanisms of learning by using nonsense syllables in highly controlled experimental procedures with adult subjects. The variable which has received the greatest attention has been the meaningfulness (m) of the verbal material. There is a reasonable consistency between the empirical findings and paired-associate theories, namely that m of the response member of a paired-associate has a greater effect upon learning than m of the stimulus member. Most paired-associate theories predict the following order of the four basic types of lists H-H, L-H, H-L, and L-L arranged according to their ease of learning (H indicates high meaningfulness, and L low meaningfulness). However, paired-associate studies have yielded contradictory results concerning the effect of familiarization on the response members prior to the actual learning task. The satiation theory, the most promising one, predicts the following order H-L, L-L, H-H, and L-H if the subjects are familiarized with the responses.

Educators, on the other hand, are concerned as to whether the material, the method, and even the findings have any objective applications to the classroom. Accordingly, the present study stands between

these two extremes and attempts to test the appropriateness of extending the paired-associate model to definition learning. Thus, the major purpose of this study is to test the hypothesis that paired-associate learning can be used as a model for learning arithmetical definitions. The acceptance of this hypothesis requires two conditions. First, there must be a one-to-one correspondence between the elements of a paired associate and a definition. Second, certain relations must be preserved, namely that the order of the types of definitions must be the same as the order of the types of paired-associates under different familiarization treatments.

The Methodology

Four arithmetic textbook series were used to gather arithmetical definitions which appear in grades five, six, seven and eight. Definitions with stimuli composed of more than one word or with symbols in the response were excluded. Ninety-seven arithmetical definitions were finally used. Forty-eight of these definitions were numerical, and the other forty-nine were geometrical. The two kinds of definitions, numerical and geometrical, were randomly arranged. The stimuli and the responses were separated from each other. The m of the definitions, their stimuli, and their responses were determined separately by the use of three rating scales each of which was judged by approximately thirty sixth grade pupils whose median age was 145 months. Meaningfulness was defined operationally in terms of the students' judged familiarity and ease of learning. The reliability coefficients were significantly different from zero ($P < .01$). The results of this step has been used first to study the interrelationships between m of definitions, m of

the stimuli, m of the responses, number of letters in the stimulus and number of words in the response; second, to select the four types of definitions H-H, L-H, H-L, and L-L.

Four sets of definitions were chosen. Each set contained four definitions, two numerical and two geometrical. One definition of each kind was longer in length of the response than the other. However, each list had approximately the same total number of words. The verbal familiarization material was composed of three sentences for each selected definition. In case of picture familiarization, the numerical definitions were explained by presenting three number operations, while the geometrical definitions were explained by drawing three consecutive pictures. The subjects who did not receive familiarization were designated as a control group. Thus the four types of definitions and the three kinds of familiarization yielded twelve treatments.

The subjects were 434 volunteer students enrolled in the seventh grade. Their median age was 151 months. The learning task was administered by the use of a group procedure in which definitions as well as the familiarization material were presented by an overhead projector. Rate of presentation of the definition stimulus and response was 5 and 15 seconds respectively in paired-associate like procedure. The course of experimental session was as follows: Pre-test, presentation of familiarization material for all groups except the control group, a learning trial followed by a test trial; two learning trials followed by the second test trial; two learning trials followed by the third test trial; two learning trials followed by the fourth test trial; two learning trials followed by the fifth test trial; post-test. During

the pre- and post-tests the subjects were instructed to express the meaning of the stimulus using their own words, during the test trials, they were asked to write the exact words of the response as shown to them in the learning trials. The subjects answers in the test trials were classified into eight different categories with the assumption that these categories represented a continuum which began with a "no answer" and ended with "recalling the exact response" and covered the different levels of the answers. On the other hand, the pre- and post-test answers were classified into three categories; wrong, partially correct, and correct answers.

Concerning the test trials answers, the mean percentage of correct (exactly similar or slightly idfferent from the actual response) responses per test trial (in case of the combined definitions, short, long, numerical and geometrical definitions) was used as a dependent variable. The types of definitions were arranged according to the dependent variable. Kendall rank order correlation coefficient was used to determine the correlation between the actual arrangement of the types of definitions and the theoretical arrangement which is predicted by paired-associate theory. Whenever the correlation was perfect, a second test was applied using z score to determine whether or not there was significant differences between any two proportions of correct responses among the types of definitions. The same analysis was repeated using the mean percentage of the exact responses per test trial as a dependent variable. As for the pre-test answers, the X^2 test was used to compare the pre-test score distributions of the levels of stimulus m, response m, subject matter types, and length variables.

Also, the same approach was repeated using post-test answers. In addition, the χ^2 technique was used to test whether or not a significant difference existed between the pre-test scores and the post-test scores.

The Results

First: The distribution of definiendum m was bimodal, while the definition or definien m distributions were found approximately normal. The mean m of the definitions was found to be significantly higher than m of the response at the .01 level. However, the mean m of the definiendum was not significantly different from the mean m of the definien at the .05 level. Furthermore, m of numerical definitions was greater than m of the geometrical definitions at the .01 level. The results show a significant correlation between the m of geometrical terms and number of letters. There was significant correlation between the response m and the number of words. The high positive correlations showed that the shorter the response or the geometrical term the higher was its m . While the intercorrelation coefficients between stimulus m or response m , and their corresponding lengths were not significantly different from zero at the .01 level, it was found that each one of these variables correlates significantly with definition m . The significant correlations between m of the definitions indicated that when definition m was high response m was high, stimulus m was high and response number of words was few. The results showed that partialling any group of variables out of the correlation of definition m with other variables did not change the zero order correlation. However, once the definition m or other variables beside definition m were partialled out, all the new correlations differed significantly from their

zero order correlation. These results emphasized the penetrating effect of definition m and its relation with response m or stimulus m . When definition m was partialled out the following results were obtained: (1) When response m was high the response was not necessarily high or low; (2) when response m was high the stimulus m was also high. Thus the effect of the variation in the number of letters in the stimuli, the variation in number of words in the responses, and the proved influence of definition m on stimulus as well as response m indicates the presence of variables in definitions which are not usually studied in paired-associate learning.

Second: The analysis of answers of the subjects in the test trials using the correct responses as a dependent variable were used to test both the theory which emphasizes the stimulus m , as well as the theory which emphasizes the response position. Each theory was tested fifteen times (with the combined definitions, long, short, numerical and geometrical definitions--per control, verbal and picture familiarization). The theory which emphasizes the role of stimulus m was accepted twice in case of control and verbal familiarization of numerical definitions. The theory which stresses the response m was accepted twice--for the control treatments with the combined and the long definitions. In each of the confirming cases there was some overlap among the types of definitions when both theories predict no overlap. Possibly the nature of the dependent variable was responsible for the failure to confirm either one of the theories with a high degree of consistency because verbal learning psychologists assume the exact reproduction of the response as their criterion measure of learning. Thus the general hypothesis proved to be untenable.

Third: When the exact response was used as a dependent variable, the results did not confirm the theory which favors the stimulus position. The theory which emphasizes the m of the response was confirmed in three cases (combined, short and long definitions) with control treatment, and once (numerical definitions) with verbal familiarization. So the choice of the exact responses as a dependent variable improved the chances of confirming the general hypothesis.

Fourth: The data concerning the familiarization conditions led to the rejection of the satiation hypothesis. Such deviation might have occurred as a result of using a familiarization procedure not completely analogous to the familiarization procedures used by verbal learning psychologists. The proactive inhibition theory explained the results better than the satiation theory.

Fifth: Analysis of pre-test scores showed that stimulus m was more critical than response m . Thus definitions with higher m stimuli were better known in advance than definitions with lower m stimuli. The pre- and post-scores supported the hypothesis predicting an increase in definition attainment as an increasing function of stimulus m . Finally the analysis of post-test scores showed the presence of controversial findings between m of the stimulus and m of the response. While the arrangement of the types of definitions indicated that m of the stimulus was more critical in the post learning than response m , the statistical results were insignificant.

These facts emphasized the difficulty in generalizing from the paired-associate model to definition learning.

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CHAPTER I

INTRODUCTION

Verbal learning psychologists are concerned with identifying the variables which affect learning. The general procedure involves the establishment of a miniature learning situation in which the learner is presented a number of verbal units for memorization. A wide range of variables has been studied within such learning situations. The variables have involved manipulations of the meaningfulness of the material, method of presentation, rate of presentation and a host of other such variables. The many possible manipulable variables have created a wide range of verbal learning experiments. Each one of them is fairly well controlled and designed to test specific hypothesis concerning effects of the variables in question.

However, this experimental approach has raised many objections. Learning psychologists (Deese, 1961; Rothkopf, 1963) claim that it tends to ignore or neglect verbal characteristics and skills in addition to being restricted to examining elementary associations. Educational psychologists have also objected to such learning situations as being too restricted and not applicable to meaningful materials.

On the other hand, the advocates of this type of learning experiment believe that it stands squarely in the center of all human learning. They claim that research in verbal learning creates phenomena and theories related to the study of the processes involved in the learning situation (Underwood, 1964). Such basic principles of

learning make it possible to understand retention, forgetting, discrimination, generalization, transfer and problem solving behavior.

Hilgard (1964) summarized the relationship between the latter points of view of learning theory and educational practices as that between any pure science and its technological applications. By pure science research, he meant that research which is guided by the problems which the researcher sets himself without regard for the immediate applicability of the results to practical situations. In applied research, on the other hand, the researcher is concerned with a practical problem directly relevant to classroom learning. The road from pure science research to established educational practice has been classified into six steps. The first three of these steps relate to pure science research in learning and the others relate to the applied or technological research. The steps may be described as follows:

- Step 1. Research on learning with no regard for its educational relevance, e.g. animal studies, physiological, . . .
- Step 2. Research on learning which is not concerned with educational practices but which is more relevant than that of Step 1 because it deals with human subjects and with content that is nearer to that taught in school, e.g. nonsense syllable memorization and retention. . .
- Step 3. Research on learning that is relevant because the subjects are school-age children and the material learned is school subject matter or skill, though no attention is paid to the problem of adapting the learning to school practices, e.g.

foreign language vocabulary learned by paired-associate method with various lengths of list and with various spacing of trials.

Step 4. Research conducted in special laboratory classrooms, with selected teachers, . . .

Step 5. A tryout of the results of prior research in a "normal" classroom with a typical teacher. . .

Step 6. Developmental steps related to advocacy and adoption.

Hilgard added that too much of the research in the past several decades has rested at Steps 1 and 2. Educational psychologists have tended to work at this end of the spectrum and then to jump, by inference, to Step 6, without being sufficiently patient about Steps 3, 4, and 5. He then emphasized the significance of the tasks to be done all along the six steps.

Accordingly, the experiment reported in this study aims at being a kind of bridge between the two endpoints: Pure learning psychology and applied educational practices. The subjects are seventh grade school children, and the material consists of arithmetical definitions. The methodological approach is very similar to the laboratory methods of Hilgard's Step 2. However this study can be located in Hilgard's Step 3 where it is basically concerned with testing the validity of extending the existing theoretical notions in what is called paired-associate learning to the learning of the definitions.

Verbal learning psychologists usually use nonsense syllables, two consonants separated by a vowel, in their experiments. These nonsense syllables are scaled according to their familiarity and ease

of learning. This dimension of scaling is called "meaningfulness" (m). Pairs of verbal units are presented to the subject (S). The left hand member of the pair is designated as the stimulus term; the right hand member, the response term. The S's task is to learn to be able to recall the response term when the stimulus term is presented alone. An example of a paired-associate unit is "LAJ-NOV" where "LAJ" is the stimulus term and "NOV" is the response term.

Similarly, a definition is also composed of two parts, the definiendum and the definien, which are equivalent to the stimulus and response of a paired-associate. For example: "Face: A region of a plane enclosed by a polygon" is a definition whose stimulus, i.e. definiendum, is the word "Face," and whose response, i.e. definien, is the phrase, "A region of a plane enclosed by a polygon."

However, this similarity is not perfect and the differences between a paired-associate and a definition are numerous. (1) The components of a paired-associate might be nonsense syllables, unrelated words, or letters. In the definition, the elements are meaningful words related contextually to each other. (2) The definition components are associated with a common meaning, while the components of a paired-associate unit are not necessarily related. (3) Almost all the studies in paired-associate learning use only one nonsense syllable with a constant number of letters as a response while in the definition study the response is a phrase. Such definition responses usually vary in length. For example, the two phrases: "The numbers zero and one," and "The process of finding how many times a number is contained in another number," are responses for the stimuli "Bigits"

and "Division" respectively. While the first response is composed of five words, the second is composed of fourteen words. (4) Stimuli' number of letters in paired-associate learning is a constant, that is each stimulus is composed of either two or three letters, but the number of letters of the definition's stimulus is a variable. For example, "Pi" and "Multiplication" are stimuli of two arithmetical definitions. However each has a different number of letters. Because of these similarities and dissimilarities, it is difficult to make any generalization from paired-associate learning to definitions other than to suggest conservatively that there may be some correspondence between them.

Again, the first objective of this study is to test the hypothesis that paired-associate learning can be used as a model for learning definitions. The acceptance of this hypothesis requires two conditions (Brodbeck, 1963). First, there must be a one-to-one correspondence between the elements of a paired-associate and a definition. Second, certain relations must be preserved. That is to say we must know whether definition learning is influenced by the same variables as paired-associate learning. The correspondence between a paired associate item and a definition is fairly obvious. The second condition, i.e. that paired-associate and definitions are influenced by the same variables requires research. The variable selected for study and research in the present investigation involves the meaningfulness (m) of the definiendum and definien. Then, the keystone is the coincidence of the findings of paired-associate experiments and the findings of the definition experiment with regard to the effects

of m on learning. If manipulations in meaningfulness have similar effects on definition learning, then the correspondence between this type of learning and paired-associate learning has been demonstrated with respect to the m variable.

The second objective of the present research is to test the appropriateness of the paired-associate model in relation to the findings on familiarization training. Verbal learning psychologists have studied the effect of pre-training or pre-differentiation on the differential effect of the stimulus and response members of a paired associate list. In the familiarization study, the material is presented frequently and in advance of the learning trials for subjects. Teachers and textbook authors also try to familiarize their readers with either the definition stimulus, definition response or both. However, the educators' approach in familiarization is different from that of verbal learning psychologists. While the former tend to use examples from experience, pictures, and models; the latter use frequent repetitions. For this reason, this study will introduce two different methods of familiarization, verbal and picture explanation, which are similar to the educators' approach. The differential effect of verbal familiarization will be compared with that of picture familiarization.

A third objective is to obtain the meaningfulness values for a number of arithmetical definitions. These values should have two advantages. First, they help to equate the experimental conditions of definition learning with the experimental conditions of paired associate learning. For example, to conduct an experiment in

paired-associate learning, it is the usual procedure to choose a number of nonsense syllables whose m values are predetermined and to relate the findings of the experiment to the level of the m values. But in the case of definition learning the m values of either the stimuli, responses or definitions are not available. Therefore to make a comparison between the experimental findings of paired-associate learning and definition learning is questionable without controlling the m of definitions' stimuli and responses. Second, there are many elaborations on m of nonsense syllables. Verbal learning psychologists have done extensive work to understand, for example, the relationship between m of nonsense syllables and letter sequence. In definition learning while there is a lack of such studies, there is a need to understand, the relationships between length of word (stimulus), length of a sentence (response) and their corresponding m values. Also there is a need to understand the relationship between the m of a sentence and the mean m of the vocabulary which forms the sentence. The knowledge of such relationships, and others to be reported, are of significance to the educational enterprise in general and to understanding the results of this study in particular.

RELATED LITERATURE

The review of the literature will include:

- (a) The methods of scaling meaningfulness of the nonsense material.
- (b) The studies of the differential effect of the meaningfulness of paired-associate components.

- (c) The studies of familiarization and its differential effect on meaningfulness of paired-associate components.

Each part of the literature will include the theoretical considerations and the empirical studies.

The Scaling of Meaningfulness

The studies of verbal learning have shown that a verbal unit such as "MEX" will be learned much more rapidly than "XYJ." The differences between the rate of learning of the verbal units have been attributed to a factor called meaningfulness (m). The words which are easy to learn are supposed to have higher meaningfulness (m) value than the words which are difficult to learn. Definitions of m have involved different approaches and sometimes different names.

The earliest operational definition of m was based upon the number of associates reported for an item in a certain fixed time. Ss were asked to state in a word or phrase what the item meant for them. If the syllable meant something but the subject could not express its meaning within the time limit, he was to say "yes." The total number of items presented ranged from 4534 to 320 per study, with the items presented by a tachistoscope or a memory drum for an exposure time which varied from two seconds to seven seconds. Principal contributors to this method were Glaze (1928), Hull (1933), Krueger (1934), Witmer (1935), Archer (1960), and Hilgard (1951). This m value has been designated as the association value.

The second method of rating the m of the items is called the production method, devised by Noble (1952), and used by Mandler (1955). Meaningfulness was defined as the mean number of responses written

during a certain time. However, the time in the production method is typically longer than the time for the association method. The maximum reported time using the production method is one hundred twenty seconds. The items were either dissyllables or nonsense syllables, presented on paper. The subject responded by writing all the different words elicited by the item, within a certain time.

The third method of rating m has employed a rating scale. The subjects were asked to rate the item in terms of either ease of learning, familiarity, or pronunciation. This approach has been used by Haagen (1949), Noble, Stockwell and Pryer (1957), Underwood and Schulz (1960) and others. This m value has been referred to as the familiarity value.

Goss and Nodine in 1965, called the association method and the production method the single-association technique and the multiple-association technique, respectively. Using the first method the number of association by a single subject to each stimulus may be limited to at most one association. With the second method the subject may respond with as many associations as he can within intervals. They called the scaling method as the experimenter-supplied stimuli for responses because each stimulus may be accompanied by one or more experimenter-supplied continuous stimuli in the form of graphic rating scales. Moreover, they assumed a direct relationship between frequency and m and that frequency can be considered as a basis for inferring m of stimuli. In this context frequency refers to the frequency of occurrence of stimuli as counted in samples of words in written texts.

The association, production and rating methods all appear to have some variance in common. The study reported by Mandler (1955) showed a correlation coefficient of .65 between the results of the production method and the number of associations method, using 100 syllables. Noble Stockwell and Pryer (1957) showed a correlation coefficient of .81 and .86 between the m values obtained by rating scale method and the values previously reported by Glaze and Krueger using the number of associations method for 100 syllables. Underwood and Schulz (1960) used Noble's items in three independent experiments. They found correlation coefficients between m values reported by Noble (who used the production method) on one side, and m values received by scaling the item's ease of learning, familiarity and pronunciation to be .90, .92, and .78. All the reported inter-correlation coefficients between the results of different techniques are significantly different from zero.

Rate of learning has been shown to be functionally related to m. Studies have shown that high m learning material is more readily learned than low m material. This relation is confirmed by the experiments conducted by Lyon (1914), Reed (1929), Davis (1930), McGeoch (1930), Sisson (1938), Noble (1952), Underwood and Richardson (1956), Dowling and Brown (1957), Sarason (1957), and Braun and Heyman (1958). The first two studies dealt with educational materials unscaled for m. The others had scaled items in the form of a serial learning task where the units were presented to the S in a constant order on each learning trial and he was required to learn them in the order presented.

Kimble and Dufort (1955), Mandler and Huttenlocher (1956), Noble and McNeeley (1957), and Noble, Stockwell and Pryer (1957) proved that the same relationship namely, that high m material is easier to learn than low m material, held in the case of paired-associate learning task where both components were of the same m value. An explanation was offered by Underwood (1949) that m of material facilitates learning because of greater familiarity of such material.

The previous studies have been concerned with scaling either nonsense syllables, nonsense figures, numbers, adjectives or nouns. There are no studies applying the concept of m for educational material, or even sentences.

The Differential Effect of Meaningfulness of Paired-Associate Components on Learning

It has been shown that nonsense syllables can be scaled according to their m and that the higher the m , the easier the learning. This part of the literature survey will show the development of the two-step theory and the empirical findings relevant to the role of the stimulus and response m on paired-associate learning.

The two-step theory has been mentioned implicitly within the framework of information theory. Miller (1951) defined the amount of information conveyed by an item as dependent on the number of alternatives from which that item is chosen. For example, it is known that the twenty-six English letters occur with different relative frequency, and it is possible to predict a letter in a word if the one or ones preceding it are known. However, the precision of prediction is dependent on the number of alternatives from which

the predicted letter is chosen. Given the letter "Q" in a word, then the only predicted letter to follow it is "U." The amount of information of "U" is dependent on one because it is the only alternative from which the choice is made. Again, given the letter "E" in a word, then to predict the letter following it is to make a choice from the other twenty-five alphabetic letters. Suppose that the letter which is chosen to follow the letter "E" is "N." The amount of information of "N" is then dependent on twenty-five, and is assumed to be greater in value than the amount of information of "U" which has been shown to depend on one alternative.

Information theory implies also that as the contextual constraints increase, the information of the components of the verbal unit decrease. For example, in order to read the verbal unit "AEHV" one may tend to pronounce each letter individually because there is no previous learned context to integrate these letters, and the information per letter is high. On the other hand, the verbal unit "HAVE" is easier to pronounce. Here the constraint imposed by the arrangement of the letters is high and the letters are not considered independent entities. Rather, they are all components of one context, namely the familiar word "HAVE."

Miller and Selfridge (1950) cited evidence that learning time increases with the amount of information communicated. By deduction, as contextual constraints increase the learning time is expected to decrease. Thus, in definition learning, the verbal unit "Repeated of: Process multiplication the addition," is more difficult than "Multiplication: The process of repeated addition."

Information theory so far has shown that the increase rate of learning for a verbal unit or a series of such units, is dependent on the degree of contextual constraints. However, the theory has not placed a particular emphasis on paired-associate learning nor on the role of meaningfulness of its components.

Hovland and Kurtz (1952) showed more explicitly than information theory that learning successive pairs of nonsense syllables involves two steps; one must not only learn the associations between the units, but also the units to be associated. This notion can also be applied in definition learning. In order to learn a definition such as "Point: A mathematical idea associated with a location in space," the subject must learn the vocabulary of the definition, i.e. the words "Point, A, mathematical, . . . , space," and then how to connect the stimulus "Point" with the response. However, the theory does not explain the steps involved in learning each unit of the paired-associate and associating them with each other.

Mandler (1954) presents three concepts in his proposal: (a) differentiating responses, (b) response integration, and (c) symbolic responses. The first concept suggests that a stimulus is differentiated from other stimuli when it evokes a response different from one evoked by the other stimulus. This concept refers to the behavior of identifying and exploring the elements of the stimulus. The second concept is concerned with the elimination of subresponses which prevent or delay reinforcement. The third concept implies that any overt response which is perceived by a human organism evokes a

symbolic response analogous to the overt response. Mandler concluded that learning a response involves three steps: Differentiation, integration and association through symbolic analogy.

Underwood and Schulz (1960) have analyzed the acquisition of paired-associate or serial lists into two stages. The first stage is referred to as the response learning or response recall stage. In this stage the response units are learned and connected to form a large unit. This step is similar to Mandler's (1954) integration step. In the second stage, the associative or hook-up stage, the subject connects the response to a particular stimulus. Underwood and Schulz suggested that stimulus m exerts its effect on the associative stage while the response m exerts its effect on response learning stage. Hence, they concluded that the effect of stimulus m on paired associate learning is less than the corresponding effect of response meaningfulness.

Two conditions must be fulfilled if paired-associate learning is to be considered a valid model for definition learning. One of these is that both the paired-associate and the definition must work on the same principle. Such principle was not clarified. Furthermore, the Paired-associate theories suggest the conclusion, that; m of the response member is more effective with respect to acquisition rate than m of the stimulus member. If the present experiment confirms this expectation, then paired-associate principles can be used for definition learning.

The following portion of literature survey will show the findings of the empirical studies relevant to the effect of m on paired

associate learning.

The earliest experiments used lists of paired-associates whose components could be classified roughly and as possibly having a high m (H) or a low m (L). The material consisted of an English word paired with a familiar word. The possible combinations were (1) H-H, high m stimulus and high m response; (2) L-H, low m stimulus and high m response; (3) H-L, high m stimulus and low m response; and (4) L-L, low m stimulus and low m response. These four combinations will be referred to in this study as paired-associate types. The lists might contain one type of paired-associate with many items, or four types of paired-associate (H-H, L-H, H-L, L-L) with very few items per type. Learning has been measured by the number of correct responses recalled directly after the end of the acquisition period.

Stoddard (1929) asked a group of school children to learn from French words to English words, and the other group to learn from English words to French words. If it is considered that English words have higher m than French words, then this study provides a test of the relative influence of m of the stimulus versus m of the response. The mean test score for subjects who learned L-H (French-English) was 15.1 of 25, and for those who learned H-L (English-French) was 8.0 out of 25. Thus, it can be concluded that L-H produced better learning than H-L and that high meaningfulness in the response position is more critical than m of the stimulus position.

Cason (1933) constructed 18 lists of 16 pairs each. The verbal units were familiar words (F) and unfamiliar nonsense syllables (U) (F-F, U-F, F-U, and U-U). He had two groups of Ss, both of

which were given heterogenous lists of the types of familiar and unfamiliar verbal units. One group of Ss was given the list to study for a period of four to eight minutes. The second group heard the pairs. An immediate recall test was administered in which the stimulus was pronounced and spelled by the experimenter and the Ss were to recall the response. Cason found that the two methods of study, auditory and visual, produced approximately the same results. Moreover, the recall of F-F (equivalent to H-H) was significantly greater than for U-U (L-L), but the U-F (L-H) and F-U (H-L) magnitude of recall was intermediate between F-F (H-H) and U-U (L-L).

Sheffield (1946) used Cason's material in which various combinations were preserved within the list, but the presentation was via the memory drum in order to control the time factor per unit. He demonstrated that H-H produced the most rapid rate of learning while L-L produced the slowest rate. The L-H and H-L rate of learning was significantly different, contrary to Cason's findings. The L-H learning was slightly inferior to H-H, while H-L was slightly faster than L-L learning. Sheffield concluded that differences in *m* of the stimulus produces relatively minor changes in the rate of learning as compared with corresponding differences in the *m* of the response.

Kimble and Dufort (1955) prepared lists of ten paired-associates in which the stimuli were ten items from Noble's dissyllables. The ten dissyllables represented a complete range of *m* in Noble's scale. Response terms consisted of common three-letter words. Thus,

it could be concluded that each list had these paired-associate types: H-H, H-L, and L-H. A group of Ss learned the list with Noble's dissyllables in the stimulus position, and a second group were given the same dissyllables in the response position. Kimble and Dufort found that Ss took more learning trials to anticipate correctly the list in which Noble's dissyllables were stimuli than when the dissyllables were responses.

Cieutat, Stockwell and Noble (1958) formed the four combinations using Noble's dissyllables. Each list had only one combination. The H-L list and L-H lists were composed of identical items, but the positions were reversed. The lists were presented for twelve trials and each trial was followed by a test trial. Learning was measured in terms of the percentage of correct responses to each trial for each list. Their results showed the difficulty of learning increases in the order of H-H, L-H, H-L, and L-L. Moreover, they found that variation in stimulus m produced a much greater effect on learning when response m was low than when it was high; and that variation in response m produced a much greater effect on learning when stimulus m was low than when it was high.

The later results were confirmed by Lambert and Paivo (1956), Weiss (1958), L'Abate (1959), Hunt (1959), Underwood and Schulz (1960), Epstein (1963), Kothurkar (1963), Nodine (1963), Harleston (1963), Martin, Cox and Boersma (1965), and Goss (1965). The generalization of the increase of learning trials in the order H-H, L-H, H-L, and L-L was found to hold under different experimental conditions whether the lists were administered to subjects singly or by a group technique, in

constant or varied order, under anticipation or recall formats and whether the subjects were college students or hospitalized mental patients. Thus, it is concluded that m of the response members is from slightly to several times more potent than m of the stimulus member. Goss (1965) recently made an extensive review of the literature on paired-associate learning and suggests that the available data are still too scanty either to account for exceptions to this generalization on rational grounds or to lead to more precise, reliable generalizations about other patterns of factors.

The previous empirical findings are consistent with the theoretical notion which has been considered as the principle upon paired-associate learning works, namely, that m of the response member is more responsible for the acquisition rate of a paired-associate learning than m of the stimulus member. But it has not been shown whether such confirmed paired-associate theory is valid in case of definition learning. Then if it is proved that definiens meaningfulness is more critical than definiendum meaningfulness the paired-associate model can be extended to include definition learning.

The Differential Effect of Familiarization of Paired-Associate Components on Learning

The preceding literature has demonstrated that high m materials are learned faster than low m materials. One explanation of this phenomenon is that the high m material tends to be more familiar to the subjects. Another explanation suggests that frequent experience with the verbal material makes it more meaningful; thus its m

increases and is easier to learn. To test the relation between m , frequency of experience and rate of learning, psychologists have designed experiments in which verbal stimuli or responses are presented to Ss prior to the learning task. The purpose of such an experiment is to test the effect of such familiarization process on rate of learning. The usual method of familiarization is to require the Ss to repeat the stimulus to themselves (Gannon and Noble, 1961; Goss, Nodine, Gregory, Taub, and Kennedy, 1962), to repeat the stimulus aloud continuously for a certain time at a relatively high rate of repetitions per second (Lambert and Jakobvits, 1960; Kamungo, Lambert and Mauer, 1962), or to look at the stimuli for a period of time (Cieutat, 1960). These approaches to familiarization have been called either pre-training, pre-learning, or satiation.

The role of familiarization has been explained by psychologists in relation to their theoretical framework. According to Miller's (1951) theory of information, familiarization reduces the number of alternate items from the range of all possible nonsense syllables. For example, the naive subject with the English language, given the letter "Q" to anticipate the second letter, responds with any letter, while the subject who is acquainted with this language will--with high probability--restrict his choice to the letter "U." The subject who is familiar with language structure is expected to restrict his responses to previously learned language habits. In addition, familiarization will tend to reduce the amount of information conveyed by each syllable at the time of learning. For example, before the

familiarization trials each word of the phrase, "The process of taking a number out of another number," is considered as unique and independent source of information by itself. The familiarization process helps the S to "chunk" the words together to form a smaller number of information units. So after familiarization one S may perceive the phrase as composed of "The process of," "taking out of another," and "number." Another S might perceive the same phrase again as composed of smaller and smaller units.

Gibson (1940) has mentioned that the familiarization procedure produces discrimination between the units to be associated and those learned in earlier lists. She predicted two types of errors to be reduced: Interlist and "invention" errors. This prediction is consistent with Miller's theory of reducing the number of alternatives to the limited number which have been offered in the familiarization trials. For example: If a S is presented frequently with a list of geometrical definitions to become familiar with, and the same list is given to the same S for learning, then the erroneous responses that are expected to be reduced are those involving recalling a numerical response or inventing a haphazard answer for the geometrical stimulus. Gibson also predicted a reduction of intralist errors if the S is familiarized with the learning material. Thus, it can be assumed that subjects who are given a list of geometrical definitions for familiarization and then for learning are less likely to attach a geometrical response to a different geometrical stimulus. Hovland and Kurtz (1952) were able to show that familiarization enables the subject to recognize the interlist and invention errors but does not

reduce the intralist errors.

Mandler's (1954) view is that with successive repetition of a response aggregate, the separate responses eventually become stimuli for each other in a way that any part of the response aggregate will tend to evoke the whole response. This is designated as an integration process and its growth is dependent upon elimination of responses which prevent or delay reinforcement. Still Mandler's explanation is directed towards the response and, in a sense, he views the familiarization process as responsible for limiting the number of alternatives and making such correct responses more integrated. Underwood and Schulz (1960) added that familiarization is a procedure for making responses more available during subsequent association learning.

Then, it could be concluded from these theoretical notions that familiarization makes two contributions: First, it reduces the number of alternatives to the learned ones; second, it reduces the separate information elicited by the components of the familiarized item, and thus makes it integrated and more available during learning.

While the preceding psychologists emphasize that familiarization facilitates learning of low meaningfulness items, there are others who state that it has a prohibitive effect, especially if the material is of high meaningfulness. The advocates of the latter theory are Lambert and Jakobvits (1960), Kanungo, Lambert and Mauer, (1962), and Kanungo and Lambert (1963). Their explanation is in terms of either meaning decrement or the development of a word-word habit. The first explanation suggests that too much repetition for the H material causes its m value to decrease, and the material becomes judged as L.

Since high m material facilitates learning and low m material retards learning, the items which were originally H become L. Therefore, familiarization of high m material may actually produce a decrement in learning. However, the same theory states that the familiarization of low meaningfulness material makes it high m and so its availability and ease of learning will increase.

In the second explanation, researchers claim that familiarization increases the number of "hooks" or associations of the item, and so the chance of associating the verbal unit with other verbal units increases. As for the L verbal unit, its number of associates will increase and thus will be more readily associated with other new items. On the other hand, the familiarization of H also increases its number of associates, but these associates will be used to tie this H item with itself rather than with another item. Hence the number of associates are assumed to be extinguished in developing word-word habits. For example, the familiarization of the dissyllable "GOJEY" makes it better integrated, develops its number of hooks and thus increases its availability for association with any other item. On the other hand, the familiarization of a well integrated verbal item as "KITCHEN" which already has many hooks will create several items as "Kitchen, kitchen, . . ." and each one of them is similar to "KITCHEN" in terms of the number of hooks. But the hooks of each item will be associated to the hooks of other items, and all of them will be consumed in developing a word-word unit such as "Kitchenkitchen" in that no other hooks are left to be associated to another new verbal unit. Therefore there

is less chance for familiarized H verbal item to be recalled as if it were an L.

The theory predicts, once more, that the paired-associate types H-H, L-H, H-L, and L-L, on familiarization with the stimuli, responses, or both, will have an acquisition rate similar to L-H, H-H, L-L, and H-L, or H-L, L-L, H-H, and L-H, or L-L, H-L, L-H, and H-H respectively. This prediction is built on the basis that the paired-associate member which is either H or L and is given familiarization will turn consequently to be L or H.

Another aspect of familiarization can be inferred from Postman and Phillips (1964) empirical findings. They observed that the relationship between amount of recall and degree of contextual constraints to be curvilinear and concluded that when material context is highly constrained, recall is difficult, as in the case of unstructured material. In addition recall is relatively easier when contextual constraint is neither high nor low. Although they reported this relationship using Miller's (1950) terminology, the role of information theory was not clarified in explanation of their findings. However, using this observation, it is possible to explain the relationship between familiarization and contextual constraint, and between contextual constraint and recall behavior. It can be argued that as familiarization increases, contextual constraints increase, and ease of recall is then determined by the degree of the imposed constraints. Taking into consideration the curvilinear relationship, the familiarization of an L material adds a moderate contextual constraint, and accordingly its recall will be easier than before familiarization

trials. But the familiarization of an H material increases the previous imposed contextual constraint and then makes it difficult to recall.

The following section will review the findings of the studies relevant to the effect of familiarization on m in serial and paired associate learning. Solomon and Postman (1952) controlled experimentally the frequency of usage of Turkish words by asking subjects to read and pronounce them with frequencies ranging from 1 to 25. They found that recognition thresholds varied inversely with frequency of prior usage. Noble (1954) offered 18 L items to 288 college students in a serial form with different frequencies. He obtained a close relation between the judged familiarity and frequency of occurrence. Arnault (1956) using nonsense shapes came to a similar conclusion to that of Noble (1954), namely that m and familiarity are closely related, doubtless as a consequence of the number of previous familiarization trials. The curves representing these relationships are negatively accelerated between zero and 40 acquisition trials, and diminish rapidly around the twentieth trial. On the other hand, Lambert and Jakobvits (1960) found that semantic satiation reliably moves the rating of the term towards the meaningless point of the scale. Kamungo, Lambert and Mauer (1962) found that satiation treatment caused a decrease in the connotative meaning of words receiving many familiarization trials.

Another criterion used to measure the effect of familiarization, other than the judged familiarity, is the number of learning trials required to learn the material. Hovland and Kurtz (1952), Noble (1955),

Riley and Phillip (1959) and Underwood and Schulz (1960), found a significant reduction in the number of trials required for mastery of serial tasks as a result of the level of familiarization.

Familiarization of L material has been found to affect the rate of learning in ways similar to that of m in paired-associate learning. It is expected, according to the theories, that greater facilitation would result when the pre-learned unit appeared as the response in the paired-associate than as the stimulus member. This means that the L response member may become an H response. For example, in a list of L-L items, in which the L response member has been prelearned, then the list would be similar to L-H list. Again, if the stimulus member of the list L-L receives familiarization, the list becomes similar to H-L list. Hence, the arrangement of the lists according to their theoretical ease of learning is as follows: Unfamiliarized L-familiarized L, familiarized L-unfamiliarized L, and unfamiliarized L-unfamiliarized L. The theories which suggest this order are, first; the two step theory which emphasizes the role of m of response member over the m of the stimulus member in paired-associate learning and, second; the familiarization theory which predicts that L material will become equivalent to H material through the pre-learning trials.

Goss (1965) reported that Scheffield (1946) compared the acquisition of an H-H list without response familiarization and an H-L list with response familiarization. He found that familiarization of response members of H-L list was facilitative. Weiss (1958) compared the acquisition of H-H, H-L, and L-L with familiarized responses,

and unfamiliarized responses. He found that mean trials to criterion adjusted for practice performance were lower with familiarized response members than with unfamiliarized response members.

However there are studies which have found no significant facilitation when response members are familiarized. Cieutat (1960) used two mixed lists of four pairs of L dissyllables with one pair representing each of the four combinations of familiarization and unfamiliarization. The same subjects were used in all the treatments. Familiarization was by looking at the familiarized items for sixty seconds. He found that familiarization with the response member inhibits learning with an unfamiliarized stimulus member, and is facilitative with a familiarized stimulus member. The arrangement of the combinations according to ease of learning was familiarized-familiarized, unfamiliarized-unfamiliarized, familiarized-unfamiliarized and unfamiliarized-familiarized. Neither familiarization of stimulus members nor familiarization of response members had a significant effect. Such unexpected arrangement of the results might be due to the use of a mixed list, and a few number of items to represent each combination. Moreover, using the same subjects for learning all combinations might have made them more experienced and more selective over the entire task.

Another study which showed that familiarization of response member did not improve learning was that of Kamungo, Lambert and Mauer (1962). They formed a paired-associate list identical with H-H, using high frequency words. Two groups learned this task, and one of them obtained semantic satiation for the response member. Those with

response satiation were inferior in the learning. Kamungo and Lambert (1963) showed that, with an H-H list, semantic satiation of either the stimulus or the response words retards subsequent learning. They explained their results in terms of the m of the members of the paired associate and the locus of familiarization.

Concerning the familiarization of the stimulus member, the results are not conclusive. The findings of Gannon and Noble (1961), Martin (1963), and Schulz and Martin (1964) support the idea of familiarization having a facilitative effect when the stimulus member was familiarized. Other studies reported that such familiarization would produce an inhibitive effect. For example, Weiss (1958) compared acquisition of familiarized and unfamiliarized stimulus members of the following paired-associate types: H-H, L-H, and L-L. He found that mean trials to criterion, adjusted for practice performance, were lower with familiarized stimulus members than with unfamiliarized stimulus for H-H and L-H, but not for L-L combination. The results of Weiss, could be reported differently if the m of the stimulus had been considered. One may conclude that H stimuli became L, and vice versa on stimulus familiarization of the H-H and L-L. The conclusion of prohibitive effect of the familiarized stimuli, explained as a result of having H items, was mentioned in Kamungo, Lambert and Mauer (1962) and Kamungo and Lambert (1963).

Finally, a study by Bailey and Jeffrey (1958) reported no significant effect for pre-learning in either member of the paired-associate. They asked Ss to learn three successive lists of paired nonsense syllables in which the stimulus term was different in each list

but the response term remained the same. In the test list the response terms were paired with syllables. The familiarized syllables were in either the stimulus position or in the response position. The test list learning of these pairs under either condition did not differ from learning under control conditions. Using a number of pre-learning trials that were insufficient to produce significant differences between the treatments might be responsible for this result.

The previous results are not consistent. These studies have employed different levels of m , different familiarization procedures, and different learning procedures. Such differences may well introduce unspecified variables that make agreement among all the results an impossibility. However, to make a better prediction or explanation, it is necessary to know the meaningfulness of each member of the paired-associate before familiarization, the locus of familiarization relevant to the familiarized and the control treatments.

SIGNIFICANCE OF THE STUDY AND THE EXPERIMENTAL HYPOTHESES

A gap has existed between verbal learning psychologists and educators. Verbal learning psychologists are concerned with studying the basic mechanisms of learning by using nonsense syllables in rigid experimental procedures with adult subjects. However, the educators have been concerned whether the material, the method, and even the findings have any objective applications to the classroom. Accordingly, the present study stands between these two extremes and attempts to test the appropriateness of extending the paired-associate model to

definition learning. Thus, the major purpose of this study is to test the hypothesis that paired-associate learning can be used as a model for learning arithmetical definitions.

The variable which has received the greatest attention among verbal learning psychologists has been the meaningfulness of the material. Many studies have been concerned with different methods of scaling the m of these materials. Such material has involved either nonsense syllables, nonsense figures, dissyllables, or numbers. However the review of the literature failed to find any educational material which has been scaled for m . Therefore one aspect of this study is concerned with determining the m of a number of arithmetical definitions as well as the m of the individual definiendum and definien.

These m values make it possible to inquire about some relationships which have not been studied in paired-associates. For example, in this definition study it is possible to determine the interrelationships between m of definitions, m of definiendum, m of definien, number of letters in the stimuli, and number of words in the response. By the use of partial correlation coefficient techniques it is possible to determine which variables effect the m of a definition. Also it is possible to determine the relationship between m of the entire definition and the summed m values of its components. However, while these relationships are important in understanding the factors which affect the m value of definitions, they are of minor concern in this study.

The verbal learning theoreticians are in agreement that m is dependent on familiarity and frequency of experience. They explain the ease of learning H material as due to its familiarity and availability for recall. In learning a paired-associate item, the learner tends to integrate the smaller units of the response to produce one which is more available and ready to be associated with the stimulus member. On the other hand, in recalling the response member of a paired-associate, the learner tries to limit his answers to the learned items and tends to recall the well integrated responses better than the unfamiliar or unavailable responses.

Because of the reasonable consistency between empirical findings and paired-associate theory it is concluded that m of the response member of a paired-associate has a greater effect upon learning than m of the stimulus. Hence, if it can be demonstrated that definition learning is influenced by the same variables as paired associate learning, then the paired-associate model can be generalized to definition learning.

Paired-associate research has yielded contradictory results concerning the effect of familiarization on either the stimuli or responses prior to the actual learning task. Psychologists have different explanations, but they have emphasized the role of the meaningfulness of the familiarized material more than its position. The data suggest that familiarization of low meaningfulness members makes them more integrated and changes them to readily available, highly meaningfulness members. On the other hand, familiarization of high meaningfulness items tends to produce a kind of satiation of meaning.

In order to test the hypothesis that the mechanism underlying the learning of arithmetical definitions is similar to the mechanism involved in paired-associate learning, it is necessary that the experimental situations remain as similar as possible. The m values which have been obtained for the arithmetical definition stimuli and responses, permit manipulation of the four basic types of definitions: H-H, L-H, H-L, and L-L. Each type of definition is represented by four arithmetical definitions. For example in case of L-H, two of them have relatively short definiens (responses), and the other two have long definiens (responses). One of the short definitions is numerical and the other short definition is a geometrical term. Similarly, in case of definitions with long responses, one of them is numerical and the other is geometrical.

This study will test the hypothesis that definition types, arranged according to their ease, are similar to the paired-associate types when arranged in accordance with the response theory. However, the empirical rank order of definition types will be correlated with the suggested order of the theory which stresses the importance of the stimulus position and the theory which favors the importance of the response position. Very little theoretical attention has been given to the role of stimulus m in paired-associate learning. Theoretical attention has been focused almost exclusively on the role of response m . However, this study will attempt to assess the role of stimulus m as well as response m . It will be possible to assess the effects of m on the stimuli and responses in a number of different instances. The effect of m will be assessed among long and short

definitions, numerical and geometrical definitions, and the combined definitions within a list.

Concerning familiarization, this study will investigate the effects of verbal and picture familiarization. This method of familiarization is contrasted with the type of familiarization procedures used in standard paired-associate learning tasks. The standard familiarization procedure typically involves frequent repetitions of the material prior to the actual learning tasks. However the familiarization procedures employed in this investigation are more similar to actual classroom practice. In addition, familiarization is devoted almost entirely to the response member of the definition.

On the basis of paired-associate familiarization data it is assumed that familiarization of a high m verbal unit reduces the m value of that unit and familiarization of a low m unit increases the m value. If it is assumed that stimulus m is more influential in learning than is the response m , then before familiarization the following rank order would be H-H, H-L, L-H, and L-L. But if familiarization has the effect of extinguishing high m values, then the order as a result of familiarization would be H-L, H-H, L-L, L-H. However, if response m is more influential in learning than stimulus m , then prior to familiarization the order of difficulty would be H-H, L-H, H-L, and L-L. But this order would be expected to change to H-L, L-L, H-H, and L-H as a result of response familiarization. The correlations between these predicted rank orders and the actual rank orders will be used as a basis for determining the generality of the paired-associate model to definition learning.

Another aspect of this study is concerned with the extent the S has actually learned to state the definition in his own words. This measure is referred to as definition attainment. The emphasis here is not upon verbatim repetition of the exact words and phrases. However the S is encouraged to put the meaning of definition's stimuli in his own words before and after the learning trials. It is believed that m of the stimulus position is more concerned with definition attainment because the connotation of definition meaning is represented in the stimulus member. The exact response is an arbitrary arrangement of words defining the stimulus. In other words, the meaning of the definition is represented by its stimulus and can be expressed in different ways or in different verbal arrangements. When the subject is asked about the meaning of a familiar stimulus, he can respond correctly in different ways, e.g. by explaining the stimulus, giving an example, or making an analogy.

This study will also compare definition attainment before and after the learning task, and attempt to state whether the m of the stimulus or the response member is more important in increasing definition attainment.

Experimental Hypotheses

A. Analysis of test trials.

The control treatments:

1. The increase of m of response member of the definition will be accompanied by an increase of mean percentage of correct responses per test trial. The arrangement of the types of definitions from superior to inferior,

with respect to the mean percentage of correct responses per test trial is as follows: H-H, L-H, H-L, and L-L.

2. The H-H, L-H, H-L, L-L arrangement will also exist if the dependent variable is the mean percentage of exact responses per test trial.
3. The stated arrangement of 1 and 2 will hold in case of using the entire task, short, long, arithmetical and geometrical definitions.

The verbal and picture familiarization treatment:

1. Verbal familiarization of the response member will be accompanied by either an increase or decrease of the mean percentage of either the correct or the exact responses per test trial. The increase will occur if the familiarized response is high in meaningfulness, and the decrease will occur if the familiarized response is low in meaningfulness. The arrangement of types of definition, according to the response theory, from superior to inferior with respect to the percentage of correct or exact responses, is expected to be in this order: H-L, L-L, H-H, and L-H.
2. Picture familiarization will produce the same order of arrangement as verbal familiarization.
3. The stated order of 1 and 2 in case of familiarization, will hold using the entire task, short, long, arithmetical and geometrical definitions.

- B. Analysis of pre- and post-definition attainment scores.
1. The increase of stimulus m will be accompanied by an increase of both pre- and post-test scores. But the increase of response m will not be accompanied by any increase in either the pre- or post-test scores.
 2. There will be a significant difference between the distributions of pre- and post-test scores.
 3. The relationship stated in 1 and 2 will hold in case of control, verbal or picture familiarization conditions.
 4. Under each familiarization treatment the significant differences between the distribution of pre- and post-test scores will decrease in the following order: H-H, H-L, L-H, and L-L.

CHAPTER II

METHOD

DETERMINATION OF DEFINITIONAL MEANINGFULNESS

Arithmetical Definition

Four arithmetical textbook series were used to gather arithmetical definitions which appear in grades five, six, seven and eight. The names of the textbooks are given in Appendix A. Definitions with stimuli composed of more than one word (e.g. "square root," "right angle") or with symbols in the response (e.g. "an angle which measures more than 90° ," "any number that can be named by a fraction of the form a/b , where a and b are integers, with the restriction that b is not 0") were excluded. Ninety-seven definitions were finally used in this part of the study. Forty-eight of these definitions can be represented in numbers and are called numerical definitions. The other forty-nine can be represented by graphs and are referred to as geometrical definitions.

The two kinds of definitions, numerical and geometrical, were randomly arranged. The stimuli and the responses were separated from each other and the m value of each was determined separately by the use of two rating scales. Meaningfulness was defined operationally in terms of the students' judged familiarity and ease of learning.

The first page of each scale contained the instructions and examples. The other pages of the rating scale included the rated items and m continuum based on five points: Very easy, easy,

indifferent, difficult, and very difficult. These pages of the rating scale were presented in different random orders. A copy of the instruction page is shown in Appendix B.

Subjects, Procedure, and Reliabilities

TABLE 1: Methodological Information Concerning the Reliability of the
Meaningfulness Scales

Information	Stimulus	Response
Reliability of AD	.9813	.9033
Reliability of ND	.9847	.9044
Reliability of GD	.9778	.8620
Reliability Method	Test Retest	Test Retest
No. of Students	30	30
Mdn. Age in Months	145	145
Grade	6	6
School	B	B
Dates of Administrating the Scale	5/7/65 5/11/65	5/7/65 5/11/65

AD = Arithmetical definitions

ND = Numerical definitions

GD = Geometrical definitions

Table 1 contains the number of students who volunteered in rating the m of each scale, their median age, their grade and their school. It also includes the dates of administering the different rating scales.

The experimenter used a standard procedure in administering the rating scales. First, the Ss were asked to read the printed instructions. Second, the experimenter explained the instructions verbally (see Appendix C) and, using the blackboard, showed how to indicate the ratings for the examples given. All questions asked by the Ss were answered, but the experimenter did not give a definite rating to the examples. Third, the Ss were asked to read all the items before rating them. Fourth, the Ss were asked to reread each item carefully and to check the appropriate point on the scale.

In order to determine the meaningfulness and standard deviation for each scaled item, the points very easy, easy, indifferent, difficult and very difficult were assigned the weights one, two, three, four and five respectively (following Thurstone and Chave, 1929).

Stimuli and responses' m values were checked for reliability by administering the rating scale twice. Therefore, for each stimulus or response two m values and two standard deviations were obtained. A third m value was computed by pooling the students' two ratings. This m value and its corresponding standard deviation are referred to as the pooled values. The pooled m value and the pooled standard deviation are considered the standard values for each item.

The reliability coefficients and the method used in estimating them are shown in Table 1. All of the reported coefficients are above .90 with the exception of the reliability of geometrical responses which is .862 and all are significantly different from zero ($P < .01$).

Appendix D contains the m values of the rated material. It should be remembered that the lower the value of m , the higher the meaningfulness of the item. This has resulted from assigning ascending weights to descending ease and familiarity of the rating scale points.

EXPERIMENTAL MATERIALS

Selection of Definitions

The stimulus m of each item was paired with its corresponding response m . Thus each definition had two m values, one for its stimulus and one for its response.

Four lists of definitions were chosen. Each set contained four definitions, two numerical and two geometrical. One definition of each kind was long and the other was short. However, each list had approximately the same total number of words.

The H-H list of definitions contained high m values for both its stimuli and its responses. Its m value for the stimuli ranged between 1.153 and 1.678. The m value for the responses ranged between 1.864 and 2.271. In the L-H list the stimuli's m values ranged between 3.983 and 4.390 while the responses ranged between 1.915 and 2.542. The H-L list consisted of stimulus m values between 1.034 and 1.898 and response m values between 2.593 and 3.898. The L-L list of definitions contained stimulus values between 3.475 and 4.559 and response values between 2.695 and 3.898. Appendix G presents the selected items.

Familiarization Materials

The materials used in the familiarization process were of two types, verbal and picture familiarization. Verbal familiarization materials were prepared as follows. The experimenter prepared three different written explanations for each selected definition. Each explanation was composed of three sentences. The three explanations were attached to the response part of the definition. Those responses and their corresponding explanations were given to three graduate students who were told that one out of every three explanations would be presented to sixth grade students. They were asked to rate each explanation according to its appropriateness for sixth grade students, by rank ordering the three explanations from "highly appropriate" to "less appropriate." The ranks were summed for each explanation. For each response, the explanation with the lowest sum of ranks was chosen as the verbal familiarization material for the corresponding definition.

In case of picture familiarization, the selected definitions were classified according to whether they were numerical or geometrical definitions. The numerical definitions were explained by presenting three number operations, while the geometrical definitions were explained by drawing three consecutive pictures. The same graduate students were requested to rank order the three number operations or consecutive pictures per definition response, with the same instructions as previously. The selected picture familiarization materials were those explanations which had the lowest sum of ranks. All the familiarization materials are shown in Appendix H.

Subjects

Four hundred and thirty-four volunteer students enrolled in the seventh grade were used as Ss. Their median age was 151 months at the time of the experiment. Appendix I shows the number of students assigned to each task.

Procedure

The learning task was administered by the use of a group procedure. Each group of Ss was assigned at random to one of the treatments. The students were given a test booklet containing eight pages. The first page provided space in order to obtain information about the S's sex, birthdate, and name. The other seven pages contained only the stimuli with blank spaces where the Ss wrote their recalled response beside each stimulus. The stimuli were arranged randomly on each page.

The definitions as well as the familiarization material were placed on thermofax transparencies and were presented manually by an overhead projector. The thermofax transparencies of the definitions were covered by two separate pieces of paper, one of which covered the stimulus and the other the response. The two covers were used to project separately either the stimulus or the response of the definition.

During the learning trials, the Ss were shown each stimulus for approximately five seconds, followed by the stimulus and the response for approximately fifteen seconds. The total time needed for each learning trial per definition was about twenty seconds. Since there were four definitions per task, each learning trial required eighty seconds. The time required for one test trial was three minutes and thirty seconds. In case of familiarization, the experimenter took

four minutes to present the familiarization material. Presentation rates were determined by the use of a stop watch.

The experimenter followed the steps shown below while he was conducting the experiment. First, the Ss were instructed to turn to the second page of the booklet and to give the meaning of each word (stimulus). This pre-test was for the purpose of determining the extent to which the definition had been attained prior to the learning task. Second, if the treatment included familiarization, the experimenter showed the Ss the corresponding familiarizations and the experimenter helped them by reading the material aloud. Third, the experimenter showed the Ss one of the stimuli, asked them to read it, and anticipate its meaning before reading the projected sentence (response) within the time limit which has been mentioned before. The third step involved the presentation of all four definitions. One complete presentation of all definitions is referred to as a learning trial. Fourth, in the test trials the Ss were asked to write down the exact sentence (response) which had been shown to them with its corresponding word (stimulus). There were nine learning trials (l) and five test trials (t) arranged in this order: l-t₁, ll-t₂, ll-t₃, ll-t₄, ll-t₅. Fifth, the Ss were asked to express the meaning of each stimulus using their own words. The post-test was to determine definition attainment after the learning task.

Treatments

It has been stated previously that there were four different types of definitions: H-H, L-H, H-L, and L-L. There were also three kinds of familiarization. The Ss received either no familiarization, verbal

familiarization or picture familiarization. Those Ss who did not receive familiarization were designated as a control group.

The combination of the four types of definitions with the three kinds of familiarization produced twelve treatment conditions. Each treatment was identified by the type of definition and the kind of familiarization. The treatments are designated by combining the symbols of the type of definition with the symbols referring to the type of familiarization. For example, H-H refers to definitions with high *m* stimuli and high *m* responses when presented without familiarization, while L-H P designates definition with low *m* stimuli and high *m* responses presented with picture familiarization.

Dependent Variables

The Ss' answers in the test trials were classified into eight different categories. It was assumed that these categories represented a continuum which started with a "no answer," and ended with "recalling the exact response," and covered the different levels of the answers. Each category was labeled to explain its common property and was assigned a score depending on its location within the continuum.

A sample of the Ss' answers to the stimulus "abscissa" will be presented to explain the scoring system. As mentioned in Appendix E, this stimulus is one of L-H definition and its response is "the distance measured horizontally to a point." Other stimuli which are found in the L-H type of definitions are "predecessor," "uniqueness" and "hypotenuse" and their responses are shown in the same appendix. The latter responses are of concern to the response of the stimulus "abscissa" since some Ss confused and/or mixed these responses with

the "abscissa" response in their test trials. The scoring system and a sample of the answers to the stimulus "abscissa" are shown below.

1. No answer: Assigned for the answers which were left blank or if the S wrote "I do not know" or "A distance" i.e. when the reported number of words was less than one quarter of the exact response.

2. Outside or intentional answer: Answers which were completely unrelated to any response in the whole task as "A line drawn to the center of a circle."

3. Confused answer: Response of one stimulus given to another stimulus as "There is only one sum correct the sum of the number."

4. Mixed answers: S mixed two different responses and responded with this mixture to a given stimulus as "A number measured horizontally."

5. Between one quarter and one half of the exact response: e.g. "The distance measured."

6. One half of the exact response but less than three quarter: e.g. "The distance measured horizontally."

7. Three quarters of the exact response, or the exact response written in a different form: e.g. "The distance horizontally to a point."

8. The exact response: As "The distance measured horizontally to a point."

Studies in paired-associate learning have been concerned with measuring the exact responses. But the strategy of this study requires a more flexible scoring system. Thus limiting the analysis to the

exact responses (category 8) would exclude other answers which were almost correct (category 7). Categories seven and eight have been combined and classified as correct responses. The mean percentage of these correct responses is a dependent variable.

This study also compared the S's mastery of the definitions before and after the learning trials. For this reason the answers of the pre- and post-tests have been classified into three categories. The assigned scores and the types of answers are shown below.

0. No answer, outside answer, confused answer or mixed answers.
1. Answers which were partially correct.
2. Correct answers.

The use of these categories permitted an assessment of definition attainment as a result of the learning trials. The dependent variable in this part of the analysis was the given score per definition in the pre- and post-tests.

DESIGN AND STATISTICAL PROCEDURE

The available variables are definition *m*, stimulus *m*, response *m*, number of letters in the stimulus and number of words in the response. These five variables are presented in Appendices D and H. The first description of these variables is in terms of their means and standard deviations. Second, analysis of variance has been utilized to test the effects of subject matter levels and definition components on meaningfulness. In making this test, the fixed-effect model for two-factor completely randomized design was applied. Third, the intercorrelation coefficients among these five variables have been

calculated in order to determine the interrelationships among them. Moreover the contribution of each definition variable to its m is shown by partialling out one or more of these variables. The partial correlations are compared to the zero order correlation coefficients, and the results of these analyses are presented in some detail in Appendix F.

The twelve treatments are produced by having four types of definitions (H-H, L-H, H-L, and L-L) and three kinds of familiarizations (control, verbal and picture). Each S received five test trials in which to recall the responses of the four stimuli. Bartlett's test has been applied to test the homogeneity of test trial variances. The test revealed a X^2 value of 402.7485 which is significant at the .01 level. The hypothesis concerning the homogeneity of test trials variances for the twelve treatments was rejected and the presence of heterogeneous variances suggested the use of non-parametric methods in data analyses.

The mean percentage of correct responses per test trial is used as a dependent variable. Appendices J, K, and L show the mean percentage of correct responses per test trial as well as the mean percentage of such correct responses in case of the combined definitions, and of short, long, numerical and geometrical definitions, under the three different familiarization procedures. The types of definitions (H-H, L-H, H-L, L-L) of any of the fifteen treatment conditions can be arranged according to the mean percentage of correct responses.

The rank order of the types of definitions suggested by the theory emphasizing the m of the response member is H-H, L-H, H-L, L-L

without familiarization, and H-L, L-L, H-H, L-H with response familiarization. On the other hand, the suggested arrangements of the types of definitions by the theory which emphasizes the m of the stimulus position is H-H, H-L, L-H, L-L without familiarization, and H-L, H-H, L-L, L-H with response familiarization. The logic behind these arrangements has been explained in the first chapter of this study.

Kendall rank order correlation coefficients were used to determine the correlation between the actual arrangement of the types of definitions as reported in Appendices J, K, and L, and the arrangement which is suggested by either the theory emphasizing the role of m in the response, or the theory which emphasizes the role of stimulus meaningfulness. Separate Kendall rank order correlations were computed in order to test the two theories relating to m of the stimuli and responses in relation to the various tasks (combined, short, long, numerical and geometrical definitions), and different types of familiarization (control, verbal, and picture familiarization).

Whenever the actual arrangement of the types of definition, under any one of the familiarization conditions, correlated perfectly with any of the suggested theoretical orders, a second test was applied to determine whether or not there were significant differences between any two proportions of correct responses among the types of definitions. The z score, and the normal distribution table were used to test whether the mean percentage of correct responses for each type of definition was greater than the other mean percentages of correct responses in the order designated by each theory.

The use of the mean percentage of correct responses as a dependent variable represents a departure from the usual performance criteria employed in verbal learning studies. Since in actual practice children are seldom required to memorize definitions verbatim, this dependent variable approximates the type of response required in the classroom. However, a second dependent variable approximating the type employed in verbal learning studies was also developed. This variable is referred to as the mean percentage of exact responses (Appendices M, N, and O) and measures the ability of the S to respond in a verbatim manner.

As has been mentioned, Ss were asked to write down, using their own language, the meaning of the stimuli before and after the learning task. The Ss answers were classified as incorrect, partially correct, or correct and were given the scores 0, 1, or 2 respectively.

Therefore, two additional dependent variables were available for each stimulus. One measuring the extent the definition was known prior to the learning task and the other measuring the correctness of the definition after the learning task.

The independent definition variables are the types of definitions, stimulus meaningfulness, response meaningfulness, kind of subject matter, and length of the definition. However, each one of these definition variables has its own levels. The levels of types of definitions are H-H, L-H, H-L and L-L. Stimulus meaningfulness or response meaningfulness variable has two levels, namely H or L. Again it is to be remembered that the arithmetical definitions are classified as numerical and geometrical definitions. Each list also has definitions

of two different lengths (levels) i.e., definitions with short and long responses. The levels of these definition variables are represented in the control, verbal and picture familiarization conditions.

Inspection of the data presented in Appendices P, Q, and R, revealed that definition attainment scores in some pre-tests were not normally distributed. For example, in case of L-H pre-test (Appendix T₁) scores, all the answers were incorrect and received a score of zero. Thus the lack of normality on the side of pre-test definition attainment suggested the use of non-parametric methods.

First, the X^2 test was used to compare the pre-test score distributions of the levels of each independent variable. For example, there are four levels of types of definitions H-H, L-H, H-L and L-L. Each type of definition has its own pre-test score distribution, and is summarized in terms of mean pre-test score and its standard deviation as shown in Appendices P₁, Q₁ and R₁. The result of the X^2 test is used to determine whether or not these four pre-test score distributions are similar in their dispersion. The available means and standard deviations are used to rank order the types of definitions. This analysis is also repeated on stimulus m, response m, subject matter types, and length variables.

Second, the X^2 test was also used in order to compare the levels of the definition variables with respect to their post-test score distributions. For example, after the learning trials, the Ss were asked to give the meaning of the stimuli. These learned definitions had either short or long responses. The distribution of the post-test score of short definitions was then compared with the distribution

of the post-test score of long definitions using the X^2 technique. Means and standard deviations of each distribution presented in Appendices P₂, Q₂ and R₂ are used to determine the superiority of one of the length levels in post-test definition attainment. Such analysis can be used to study the differential effect of the levels of each definitional variable on definition attainment.

The third aspect of this part of the study is concerned with the effect of the learning task on definition attainment by comparing the distributions of pre- and post-test scores. The X^2 technique was also used to test whether or not there was a significant difference between the pre-test scores and post-test scores. Such comparison is made using the answers of the Ss who received verbal, picture, or no familiarization. Hence, for each type of familiarization there is a X^2 value which shows the degree of change in definition attainment due to the familiarization procedure and the learning trials.

In the previous analyses the pre-test or post-test scores were pooled over all the types of definitions. It was not possible, then, to study the effect of the independent definition variables on each of H-H, L-H, H-L, and L-L lists. Therefore more specific analyses were performed in order to study the distributions of the pre-test or post-test relevant to the types of definitions under each familiarization treatment.

The independent variables are (1) types of definitions (H-H, L-H, H-L, L-L), (2) stimulus meaningfulness (H, L), (3) response meaningfulness (H, L), (4) subject matter (numerical, geometrical

definition), and (5) length (short, long). But in the analysis of pre- or post-test scores of each type of definition, the variables (1) types of definition, (2) stimulus meaningfulness, and (3) response meaningfulness are excluded; and the analysis is limited in order to study the effect of the levels of either subject matter or length variables on pre- or post-test scores of each type of definition under the familiarization treatments (Appendices S, T, U and V). In addition, χ^2 tests of both pre- and post-test scores for each type of definition under the familiarization treatments were computed in order to give an indication of degree of change in attaining these definitions due to familiarization and learning.

It will be observed that the results of the first part of the design concerning the generation of definition meaningfulness are presented in Appendix F. The results of the second and third part of this study related to the Ss answers in the test trials and the Ss definitional attainment will be presented in the following chapter.

CHAPTER III

RESULTS

The presentation of the results will follow the design and statistical procedure as shown on page 45. The first portion of the results is reported in Appendix F, but a brief summary will be given below. The second and third parts are concerned with the results of Ss' responses in the actual learning task and in the pre- and post-definition attainment conditions.

DEFINITIONAL MEANINGFULNESS

The following discussion is centered around the scaling of definition meaningfulness (m). The distribution of stimulus meaningfulness was bimodal, while the definition or response meaningfulness distributions were found to be approximately normal. The variance of stimulus meaningfulness is significantly greater than the variance of either the response m or definition m . Mean m of the definitions is found to be significantly higher than the mean m of the response (definien) at the .01 level, and the mean m of the stimulus (definiendum) at the .05 level. However, the mean m of the definiendum is not significantly different from the mean m of definien at the .05 level. In addition m of numerical definitions is greater than m of the geometrical definitions at the .01 level.

Concerning the number of letters and meaningfulness, the results indicated that meaningfulness of neither arithmetical nor

numerical stimuli (definiendum) correlates with their number of letters. On the other hand, there is a significant correlation between stimulus (definiendum) m of geometrical terms or the scaled vocabulary m and number of letters. There is, moreover, significant correlation between the response (definiens) number of words and response m in case of arithmetical, numerical and geometrical items. The high positive correlations showed that the shorter the response the higher was its meaningfulness.

While the intercorrelation coefficients between stimulus m , or response m , and their corresponding lengths are not significantly different from zero at the .01 level, it is found that each one of these variables correlates significantly with definition m . For example, definition m correlates significantly and positively with stimulus m . The significant correlation between m of the definitions indicated that when definition m was high response m was high, response standard deviation was small, and response number of words was few.

Investigation of the results shows that partialling any group of variables out of the correlation of definition m with other variables does not change the zero order correlation coefficient. However, the correlation of response m , and response number of words changes significantly, when definition m or definition m plus other variables are partialled out, and dropped to a value of which is not far from zero at the .05 level. Again, response m and stimulus m have been found to have an insignificant correlation. Once the definition m or other variables beside definition m were partialled out, all the new correlations differed significantly from their zero order

correlation. These results emphasize the role of definition m and its relation with response m or stimulus m . For example, the new higher correlations resulted from partiallizing definition m may mean (1) when response m was high the length of the response was not necessarily high or low (2) when response m was high, the stimulus m was also high.

The composite definition m showed resemblance to the actual definition m except that the former correlated with stimulus m higher than its correlation with response m at the .01 level of significance. But in case of definition m , the entire preceding statement is reversed except that the difference is not significant at the .05 level.

The meaningfulness value of the composite response is obtained by adding the m of the individual words (vocabulary) which compose the response. It has been noticed that the composite response m correlates significantly at the .01 level, only with the standard deviation of either stimulus m or response m . However, the correlation between response m and composite response m is almost zero at the .05 level.

DIFFERENTIAL EFFECT OF MEANINGFULNESS OF DEFINITION COMPONENTS ON SUBJECTS' LEARNING

This part will present separately the results of control, verbal and picture familiarization on the S 's test-trial scores. In presenting each of them, Kendall rank order correlation coefficients between the actual arrangement of the types of definitions according to the mean percentage of correct responses and the expected theoretical orders will be computed. In instances for which the correlation proved to be perfect, z score will be used to determine whether for each type

of definition the proportion of correct responses is significantly greater than the other proportions as designated in the theoretical order.

A. Rank Order of the Types of Definitions According to the Percentage of Correct Responses for the Control Treatment

Correct responses have been defined (page 45) as the answers which were exactly similar to the learned responses, or the reproductions which were almost similar to the exact responses, but stated in slightly different forms. It contains the percentages of correct responses for the short, long, numerical, geometrical and the combined definitions. The next to the last column in Appendix J contains the sum of the percentages of correct responses per test trial. This sum is appropriate because the number of responses per test trial is the same for all test trials. The last column represents the mean percentage of correct responses of the test trials, and these values will be used to determine the rank of the definition types.

Table 2 presents the rank order of the definitions order according to the percentage of correct responses. The rank order of the type of definitions has been correlated with both the rank order suggested by the theory that emphasizes the role of response (H-H, L-H, H-L, L-L), and the suggested order of the theory emphasizing the role of stimulus (H-H, H-L, L-H, L-L). The Spearman rank order correlation coefficient could have been used to test the degree of association between either of the suggested findings and the present findings but its available probability table covers only the case of perfect correlation (Siegel, 1956: P. 285). Instead, Kendall rank order correlation coefficient

TABLE 2: Rank Order of the Mean Percentage of Correct Responses for the Types of Definitions in the

Control Treatment									
1	2	3	4	5	6	7	8	9	
Kind of Task	H-H	L-H	H-L	L-L	Response Position	Stimulus Position	Probability	Probability	
Combined Definitions	1	2	3	4	1.000*	.667	.667	.167	
Short Definition	1	2	4	3	.667	.167	.333	.375	
Long Definition	1	2	3	4	1.000*	.667	.667	.167	
Numerical Definition	1	3	2	4	.667	.167	1.000*	.042	
Geometrical Definition	1	2	4	3	.667	.167	.667	.167	

*Significant tau at the .05 level

is used and designated by Υ in Table 2. The probability of obtaining the Υ value, for one tailed test is shown in columns seven and nine of the preceding table (Table 2). The .05 level has been chosen as the level of significance of Υ .

Investigation of Table 2 reveals that the theory emphasizing the m of the response is supported in two cases: First, when all the definitions of the task are considered; and second, when the long definitions are considered. The same theory has been rejected in three other cases, namely with short, numerical and geometrical definitions. On the other hand, the theory which emphasized the m of the stimulus position is accepted only in the case of numerical definitions and is rejected in the remaining cases.

Again, while each theory suggests a different arrangement for the types of definitions, both of them assume that there must be a significant difference between any two types of definitions. For example, the theory which emphasizes the role of response m, and which suggests that the following order H-H, L-H, H-L, L-L, requires a significant difference between H-H and L-H, H-L, or L-L as well as between any of L-H, H-L and L-L conditions. In other words, the proportion of correct responses per test trial of H-H definitions must be significantly greater than the proportion of correct responses per test trial of either L-H, H-L, or L-L definitions. The presence of significant differences insures that the discrepancies between the proportions of correct responses are not due to chance but are caused by differences in the location of m.

The combined and long definitions have been shown (Table 2) to follow the sequence which is stated by the response m theory, while

numerical definitions follow the sequence which is stated by the stimulus m theory. The normal distribution table and its standard score z are used to test whether each proportion of correct responses is significantly greater than the other proportion in the order designated by each theory. The results are shown in Table 3.

TABLE 3: z Values for the Differences Between Proportions of Correct Responses in the Control Treatment

Types of Definition	L-L	H-L	L-H	Kind of Task
H-H	13.0**	12.8**	8.3**	Combined Definitions
	17.8**	12.5**	8.0**	Long Definition
	10.6**	1.85*	3.3**	Numerical Definition
L-H	5.4**	4.0**		Combined Definitions
	8.3**	4.2**		Long Definition
	6.7**	1.64*		Numerical Definition
H-L	1.46			Combined Definitions
	4.2**			Long Definition
	8.5**			Numerical Definition

* Significant difference at the .05 level (one tail test)

**Significant difference at the .01 level (one tail test)

Table 3 reveals that there are significant differences between the types of definition, using the combined definitions, except in the case where H-L is not significantly greater than L-L at the .05

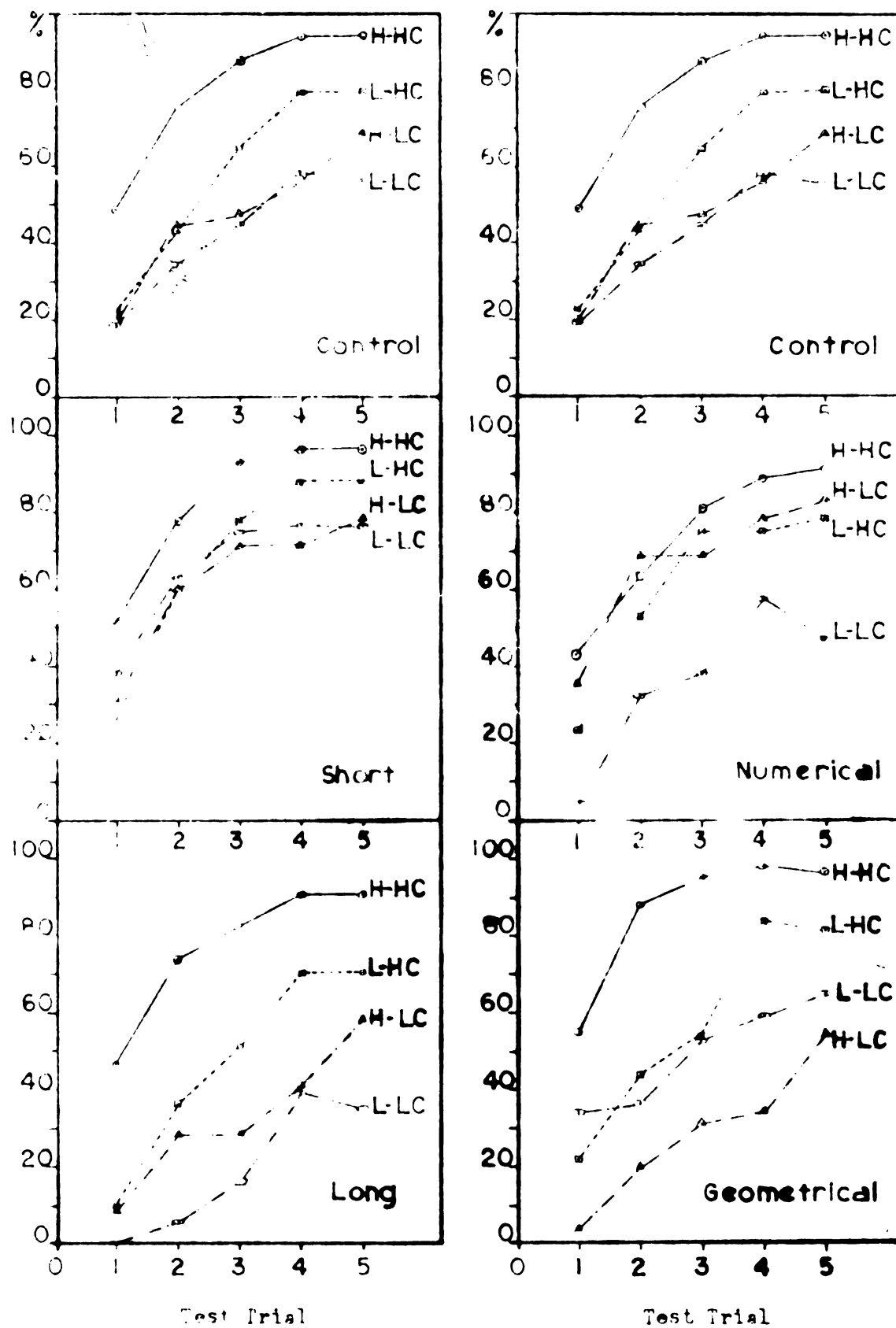


Figure 1: The Percentage of Correct Responses Per Test Trial For
 Control Treatment

level. However, in the case of long definitions all the differences are significant at the .01 level.

It has been mentioned that the results of numerical definitions followed the theory which emphasizes the stimulus position. The differences between the proportions of correct responses in this case are significant at the .01 level except the difference between H-L and L-H which is significant at the .05 level.

Figure 1 shows the corresponding curves of the proportion of correct responses per test trial. In general these curves confirm the previous statistical results which have been obtained (Table 2) from the mean proportion of correct responses over all the test trials. However, some curves are overlapping, and it is difficult to derive from them any statistical conclusion similar to those presented in Table 3, other than a general knowledge of the arrangement of the types of definitions for each kind of task.

B. Rank Order of the Types of Definitions According to the Percentage of Correct Responses for the Verbal Familiarization

Appendix K shows the mean percentage of correct responses of the test trials for the Ss who received verbal familiarization. The order of the types of definitions (H-H, H-L, L-H, L-L) according to the percentage of correct responses, and under different tasks, short, long, numerical, geometrical, and the combined definitions are shown in Table 4.

The theory which emphasizes the role of response position in learning suggests the following descending order: H-H, L-H, H-L, L-L. When the response member is familiarized, the H response will become

TABLE 4: Rank Order of the Mean Percentage of Correct Responses for the Types of Definitions in the

Verbal Familiarization

1	2	3	4	5	6	7	8	9
Kind of Task	H-H	L-H	H-L	L-L	Response Position	Stimulus Position	Probability	Probability
Combined Definitions	1	4	2	3	.333	.375	.667	.167
Short Definition	1	4	3	2	.000	.625	.333	.375
Long Definition	1	3	2	4	.000	.625	.333	.375
Numerical Definition	2	4	1	3	.667	.167	1.000*	.042
Geometrical Definition	1	4	3	2	.000	.625	.333	.375

*Significant tau at the .05 level

L and vice versa. However, it is desired that after familiarization the theoretical descending order be preserved. Hence, the original definition order must be H-L, L-L, H-H, L-H which becomes H-H, L-H, H-L and L-L after the process of familiarization.

Column 6 of Table 4 shows the Kendall rank order correlation coefficient between the hypothetical order explained above and the experimental results. All the reported correlations are zero except in case of short definitions which is .333 and numerical definitions which is .667 and are not significantly greater than zero at the .05 level.

The theory which emphasizes the stimulus position may be confirmed in the case of verbal familiarization of the response. The expected order of the types of definitions is H-L, H-H, L-L and L-H which hypothetically would become H-H, H-L, L-H, and L-L after receiving verbal response familiarization. The Kendall correlations between this expected order and the actual orders are shown in column 8 of Table 4. All of the reported correlations have the value of .333 (short, long, geometrical definitions) and .667 (combined definitions) but they are not significantly greater than zero. The only exception is the case of numerical definition which correlates perfectly and is significantly greater than zero.

Table 5 shows the two values for the differences between proportions of correct responses of the types of numerical definitions when verbal familiarization was received by the Ss. Investigation of Table 5 shows that the proportion of correct responses of L-L types of definitions are not significantly greater than the proportion of correct

responses of L-H type of definitions at the .05 level. The difference between the percentage of correct responses of L-L is significantly greater than the percentage of correct responses of H-H type of definitions at the .05 level. The other two values reported in Table 5 show that the differences in percentages of correct responses for the other types of definitions are significant at the .01 level.

TABLE 5: z Values for the Differences Between Proportions of Correct Responses for Numerical Definitions with Verbal Familiarization

Definition Type	L-L	H-L	L-H
H-H	2.123*	6.019**	4.426**
L-H	1.48	10.48**	
H-L	9.102**		

* Significantly greater at the .05 level

**Significantly greater at the .01 level

Figure 2 shows the corresponding curves for the verbal familiarization procedure. Investigation of the learning curves for the combined definitions, shows some irregularity in the percentage of correct responses of the L-H type of definition. The order of the types of definitions in the first test trial according to their percentages of correct responses is as follows: H-HV, H-LV, L-LV, L-HV. In the second test trial the arrangement of the percentages of correct responses is the same as the first test trial, except that the percentage of correct responses of L-HV showed superiority to the other three

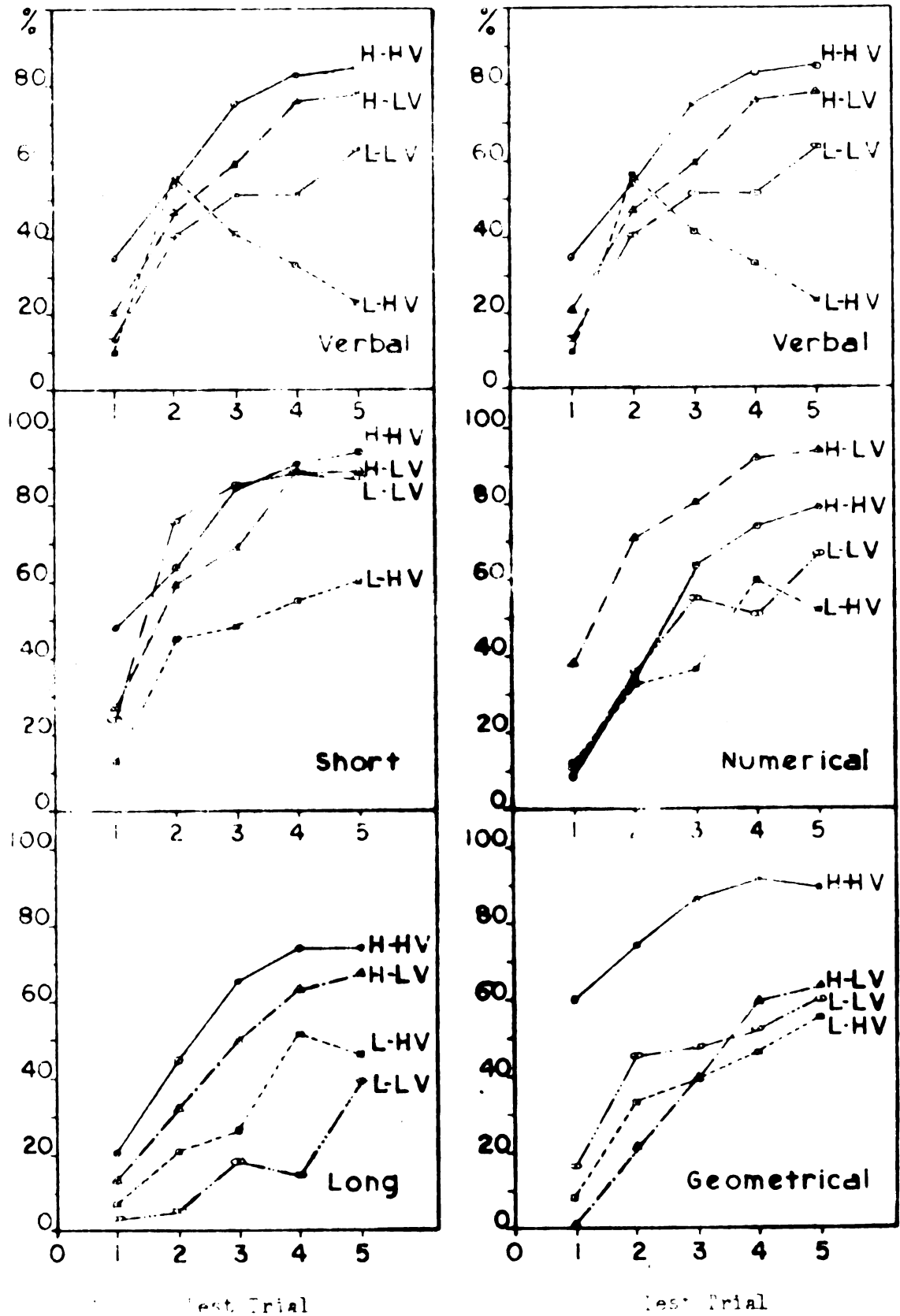


Figure 2: The Percentage of Correct Responses Per Test Trial For Verbal Familiarization

types of definition. Thus the arrangement of the types of definitions according to their percentage of correct responses in the second test trial is as follows: L-HV, H-HV, H-LV, L-LV. Again in the third, fourth and fifth test trials the percentage of correct responses of L-HV became lower than that of the other three types of definitions. Thus the new arrangement of the types of definitions in the last three test trials is as follows: H-HV, H-LV, L-LV, and L-HV. However, while the percentage of correct responses of H-HV, H-LV, and L-LV increases in every successive test trial, it is noticed that the percentage of correct responses of L-HV decreases in the successive test trials after the second one. Looking back over the S's test booklets it appears that the Ss reported increasingly confused answers with L-HV as there were more learning trials. So instead of having an increase in the percentage of correct responses in every successive test trial, there was a decrease as a result of the increasing confusion.

C. Rank Order of the Types of Definitions According to the Percentage of Correct Responses for the Picture Familiarization

The expected order of the types of definitions, in this case, is similar to that of the previous case of verbal familiarization. Again the theory which emphasizes the role of response position anticipates the order of the types of definitions as follows: H-L, L-L, H-H, L-H, while the theory which emphasizes the role of stimulus position predicts this order: H-L, H-H, L-L, L-H. Both theories predict a decrease in the H response (H to L) and an increase in the L response (L to H) as a result of picture familiarization.

Table 6 shows the Kendall rank order correlation coefficients between the actual results of picture familiarization and the theoretical order. The results shown in Table 6 revealed that the Kendall rank order correlation coefficients of the expected and the actual orders are not significantly greater than zero. Furthermore, some show a correlation of zero or a negative correlation.

Figure 3 shows the percentage of correct responses per test trial for the different types of definitions. The curves for the combined definitions, short definitions, and geometrical definitions follow the pattern H-HP, L-LP, L-HP, and H-LP. Yet this pattern is not consistent with either the stimulus or response theories as has been confirmed by the findings in Table 6.

D. Summary of the Results When the Correct Responses are Taken as a Dependent Variable

The answers of the Ss in the test trials have been classified into several categories. The answer which is an exact reproduction of the response, or similar to the response but stated in a slightly different manner, is defined as a correct response. The preceding three sections of the results show to what extent the two theories emphasizing either the stimulus position or response position were confirmed by using the correct responses as a dependent variable.

For example, the theory which emphasizes the role of stimulus was tested five times (with the combined definitions, long, short, numerical and geometrical definitions) per familiarization condition (control, verbal, or picture). Thus it was given fifteen chances of possible confirmation. Yet it has been accepted only twice--in case

TABLE 6: Rank Order of the Mean Percentage of Correct Responses for the Types of Definitions in the

Picture Familiarization									
1	2	3	4	5	6	7	8	9	
Kind of Task	H-H	L-H	H-L	L-L	Response Position	Response Position	Stimulus Position	Stimulus Position	Probability
					τ		τ		Probability
Combined Definitions	1	3	4	2	-.667	.167	.000		.625
Short Definition	1	3	4	2	-.667	.167	.000		.625
Long Definition	1	4	3	2	.000	.625	.333		.375
Numerical Definition	1	4	2	3	.667	.167	.667		.167
Geometrical Definition	1	3	4	2	-.667	.167	.000		.625

*Significant tau at the .05 level

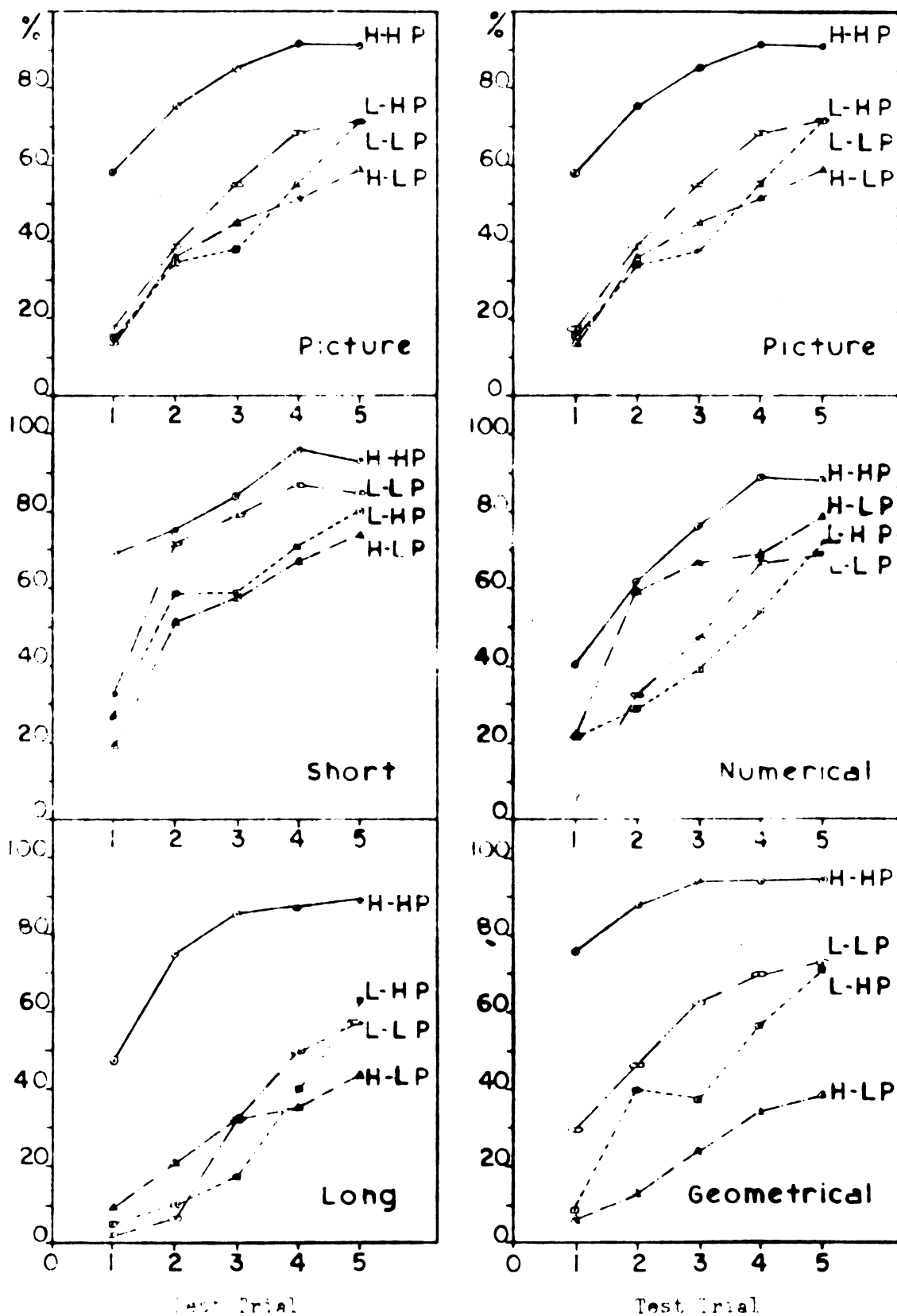


Figure 1. The Percentage of Correct Responses Per Test Trial for
Picture and Numerical.

of control and verbal familiarization of numerical definitions. This is also true in the case of the theory which stresses the role of response meaningfulness. It has been tested fifteen times and is accepted twice--for the control treatments with the combined and the long definitions. However, in each of the confirming cases there is some overlap among the types of definitions when in fact the theory predicts no overlap.

Possibly it is the nature of the dependent variable which is responsible for the failure to confirm either one of the theories with a high degree of consistency. For this reason the following analysis will be limited to the exact responses, as a dependent variable. This is because the two theories have been built by verbal learning psychologists who consider the dependent variable to be the exact response. For example, verbal learning psychologists assume the S' answer which is an exact reproduction of the response as their criterion measure of learning, and any answer which differs from the exact response is assumed to be wrong. In this study accepting the answers which are similar to the response but stated in a slightly different manner as dependent variable violates the condition of analogy between paired-associate and definition learning experiments. To test again whether the suggested arrangement of types of definition correlates significantly with the actual arrangement, the mean percentage of the exact responses is considered as the dependent variable.

E. Rank Order of the Types of Definitions According to the Percentage of the Exact Responses for the Control Treatment

Appendix M shows the percentage of exact responses per test. The mean percentage of exact responses is shown in the last column of the appendix, while the rank order of the types of definitions under the five different task classifications (combined definitions, short, long, numerical and geometrical definitions) is shown in Table 7.

Inspection of Table 7 reveals no significant correlation between the arrangement expected according to the theory which emphasizes the m of stimulus, and the actual arrangement of the types of definitions when based on the mean percentage of exact responses. Thus it can be said that the theory which emphasizes the m of the stimulus position has not been confirmed when exact responses were considered. On the other hand, Table 7 shows that the response theory is confirmed in three cases at the .05 level, namely, with the combined definitions, short definitions and long definitions.

Table 8 shows the z values for the differences between proportions of exact responses for the control treatment. Long definitions showed, according to Table 8, significant differences between the types of definitions at the .01 level. For short definitions, at .05 level, the difference is significant between L-H and H-H and insignificant between L-H and H-L types of definitions. However, other differences are significant at the .01 level. In the case of the combined definitions, the differences are significant at the .01 level with the exception of that between L-H and H-L which is significant at the .05 level.

TABLE 7: Rank Order of the Mean Percentage of Exact Responses for the Types of Definitions in the

Control Treatment									
1	2	3	4	5	6	7	8	9	
Kind of Task	H-H	L-H	H-L	L-L	Response Position	Proba- bility	Stimulus Position	Proba- bility	
					τ		τ		
Combined Definitions	1	2	3	4	1.000*	.042	.667	.167	
Short Definition	1	2	3	4	1.000*	.042	.667	.167	
Long Definition	1	2	3	4	1.000*	.042	.667	.167	
Numerical Definition	3	2	1	4	.000	.625	.333	.375	
Geometrical Definition	1	2	4	3	.667	.167	.333	.375	

*Significant tau at the .05 level

TABLE 8: z Values for the Differences Between Proportions of Exact Responses for the Control Treatment

Types of Definitions	L-L	H-L	L-H	Kind of Task
H-H	11.465**	6.535**	5.332**	Combined Definitions
	8.010**	2.660**	1.980*	Short Definition
	8.588**	7.183**	4.341**	Long Definition
L-H	7.265**	2.241*		Combined Definitions
	6.150**	.660		Short Definition
	4.372**	2.900**		Long Definition
H-L	5.025**			Combined Definitions
	5.480**			Short Definition
	2.718**			Long Definition

* Significant difference at the .05 level (one tail test)

**Significant difference at the .01 level (one tail test)

F. Rank Order of the Types of Definition According to the Percentage of the Exact Responses for the Verbal and Picture Familiarization Treatments

Table 9 shows the actual rank order of the types of definitions according to the percentage of exact responses in case of verbal familiarization (Appendix N). Inspection of Table 9 reveals that numerical definitions are consistent with the theory which emphasizes the response position with verbal familiarization. However, it has been previously shown that the same numerical definitions were also consistent with the

TABLE 9: Rank Order of the Mean Percentage of Exact Responses for Types of Definitions in the

Verbal Familiarization

1	2	3	4	5	6	7	8	9
Kind of Task	H-H	L-H	H-L	L-L	Response Position	Proba- bility	Stimulus Position	Proba- bility
					τ		τ	
Combined Definitions	1	4	2	3	.333	.375	.667	.167
Short Definition	2	4	3	1	.333	.375	.000	.625
Long Definition	1	3	2	4	.333	.375	.333	.375
Numerical Definition	3	4	1	2	1.000*	.042	.333	.375
Geometrical Definition	1	4	3	2	.000	.625	.333	.375

*Significant tau at the .05 level

theory of the stimulus position in control and verbal familiarization treatments when the correct response was used as a dependent variable. Other Kendall rank correlations reported in Table 9 are not significantly greater than zero.

Table 10 shows the z values for the differences between proportions of exact responses for numerical definitions with verbal familiarization. Investigation of this table reveals that the proportion of exact responses of L-L are not significantly greater than those of H-H, in case of numerical definitions under verbal familiarization. The other reported differences are significant at the .01 level.

TABLE 10: z Values for the Differences Between Proportions of Exact Responses for Numerical Definitions with Verbal Familiarization

Types of Definitions	L-L	H-L	L-H
H-H	.232	7.617**	4.842**
L-H	5.791**	23.313**	
H-L	8.056**		

**Significant difference at the .01 level

Table 11 shows the Kendall rank order correlation coefficients of the actual order of types of definitions with the expected order of each theory. The actual arrangement of types of definition is based on the mean percentage of exact responses reported in Appendix O. The results of Table 11 showed that all the correlations are not significantly different from zero. This result is consistent with

TABLE 11: Rank Order of the Mean Percentage of Exact Responses for Types of Definitions with the

Picture Familiarization

1	2	3	4	5	6	7	8	9
Kind of Task	H-H	L-H	H-L	L-L	Response Position	Stimulus Position	Proba- bility	Proba- bility
Combined Definitions	1	4	3	2	.000	.625	.333	.375
Short Definition	1	4	3	2	.000	.625	.333	.375
Long Definition	1	2	3	4	-.333	.375	.000	.625
Numerical Definition	1	4	2	3	.000	.625	.333	.375
Geometrical Definition	1	3	4	2	-.333	.375	.000	.625

*Significant tau at the .05 level

picture familiarization when the dependent variable is the correct response.

G. Summary of the Results When the Exact Responses are Taken as a Dependent Variable

In conclusion, when the exact response is used as a dependent variable, the results do not at all confirm the theory which favors the stimulus position. The second theory, namely, the theory which emphasizes the role of m on the response member is confirmed in three cases (the combined definitions, short and long definitions) with control treatment, and once (numerical definitions) with verbal familiarization. The picture familiarization confirmed neither of the two theories.

Thus, when each theory was given fifteen chances of possible confirmation as the exact response of the definitions was recalled, the theory which favors the m of the response position was confirmed four times, while the theory which emphasizes the m of the stimulus position was unsupported at all.

SUBJECTS' PRE- AND POST-DEFINITION ATTAINMENT

The presentation of the results follows the sequence which is suggested in the design and statistical procedure (page 45). The results of each familiarization treatment will be presented separately. Under each familiarization treatment (control, verbal, picture) there will be a discussion of (a) the relationships between pre-test scores of the levels of each definition variable, (b) the relationships

between post-test scores of the levels of each definition variable, and (c) the relationship between pre- and post-test scores of the familiarization treatment. This will be followed by presenting (a) the relationship between pre-test scores of the levels of subject matter variable or length variable for each of the H-H, L-H, H-L, and L-L definitions; (b) the relationship between post-test scores of the levels of subject matter or length variables for H-H, L-H, H-L, and L-L definitions; (c) the relationship between pre- and post-test scores for H-H, L-H, H-L, and L-L types of definition. The above sequence will be followed in presenting the results of the control, verbal, or picture familiarization treatments.

A. The Relationship Between Pre- and Post-Tests' Scores With Definition Variables in Case of the Control Treatment

Table 12 shows the X^2 values of definition variables with either the pre-test score or the post-test score for the control treatment. It also shows the X^2 value of pre- and post-test scores for the same treatment.

Investigation of Table 12 shows that the $\underline{S_s}$ ' pre-test scores were significant at the .01 level with respect to types of definition, stimulus meaningfulness and length variables. As for the types of definitions variable, Appendix P₁ shows that the mean pre-test score is .48, .34, .00, and .01 for H-H, H-L, L-H, and L-L respectively. The arrangement of definitions suggests that meaningfulness of the stimulus position in the pre-test is more concerned with the previous attainment of the definition. This observation is confirmed by the fact that the correlation coefficient between levels of stimulus

meaningfulness and pre-score values is .454 for $N = 528$ which is significant at the .01 level. With respect to stimulus meaningfulness variable, Appendix P₁ shows that the mean pre-test scores for H and L stimuli are .40 and .01. This indicates that definitions with higher meaningfulness stimuli were better known in advance than the definitions with lower meaningfulness stimuli. As for the length variable, the mean pre-test score for short and long definitions are .11, and .29 respectively. The longer definitions seemed to be better known than the short ones.

TABLE 12: χ^2 Values of Pre- and Post-Tests' Scores With Definition Variables, in Case of Control Treatment

Variables	χ^2 with Pre-Test Score	χ^2 with Post-Test Score
Types of Definitions	127.02**	41.93**
Stimulus Meaningfulness	115.81**	12.95**
Response Meaningfulness	1.90	14.99**
Subject Matter	1.39	3.75
Length	25.18**	5.28
Post-Test Score	24.87**	

* Significant at the .05 level

**Significant at the .01 level

After the learning trials (Table 12) the Ss' post-test scores showed significant variation as a function of definition types, stimulus m, and response m variables, while the length variables failed

to produce significant statistical variation. Types of definitions and stimulus meaningfulness have exactly the same effect as in the pre-test results, except that there is a tendency for the values of X^2 to be attenuated. The mean post-test scores for H-H, L-H, H-L, and L-L, as shown in Appendix P₂ are 1.53, 1.00, 1.11, 1.07 and for H, L stimuli 1.29 and 1.03 respectively. These two results indicate that definitions with higher meaningfulness stimuli were attained better than the definitions with lower meaningfulness stimuli. The response meaningfulness variable showed that when meaningfulness was high, the post-test score was also high (mean post-test scores for H and L are 1.24, 1.09 respectively) and the X^2 value became higher than in the case of pre-test results.

Table 12 shows also that X^2 test indicated significant variation between the two distributions of pre- and post-test scores at the .01 level. This result suggests that there was a significant change in attaining the definitions in the control treatment after receiving the learning trials.

Table 13 shows the X^2 values of pre- and post-tests' scores with subject matter and length variables for each of H-H, L-H, H-L and L-L definitions under the control treatment. Appendices S₁ and S₂ show the corresponding proportional distribution of pre- and post-test scores for H-H definitions. Investigation of Table 13 and Appendices S₁ and S₂ reveals that the H-H type of definition had varied significantly in case of either pre- or post-test scores with length variable. The mean scores of short and long definitions in the pre-test are .19 and .78, while in the post-test results they are

1.36 and 1.69 results. Then for the H-H type of definitions, the definitions with longer responses were better attained before and after the learning task than definitions with shorter response.

TABLE 13: χ^2 Values of Pre- and Post-Tests Scores for Types of Definitions Under Control Treatment

Types of Definitions	Subject Matter		Length		Pre and Post
	Pre	Post	Pre	Post	
H-H	1.74	3.12	30.46**	9.94**	15.10**
L-H	.00	.16	.00	8.40*	.00
H-L	2.09	6.67*	12.09**	7.42*	6.54
L-L	2.03	.31	.00	19.43**	1.10

* Significant at the .05 level

**Significant at the .01 level

As for the L-H type of definition, there is a significant difference between short and long definitions with post-test score. Appendices T_1 and T_2 show that mean post score for short and long definitions of L-H are 1.07 and .93 respectively. Thus the L-H definitions with shorter responses were better attained than the L-H definitions with longer responses.

In case of the H-L type of definitions, Table 13 shows significant χ^2 values among subject matter levels with post-test score and the length variable in both the pre- and post-test scores. Appendices U_1 and U_2 show that H-L numerical definitions were better attained than the H-L geometrical definition, where their mean post-test

scores are 1.27 and .94 respectively. It also shows that the mean pre-test score for short and long definition are .24 and .44, while they are 1.17 and 1.04 for post-test scores. These latter means indicate that definitions of long responses were better known before the learning task, and then the relation is reversed to indicate that definitions with short responses were better attained after the learning task.

The L-L definitions which have shorter responses were attained better than L-L definitions with longer responses. The mean post-test scores for L-L short and long definitions are 1.37 and .67 as shown in Appendix V₂.

A difference is observed between the distributions of pre- and post-test scores which is significant in the use of H-H, but not significant for H-L. However, the X^2 value for H-L pre- and post-test scores approximates significance at the .05 level. In case of L-H and L-L, the distributions of pre- and post-test scores are almost identical. The arrangement of the pre- and post- X^2 values shows a significant development in the Ss attainment of the definition after the learning trials in case of H-H, reasonable development with H-L and quite negligible development in case of L-L and L-H. This may indicate that progress in attainment of the definition is more dependent on the meaningfulness of the stimulus position than on the meaningfulness of the response position. However, this finding was confirmed by the results reported in Table 12 that pre- or post-attainment scores were significantly high when the stimulus meaningfulness was high rather than low.

B. The Relationship Between Pre- and Post-Tests' Scores With Definition Variables, in Case of Verbal Familiarization

TABLE 14: χ^2 Values of Pre- and Post-Tests' Scores With Definition Variables, in Case of Verbal Familiarization

Variables	χ^2 With Pre-Test Score	χ^2 With Post-Test Score
Types of Definitions	149.58**	3.84
Stimulus Meaningfulness	68.32**	1.01
Response Meaningfulness	9.55	1.30
Subject Matter	1.13	3.92
Length	6.39*	18.90**
Post-Test Score	36.22**	

* Significant χ^2 at the .05 level

**Significant χ^2 at the .01 level

Table 14 shows the χ^2 values of definition variables with either the pre-test score or the post-test score for the verbal familiarization treatments. Appendices Q₁ and Q₂ also show the pre- and post-test scores for the same treatment. Investigation of Table 14 shows that the Ss' pre-test scores had varied significantly at the .01 level with types of definitions, stimulus meaningfulness variables and at the .05 level with length variable. As for the types of definition variable, Appendix Q₁ shows that mean pre-test scores are .42, .00, .52, and .06 for H-H, L-H, H-L and L-L respectively. In case of stimulus m levels, the higher pre-test scores were associated with the higher meaningfulness.

The mean pre-test scores of H and L stimuli are .35, and .04. The response m shows peculiar relationship with pre-test scores. The mean pre-test score of H and L responses are .17 and .25 respectively. Thus it could be stated that definitions with low meaningfulness values were known better before receiving learning trials than those of the high meaningfulness values. The definitions with shorter responses were relatively less known before the experiment than the definitions with longer responses. Appendix Q₁ indicates that the mean pre-test score for short and long definitions are .17 and .26 respectively.

The post-test scores were significantly different with the levels of the length variable as shown in Table 14. Appendix Q₂ shows that the mean post-scores of short and long definitions are 1.29 and 1.06 respectively. Thus the definitions with short responses produced significantly higher scores in the post-test than definitions with long responses.

The X^2 value as shown at the end of Table 14, of the pre- and post-test scores indicates a significant development in the Ss' attainment of the definitions after receiving verbal familiarization and a number of learning trials.

Table 15 shows the X^2 values of pre- and post-tests scores with subject matter and length variables for each of H-H, L-H, H-L, and L-L definitions under verbal familiarization. Appendices S₁, S₂, T₁, T₂, U₁, U₂, V₁, and V₂ show also the corresponding proportional distribution of pre- and post-test scores for H-H, L-H, H-L, and L-L types of definitions respectively.

TABLE 15: χ^2 Values of Pre- and Post-Tests' Scores for Types of Definitions Under Verbal Treatment

Types of Definitions	Subject Matter		Length		Pre and Post
	Pre	Post	Pre	Post	
H-H	3.05	7.39*	10.02**	5.40	24.64**
L-H	.00	.62	.00	5.22	.00
H-L	2.21	15.92**	9.02*	11.42**	22.60**
L-L	6.21*	2.20	6.21*	28.44**	3.19

* Significant at the .05 level

**Significant at the .01 level

Study of Table 15 and Appendix S₁ shows that H-H definitions exhibited significant variation in the case of pre-test score with the length and subject matter variables. The mean scores of short and long definitions in the pre-test are .21 and .62 respectively. Then for H-H definitions, the definitions with longer responses were known better before the learning task than definitions with short responses. In addition, the H-H geometrical definitions were attained after receiving verbal familiarization and learning trials better than numerical definitions since their mean scores are 1.33 and 1.05 respectively.

As for H-L definitions, Table 15 and Appendix T₁ show that they had significant variation in pre-test score with the length variable. The mean scores of short and long definitions in the pre-test are .42 and .61 respectively. It seems that definitions with long responses are better known in advance than definitions with short responses.

However this relation did not change after the familiarization and the learning trials, confirming that H-L definitions with long responses are better attained than short definitions. Appendix U₂ shows that the mean post-test scores of short and long definitions are 1.13 and 1.19 respectively. Moreover, the H-L definitions showed significant χ^2 value with post-test score and the subject matter levels. The mean post-test score for H-L numerical and geometrical definitions are 1.42 and .90. So, the H-L numerical definitions seemed to be better attained after receiving verbal familiarization and a number of learning trials than the H-L geometrical definitions.

Table 15 and Appendices V₁ and V₂ show that L-L definitions pre- or post-scores exhibited significant variation when covaried with the length variable. In either pre- or post-test scores, the short definitions of L-L produced higher scores than the longer ones. The mean pre-test scores for short and long L-L definitions are .11, .00 and their post-test scores are 1.57, .90. Table 15 indicates also that L-L definitions' pre-test scores are significantly different in case of subject matter. However, this significant difference is in favor of geometrical definitions over numerical definitions.

The comparison of pre- and post-test scores of the types of definitions showed significant differences in case of H-H and H-L and insignificant differences with L-L and L-H. Thus, with verbal familiarization, the m of stimulus position in the combined definitions is responsible for the progress of definition attainment after the learning trials.

C. The Relationship Between Pre- and Post-Tests' Scores with Definition Variables, in Case of the Picture Treatment

TABLE 16: χ^2 Values of Pre- and Post-Tests' Scores with Definition Variables, in Case of Picture Familiarization

Variable	χ^2 with Pre-Test Score	χ^2 with Post-Test Score
Types of Definitions	165.71**	19.49**
Stimulus Meaningfulness	142.17*	3.43
Response Meaningfulness	5.87	8.47**
Subject Matter	.81	3.72
Length	16.16**	2.03
Post-Test Score	41.10**	

* Significant χ^2 at the .05 level

**Significant χ^2 at the .01 level

Table 16 contains the χ^2 values of pre- and post-tests' scores with definition variables in the case of picture familiarization. Appendix R₁ shows the proportional distribution of pre- and post-tests scores with definition variables in the case of picture familiarization. Both Table 16 and Appendix R₁ will be used to clarify the relationships between definition variables and either pre-test or post-test scores.

According to Table 16 the pre-test scores for the picture familiarization follow exactly the same pattern as those of the control treatment. There are significant differences between the pre-test scores of

the levels of the types of definitions, stimulus meaningfulness, and length variables. As for the types of definition variable, Appendix R₁ shows that the mean pre-test score is .63, .00, .35, .09 for H-H, L-H, H-L, and L-L respectively. The arrangement of definitions (H-H, H-L, L-L, L-H) suggests that the meaningfulness of stimulus position in the pre-test is more concerned with the previous knowledge of the definition. With respect to stimulus meaningfulness variable Appendix R also shows that the mean pre-test score for H and L stimuli are .51, and .04. This indicates again that definitions with higher meaningfulness stimuli were better known in advance than definitions with lower meaningfulness stimuli. As for the length variable, the mean pre-test scores for short and long definitions are .19 and .33 respectively. The longer definitions seemed to be better known than short ones.

Analysis of the post-test scores of Table 16 and Appendix R₂ showed significant differences between types of definitions. The mean post-test values for H-H, L-H, H-L and L-L are 1.60, 1.40, 1.23 and 1.39 respectively. It seems that high meaningfulness in the response had higher attainment values in the post-test than those with low meaningfulness. This observation is confirmed by finding a significant difference between the levels of response meaningfulness. The mean post-test score for H and L responses, after picture familiarization and the learning trials, are shown in Appendix R to have the values 1.49 and 1.32 respectively.

Table 16 indicates also that the χ^2 test showed significant variation between the two distributions of pre- and post-test scores at the

.01 level. This result points to the presence of significant change in attaining the definitions in the picture familiarization treatment after receiving the learning trials.

TABLE 17: The X^2 Values of Pre- and Post-Tests' Scores for Types of Definition Under Picture Familiarization

Types of Definitions	Subject Matter		Length		Pre and Post
	Pre	Post	Pre	Post	
H-H	.12	10.48**	26.14**	.82	16.68**
L-H	.00	8.36*	.00	1.51	.00
H-L	1.82	6.33*	9.42**	2.41	16.47**
L-L	.00	.58	4.91	13.66**	4.84

* Significant X^2 at the .05 level

**Significant X^2 at the .01 level

Table 17 shows the X^2 values of pre- and post-tests' scores for types of definition under picture familiarization. The results reported in Table 17 indicate that H-H definitions had significant differences between the post-test scores of numerical and geometrical definitions. Appendix S_2 shows that the mean post-score of numerical and geometrical definitions are 1.51 and 1.68 respectively. Thus, after picture familiarization the attainment of geometrical definitions was greater than that of numerical definitions. Appendix S_1 shows that the mean pre-test scores of short and long H-H definitions are .37 and .89 respectively. It indicates that H-H definitions with longer responses were better known than H-H definitions with shorter responses.

According to Table 17, post-test scores of L-H definitions showed significant differences from the levels of the subject matter variable. The mean post-test scores of L-H numerical and geometrical definitions after receiving picture familiarization as shown in Appendix T₂ are 1.58 and 1.22 respectively. Thus picture familiarization and learning trials made L-H numerical definition more highly attained than geometrical definitions.

The mean post-test scores of H-L definitions are shown in Appendix U₂ to have the values 1.40, 1.06 for numerical and geometrical items respectively. Table 17 shows also that there is a significant difference between these two distributions. The results indicate that H-L numerical definitions are attained better than geometrical definitions after picture familiarization and the learning trials. The mean pre-test scores of H-L short definitions are less than the mean pre-test of H-L long definitions (.26 and .44 for short and long definitions respectively). This emphasizes the fact that H-L definitions with longer responses are known better than the corresponding definitions with shorter responses.

Table 17 shows also significant differences between post-test scores of numerical and geometrical L-L definitions. The mean post-test scores for L-L numerical and L-L geometrical definitions as reported in Appendix V₂ are 1.63 and 1.15 respectively. Thus it appears that with picture familiarization and the learning trials the attainment of L-L numerical definitions was higher than geometrical definitions.

The comparison of the pre- and post-test scores showed significant differences in their distributions with H-H and H-L, but insignificant differences in case of L-L and L-H types of definitions. The arrangement of the definitions according to the magnitude of χ^2 value of the pre- and post-test scores are H-H, H-L, L-L and L-H. Thus, following the previous uses of control and verbal familiarizations, the stimulus position is more responsible for the attainment of the definitions than is the response position. Thus, the higher the m of the stimulus, the more readily the definition is attained.

CHAPTER IV

DISCUSSION AND CONCLUSIONS

One objective of this study is to investigate the relationships between definition m, definiendum m, definien m, length of definien- dum and the number of words in the definien. The data concerning the relationship between length of words and their judged meaningfulness were not conclusive. Meaningfulness of the scaled vocabulary and m of the geometrical stimuli correlated significantly with their number of letters, while the numerical stimuli did not correlate significantly. On the other hand the correlation between response m and response num- ber of words was found to be significant. Such significant correla- tions were in accordance with the conclusion that the decrease of length was accompanied by an increase of meaningfulness.

The insignificant correlation of numerical stimuli might be due to limiting the selection of items to a narrow proportion which were not representative of all possible numerical items. Thus, this result could be due to a restriction in range among the numerical stimuli. The other significant correlations may be explained in terms of Zipf's Principle of Least Effort (1949) and the empirical findings of Leply (1950) and Cofer and Shevitz (1952). Zipf noticed that individuals have a tendency to use short words more often than long ones and sug- gested that frequency of occurrence of words is inversely related to their length. Empirical studies have found significant correlations between frequency of words and number of associates (meaningfulness).

Then inductively, the length of words may be inversely related to m , a notion which is in agreement with the findings of the present study. Although the preceding logic was based on studies concerned with words, it seemed that it could be extended to include sentences.

Meaningfulness of definitions revealed significant relationships with m of the stimuli, m of the response, and inversely with number of words in the response. Furthermore there was no significant correlation with the number of letters in the stimuli. This indicates that definition m correlates with m of both members, the stimulus and the response, while these members do not correlate with each other significantly. Moreover, when m of either one of these members was partialled out, there was no significant change in the zero order correlations, but the partiallization of definition m produced a significant change in the zero order correlation. Thus it is concluded that definition m has a more critical effect than m of either the stimulus or the response, and any partiallization for its effect will cause significant changes in m of the other two components.

Unfortunately the review of research failed to confirm this conclusion for the following two reasons; first, most of the paired-associate studies used nonsense syllables that had no mutual relevance in meaning between them, in either the stimulus or the response position, while in the definition the stimulus and response are related through a common meaning which is presented by either one of them. This lack of common relationship might have encouraged the researchers to avoid the study of m of the combined members of paired-associate and its effect on m of both the stimulus and response. Second, the other

paired-associate studies which used meaningful words as adjectives or nouns avoided using synonymous verbal units in both positions of the paired-associate in order to control for previous learning. For example, a list composed of paired-associates such as "car-automobile," will enable the learner to use his past knowledge to recall the response "automobile" when car is presented. Then the processes of integrating the response, and associating it with the stimulus will depend heavily on the established experience of the learner which is assumed to be eliminated or controlled.

A finding which has no counterpart in the literature of meaningfulness was the increase of stimulus meaningfulness with the increase of response meaningfulness, when definition m is controlled. Thus the higher the m of the stimulus, the higher the m of the response. Another result was that definition m , or response m , correlated negatively with response length. The increase of either definition m or response m was accompanied by shorter responses. But, when definition m was held constant, the correlation of response m with response number of words dropped to zero. Response length seems to be related more to definition m than to response m . The partialization of the former produces a greater effect than the partialization of the latter. This may mean that writers tend to state the unfamiliar and uneasy definitions, using unfamiliar and difficult responses, in terms of a long sentence. But when familiarity of definition is excluded, low or high meaningfulness responses may or may not be accompanied by short or long sentences. Thus it can be concluded that definition m is the most

critical variable influencing the relationships between stimulus m , response m and response length.

The correlation of definition m with summed m of the stimuli and responses was found also to be high. Such summation of stimulus and response m was termed the composite definition. But when definition m , response m or stimulus m was correlated with the sum of the component words of the response, the correlation was practically zero. The latter finding emphasizes an important point, namely that high m words do not insure high or low m responses. In other words the sum of m is not a reliable predictor of the ease or difficulty of the stimulus, the response or the definition.

The second aspect of this study was concerned with the appropriateness of extending the paired-associate theories to definition learning. Subjects answers during the test trials were analyzed using two different criteria. When the correct responses (the answers which were an exact reproduction of the response or similar to the response but stated differently) were used as a dependent variable, the results were inconclusive. The data led to the rejection of the experimental hypothesis which stated that the increase of m of the response member of the definition will be accompanied by an increase of mean percentage of correct responses per test trial. The actual arrangement of the types of definitions from superior to inferior did not follow the predicted arrangement: H-H, L-H, H-L, L-L or H-L, L-L, H-H, L-H with control or familiarization treatments respectively.

The following conclusions were drawn from the analysis of test trial data using the correct responses as the dependent variable. The

theory which emphasizes the role of response m was tested fifteen times. It has been accepted twice--for the control treatment with the combined and the long definitions. However, in case of combined definitions there was some overlap between H-L and L-L while the theory predicts no overlap. Thus there remains only one case--long definitions--out of fifteen cases which supports the theory.

The results might be in accordance with some empirical studies which claim that m of the stimulus is of greater importance than m of the response. Such claim was supported twice--in case of the control and the verbal familiarization of numerical definitions. But in the case of numerical definitions with verbal familiarization there was overlapping between the L-H and the L-L lists. The theory which emphasizes the role of stimulus m was supported one time out of the fifteen cases.

Thus it is clear that the instances of support for either the theory of the stimulus or the theory of the response were scarce and insufficient to merit acceptance of paired-associate theories as a model for definition learning when the dependent variable is the percentage of correct responses. However, it is obvious that the choice of the two types of dependent variables employed in this study do not exhaust all possible methods of scoring correct responses. For example, some subjects tended to explain the response using either their own words or the sentences which were presented in the familiarization prior to the learning trials. Such answers, although they explained the response correctly, were excluded as correct responses because they did not meet the exact response criterion. (On the other hand, the

second dependent variable was not limited to the exact responses in the definition. This criterion included answers which were similar but stated in a slightly different way than the exact responses.) Thus this dependent variable was not as restrictive as the dependent variables employed in paired-associate learning studies. For example, the empirical studies which were cited in the first chapter of this study assumed that the exact reproduction of the response was the measure of learning and any answer which deviated from the exact response was considered incorrect. The definition of the correct response then violated the condition of the one-to-one correspondence between paired-associate and definition learning experiments and might have caused the rejection of the general hypothesis.

When the dependent variable was limited to include only the S's answers which were exactly the same as the learning task responses, the results were different than in case using the more lenient criterion. It was noticed that the results did not confirm the theory which favors the stimulus position in the case of either control, verbal, or picture familiarization. This theory was given fifteen empirical tests using exact responses as the dependent variable, but no one of these tests proved to support the theory.

The theory which emphasizes the role of response *m* was confirmed three times in case of combined, short, and long definitions with the control treatment and was not supported in case of numerical and geometrical definitions with the same treatment. But the coefficient of concordance for the five tests of the control treatment revealed a significant value ($S = 81$, $W = .648$, $P < .01$) favoring the theory of

response position. Thus it is concluded that without prior familiarization, and with the exact responses as the dependent variable, paired associate theory can be extended to include definition learning. This general conclusion is equivalent to previous conclusions reached by Stoddard (1929), Cason (1933), Sheffield (1946), Kimble and Dufort (1955), Cieutat, Stockwell and Noble (1958) and many others who were reported in the first chapter of this study. The supported order of types of definitions is as follows: H-H, L-H, H-L and L-L. In the control treatment it seems that subjects' behavior in definition learning is similar to their behavior in case of learning paired-associates, when these subjects are asked to give the verbatim response.

When the subjects were given verbal familiarization prior to the learning trials, the arrangements of the types of definitions were found to be inconsistent with each other. One of these arrangements namely the numerical definitions, was in agreement with the theory which emphasizes the response position. The other arrangements also differed. The coefficient of concordance ($S = 57$, $W = .456$, $P > .05$) for the five tests (combined, short, long, numerical and geometrical definition) was not significant. The summed rank order of the types of definitions suggested this order: H-H, H-L, L-L and L-H.

Similarly, when the subjects received picture familiarization before the learning trials, the arrangements of the types of definitions were not in agreement with each other. Their coefficient of concordance ($S = 69$, $W = .55$, $P > .05$) was found to be insignificant. Yet the summed rank order of the types of definitions yielded this order: H-H, L-H, H-L, and L-L.

The data concerning the familiarization conditions led to the rejection of the hypothesis which stated that verbal or picture familiarization of the response member would be accompanied by either an increase or decrease of the mean percentage of the exact response per test trial. The increase would occur if the familiarized response were low in meaningfulness, while the decrease would occur if the familiarized response were high in meaningfulness, and the expected arrangement of the types of definitions according to the response theory would be H-L, L-L, H-H, and L-H.

The differences in the expected and actual arrangements might be due to different methodological considerations. In paired-associate studies, the nonsense syllables of either the stimulus and the response are not related in meaning, but it has been shown that definition components are highly correlated with definition m. Thus while the experimental approach was directed towards the response member, it seems that definition m influenced and affected the stimulus m by the familiarization procedure. The familiarization process could not be limited to the response member only. Apparently it influenced the stimulus member as well either by presenting the stimulus at the time of the familiarization or by the nature of the relationship between definition m, definiendum m, and definien m.

But if stimulus m and response m were both affected--according to this discussion--then a question arises as to why the revealed arrangements had low concordance. Probably the responses were not equally familiarized prior to the learning process. Some paired-associate studies have reported employing familiarization tests before the

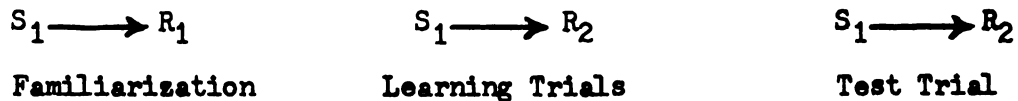
learning trials to ensure that familiarization was equally effective. For example, Epstein, Rock and Zuckerman (1960) had their subjects learn twelve short lists, each of which consisted of a nonsense syllable and four members. The syllables were later paired to form lists of pairs of familiarized items. Battig, Williams, and Williams (1962) used nonsyllables for a verbal discrimination task. Both members of some pairs became the stimulus or response members of pairs for paired-associate learning. Members of other pairs were separated and paired with syllables which subjects had not seen previously. Another procedure to equalize the familiarization was reported by Schulz and Martin (1964). Their subjects spelled the stimuli, then the stimuli were recalled after every trial. A similar step to equalize the effect of familiarization prior to the learning process was not considered in this study because it is not an ordinary procedure in the actual instructional situation.

A second interpretation for the absence of concordance between the arrangements of types of definitions may be due to the effect of proactive inhibition. It has been noticed that the subjects' answers to the test trials were influenced by presenting two kinds of material; the familiarization material and the learning material. When the subjects were asked to recall the learning material, they in fact at times answered by reproducing the familiarization material.

This points to the presence of mutual interference between the two sets of responses to the extent that the responses from the two sets were competing with one another at recall. The overt intrusions

of responses from the competing set of responses actually displaced the exact responses.

Moreover, an investigation of the experimental situation, showed that in the familiarization situation, learning trials, and test trials, the stimulus was presented without any change. It is designated as S_1 . The explanation of responses which were presented for familiarization is designated as R_1 while the learning material is designated as R_2 . Thus the presence of constant stimuli (S_1) and two different response sets (R_1 and R_2) can be represented tentatively as follows:



The observation of the presence of interference between R_1 and R_2 is supported by Deese (1958) who reported that a safe generalization about paired-associate learning states that when the same stimulus items and different response items are used in two tasks, there is negative transfer. Most important is his conclusions that holding stimulus similarity between the tasks (familiarization and learning trials) constant, transfer can be varied from positive to negative by changing the responses in the two tasks (familiarization and learning trials) from being identical or very similar to being very different from each other.

In this study it can be assumed that R_1 i.e. the familiarization of the response was kept relatively easy and familiar. However the R_2 responses were either H or L depending on the type of definition learned. For example, R_2 was either H or L as a result of having one of these types of definitions, H-H, L-H, H-L, or L-L. Then the number

of intrusions and their positive or negative effect on the recall of R_2 would be different, as a result of learning different types of definitions.

Besides, each response set R_1 or R_2 was a combination of two factors--length (short and long) and subject matter (numerical and geometrical). The analysis of the test trials using the exact responses has been done for each level of these two factors plus their combination. The short definitions or numerical definitions have been analyzed separately for each type of definition. But it is worth noticing that the kind of similarity between the short responses is completely different from the similarity between numerical responses, because the former similarity was based on length, while the latter similarity resulted from being related to the same subject matter. The elements which were responsible for the similarity of length (number of words in the response) should have been different than elements which were responsible for the similarity of subject matter (say; responses that deal with numbers) and thus each kind of element would have exerted different effects on the test trials. By the same token, the effect of similarity between short responses, could be different than the effect of similarity between long definitions, since the increase of length might have differential effect on the material and on the learner. Similarly, the subjects might have adopted a strategy for the similarity of numerical definitions which was different from their strategy in approaching similar geometrical definitions.

In conclusion, it is suggested that the interaction between types of definitions and the types of similarities located among the learning

task R_2 (combined, short, long, numerical and geometrical) is responsible for the insignificant concordance between the arrangement of types of definitions when subjects received either verbal or picture familiarization. Apparently the previous interaction was working in the same manner with verbal or picture familiarization. When the arrangements of the types of definitions, in both verbal and picture familiarization, were checked for concordance, it was found to be significant ($S = 266$, $W = .532$) at the .01 level and in favor of this order: H-H, L-L, H-L, and L-H (L-L although higher was similar to H-L). Such interaction between types of definitions and familiarization was absent in the control treatment because of the absence of the familiarization task R_1 and the arrangement of the types of definition (H-H, L-H, H-L, L-L) was completely different.

The prediction of Lambert and Jakobvits (1960), Kamung, Lambert and Mauer (1962), and Kamungo and Lambert (1963) that familiarization of high meaningful material would have a prohibitive effect due to either meaning decrement or the development of a word-word habit, seemed to be untenable as applied to this experiment. According to this theory the H-H type of definition must be ranked in the third position as a result of the satiation effect; but it was found to be in the first rank with respect to the other types of definitions. Similarly the H-L type of definitions was predicted to be ranked the first, while it was found to be located in the third position. The rank order between the predicted arrangement of the types of definitions, and the arrangement that resulted from summing the ranks in verbal and picture familiarization was not significant. Probably

because this theory was based on the assumption that the familiarization procedure would mean frequent repetition of R_2 , which was not the case in this study.

The third objective of this study is to investigate the differences between pre- and post-test scores due to the familiarization and learning trials. The pre- and post-test scores were analyzed on the basis that the subjects' answer would be assumed correct if he explained the meaning of the definiendum correctly without regard to the exact terminology used during the learning trials. The pre-test data have shown that subjects' previous knowledge was significantly different in case of the types of definitions, stimulus meaningfulness and length. The subjects' mastery of the definitions seemed to be in this order: H-H, H-L, L-L and L-H. Definitions with higher meaningfulness stimuli were better known in advance than the definitions with lower meaningfulness stimuli.

Analysis of post-test scores showed the presence of controversial finding between m of the stimulus and m of the response. It indicated that post learning was more effective in this order: H-H, H-L, L-L, and L-H for control treatment. The arrangement tends to indicate that m of the stimulus was more critical in the post learning than response m . Such apparant critical effect of stimulus m was statistically significant only in case of the control treatment even though response m was also a source of statistically significant variance in case of control and picture familiarization. The verbal familiarization procedure supported neither stimulus m nor response m .

It has been mentioned that stimulus m had a greater effect on the pre-test scores. On the other hand, the statistical analysis of post-test scores showed that neither the m of the stimulus nor the m of the response had a consistent effect over all the familiarization treatments. Probably the familiarization treatment and the learning trials had affected response m more than stimulus m. As a result of the familiarization and learning response m gained a differential effect over stimulus m and there was no consistent effect in case of the three familiarization treatments.

The comparison between pre-test and post-test scores revealed that there was a significant gain in definition attainment. Such observation was supported by the results of control verbal, and picture familiarization treatments. The arrangement of types of definitions according to the magnitude of change between pre- and post-test scores were H-H, H-L, L-L and L-H. The consistency of this arrangement still suggests that stimulus m is more critical in the gain of definition attainment. Individual comparisons between pre- and post-test scores for each type of definition under familiarization treatment confirmed the previous conclusion.

Concerning the length of responses, the results showed consistently in the three familiarization treatments that previous attainment was better with longer definitions than short ones. The post-test analysis showed post-test scores of shorter definitions to be better attained than longer ones especially in case of verbal familiarization. The individual analysis of types of definitions with the length variable showed a trend towards better pre- or post-attainment for longer

definitions when stimulus m was high and for shorter definitions when stimulus m was low. However, the subject matter showed inconsistency and many insignificant results.

The pre- and post-test scores led to the following decisions concerning definition attainment hypotheses. First, that the increase of stimulus m will be accompanied by an increase of pre-test scores is a tenable hypothesis and that the definition of high m stimuli are better known than definitions of low stimuli. Second, the hypothesis which stated that an increase of definition attainment will follow also the m of the stimuli is supported. The higher the m of stimuli the higher the difference between pre- and post-test scores, while lower m stimuli are associated with lower differences between pre- and post-test scores. Third, the data did not support the hypothesis that the increase of stimulus m is accompanied by an increase in the post-test scores.

In summary, the general hypothesis that paired-associate learning theory favors the m of response was unsupported when the dependent variable was the mean percentage of correct responses. Only when the mean percentage of exact responses was chosen as a dependent variable for the control treatment, was the general hypothesis supported. This supports the paired-associate theory which stresses response m in definition learning. However, the paired-associate predictions concerning the presence of satiation as a result of familiarization were not confirmed. A possible interpretation of the absence of satiation in meaning may be due to the type of familiarization procedure employed. Unlike the procedures used in paired-associate studies, the present

procedure avoided repetitions of the responses. Instead, it explained the response only once, using familiar expressions that were somewhat different from those responses learned by the Ss during the learning tasks.

This fact emphasizes the difficulty in generalizing from the paired-associate model to definition learning. The molecular nature of such a model and its corresponding operational definitions for such concepts as familiarization, stimulus, response, meaningfulness, and even learning have no exact analog in definition learning. Until verbal learning model become broader in scope, generalization from these molecular models to more complex learning situations should be made with caution.

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APPENDIX A

Arithmetic Textbooks Series Used in Gathering the Definitions

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APPENDIX B

Name _____ Grade _____
 Birth Date _____ Sex _____

When we read or hear a new word for the first time, we might say that "this word looks familiar and easy for me to learn and to memorize," or "this word looks unfamiliar and difficult for me to learn and to memorize." So there are different kinds of words. The word might be: Very easy, easy, indifferent, difficult, very difficult to learn and to memorize. Not all the words are the same according to their easiness.

In the following pages, there are lists of arithmetic words, and five columns. You are to tell whether the word is familiar and easy or unfamiliar and difficult for you to learn and to memorize.

Each column is prepared to indicate a certain degree of difficulty in learning and memorizing. There is a column to check the very easy, easy, indifferent, difficult, or the very difficult word.

Read all the words first, then read each word carefully and decide the easiness of each one. Check with the mark (X) the proper column following the word.

Do not rush, but do not slow down. Be sure to read each word carefully, giving it just one mark. Example:

	Very Easy	Easy	Indif- ferent	Diffi- cult	Very Diffi- cult
1. Rectangle					
2. Cotangent					
3. Miruend					

APPENDIX C

The Instructions for Rating the Meaningfulness

In arithmetic classes and textbooks, we used to hear and read certain words (sentences). These words (sentences) might look easy for you to learn and to memorize, or they might be hard for you to learn or to memorize. Also, these words (sentences) might be familiar to you or unfamiliar. The degree of familiarity or ease to learn each word (sentence) differs from one student to another.

The booklet given to you contains a number of such words (sentences) that are used in arithmetic classes. You are going to read them carefully, and always ask yourself this question, "Is this word (sentence) familiar and easy for me to learn?" and "How far is this word familiar and easy?" So this first reading is to get acquainted with the words presented in the booklet and to think about your own judgement for each word (sentence).

There will be a second reading. In this reading you will show your own judgement for the familiarity and ease of the word (sentence) by marking the appropriate column directly in front of each word (sentence). On the first page there are some examples, also there are five columns. The first column is where to mark if the word (sentence) is very easy, the second is for easy, the third is for the indifferent words (sentences), the fourth is for the difficult, and the fifth is for the very difficult words (sentences).

(The experimenter used the board to show the five columns).
Suppose I found that the first word (sentence) is difficult, where

may I put the mark (X)? [The students were encouraged to answer as a group]. Suppose I found that the word (sentence) is easy, where may I put the mark (X)? [The students were encouraged to answer as a group]. Sometimes the word (sentence) might look for me neither easy nor difficult. This word is called indifferent. Where may I check for indifferent? [The students answered]. Any question?

Now, to sum up, you are going to indicate for each word (sentence) how far it looks familiar and easy for you to learn. Second, you shall read the words carefully but do not mark any of them, just decide for yourself. Third, you shall read each word and you will show your own idea about the ease and familiarity of the word (sentence) by writing the mark (X) in the proper column.

We are going to work as a group. When you finish the first reading just raise your head and wait until all of you are asked to begin the second reading. Remember do not rush or slow down and read each word carefully.

Any question?

Begin.

APPENDIX D

The Meaningfulness Values of the Definition Components

Rank	Item No.	Definition	Type	Definition m		Definiendum m	
				Mean	SD	Mean	SD
1	25	Plane: A flat surface	G	1.040	0.196	1.424	0.848
2	63	Hexagon: A figure with six sides	G	1.080	0.271	1.729	1.087
3	9	Numerals: The names for numbers	N	1.080	0.271	1.169	0.457
4	44	Triangle: A three sided polygon	G	1.120	0.431	2.661	1.397
5	86	Multiplication*: The operation of repeated addition	N	1.292	0.611	1.729	1.006
6	75	Equator: An imaginary circle half-way between the poles	G	1.400	0.566	1.644	1.004
7	45	Addition*: The inverse operation of subtraction	N	1.400	0.748	1.949	1.281
8	95	Face*: A side of a pyramid	G	1.417	0.862	2.271	1.424
9	26	Subtraction*: The inverse operation of addition	N	1.440	0.697	2.136	1.282
10	2	Subtraction*: The process of taking a number away from another number	N	1.440	0.753	1.237	0.532
11	85	Algebra: Generalized arithmetic	N	1.458	0.763	2.593	1.329
12	10	Multiplication*: The inverse operation of division	N	1.480	0.574	2.085	1.253
13	82	Base*: A side of a geometric figure	G	1.500	0.866	2.932	1.351
14	58	Percentage*: A given rate in every hundred	N	1.520	0.640	2.220	1.208
15	39	Range: The difference between highest and lowest score	N	1.600	0.693	1.729	1.006
16	1	Bigits: The symbols zero and one	N	1.600	0.800	1.237	0.532
						4.203	0.859

Rank	Item No.	Definition	Type	Definition m		Definiendum m	
				Mean	SD	Mean	SD
17	68	Addends: The number added to each other	N	1.600	0.849	1.475	1.031
18	11	Equation: A number sentence that contains "is equal to"	N	1.600	0.849	2.153	1.132
19	16	Line: A set of points	G	1.600	0.849	2.288	1.180
20	28	Element: A member of a set	G	1.600	0.938	1.881	1.010
21	24	Percentage*: A given proportion in every hundred	N	1.640	0.686	2.017	1.081
22	70	Division*: The inverse operation of multiplication	N	1.640	0.794	2.322	1.478
23	38	Centimeter: One hundredth part of a meter	G	1.680	0.882	2.458	1.267
24	76	Addition*: An operation on two numbers called addends	N	1.680	0.882	2.712	1.530
25	50	Duty: An import tax	N	1.680	1.191	2.407	1.354
26	78	Latitude: The distance north or south of the equator measured in degrees	G	1.708	0.735	1.898	1.100
27	34	Area: The number of square units the surface contains	G	1.720	0.722	2.881	1.277
28	41	Factors: The numbers multiplied together	N	1.720	0.826	1.475	0.945
29	74	Proportion: A statement that two ratios are equal	N	1.760	0.709	2.424	1.265
30	66	Data: Numerical facts	N	1.760	1.031	2.678	1.346
31	21	Fraction: A numeral that represents one or more of the equal parts of the whole	N	1.800	1.020	2.424	1.291
32	87	Predecessor: A number that precedes another number	N	1.833	1.067	1.915	1.094
33	5	Terms: The numerator and denominator of a fraction	N	1.840	0.967	1.678	1.142

Rank	Item No.	Definition	Type	Definition m		Definiendum m	
				Mean	SD	Mean	SD
34	23	Millimeter: One thousandth part of a meter	G	1.880	0.816	2.475	1.240
35	47	Degree: A standard unit of angle measure	G	1.880	1.070	3.085	1.253
36	77	Divisible: When a natural number is divided by another number, and the remainder is zero	N	1.917	0.997	2.288	1.415
37	48	Frequency: The number of times any score was made	N	1.920	0.935	2.009	1.074
38	7	Concentric: Two circles that have the same center	G	1.920	1.197	2.017	1.097
39	4	Reciprocals: Two numbers whose product is one	N	1.960	0.999	1.949	1.171
40	54	Face*: A region of a plane enclosed by a polygon	G	2.000	0.849	3.458	1.357
41	73	Zero: A symbol of the cardinality of the empty set	N	2.040	1.038	3.429	1.356
42	64	Discount: The rate of reduction	N	2.040	1.148	2.780	1.316
43	49	Mode: The most frequent or common score	N	2.040	1.216	2.034	1.178
44	62	Placeholder: A symbol that holds a place for a numeral in a number sentence	N	2.080	1.055	2.593	1.391
45	67	Set: A collection of objects called elements	G	2.120	0.909	2.492	1.307
46	84	Chord: The line that connects any two points on the circle	G	2.125	0.927	2.119	1.222
47	89	Hypotenuse*: The longest side of a right triangle	G	2.125	1.092	2.220	1.222
48	19	Modulo: The number of digits used in arithmetic	N	2.200	1.200	1.932	0.918

Rank	Item No.	Definition	Type	Definition m		Definien m		Definiendum m	
				Mean	SD	Mean	SD	Mean	SD
49	36	Division*: The process of finding how many times a number is contained in another number	N	2.200	1.233	1.864	1.214	1.153	0.404
50	32	Axiom: A statement accepted as true without proof	N	2.240	1.031	2.085	1.197	4.661	0.627
51	15	Duodecimal: A system based upon twelve	N	2.240	1.274	2.136	1.200	4.271	0.936
52	96	Longitude: The distance east or west of the prime meridian measured in degrees	G	2.250	1.331	2.797	1.312	1.712	1.026
53	40	Volume: The measure of the region enclosed by the solid	G	2.280	0.960	3.051	1.346	1.627	0.862
54	6	Successor: A natural number that follows any natural number	N	2.280	1.217	2.322	1.199	2.966	1.178
55	92	Graph: A drawing to picture the relationships among the elements of many sets	G	2.292	1.207	2.881	1.277	1.678	0.891
56	14	Base*: A number upon which a numeration system is constructed	N	2.400	0.938	2.627	1.364	1.746	1.067
57	37	Distribution: A set of numbers arranged in a frequency table	N	2.440	0.852	2.966	1.221	2.492	1.332
58	60	Ellipse: An elongated circle	G	2.440	1.267	3.484	1.379	3.475	1.382
59	55	Median: The middle score of an arranged set of scores from highest to lowest	N	2.480	0.854	2.661	1.323	3.288	1.462
60	65	Cube: A right prism whose faces are congruent squares	G	2.520	0.900	3.644	1.204	1.576	1.092
61	18	Perimeter: The sum of the measures of the sides of a surface	G	2.520	1.136	2.949	1.358	3.102	1.446

Rank	Item No.	Definition	Type	Definition m		Definien m		Definiendum m	
				Mean	SD	Mean	SD	Mean	SD
62	30	Legs: The two perpendicular sides of a right triangle	G	2.560	1.023	2.983	1.420	1.814	1.408
63	42	Digits: Ten different symbols are used to unite numerals in the decimal system	N	2.560	1.098	2.305	1.211	2.153	1.448
64	83	Closure: The sum and product of any two whole numbers are whole numbers	N	2.625	1.148	2.068	1.219	2.831	1.317
65	80	Semicircle: An arc of a circle bounded by the endpoint of a diameter	G	2.625	1.184	2.983	1.295	2.169	1.278
66	91	Polygon: A closed plane figure with sides that are line segments	G	2.667	0.943	3.288	1.403	2.746	1.491
67	35	Subset: If all elements are contained in a bigger set	G	2.720	0.826	3.000	1.315	2.678	1.308
68	12	Hypotenuse*: The side opposite the right angle in a triangle	G	2.720	0.960	2.542	1.253	4.373	1.056
69	61	Point: A mathematical idea associated with a location in space	G	2.720	1.217	3.153	1.299	1.322	0.853
70	29	Congruence: Two geometric figures that have the same size and shape	G	2.720	1.217	2.559	1.344	4.339	0.932
71	71	Cardinality*: The number of elements contained in a given set	N	2.880	1.070	2.746	1.335	3.932	1.376
72	56	Cardinality*: The number property of the set	N	2.880	1.275	2.695	1.093	3.960	1.340
73	79	Abcissa: The distance measured horizontally to a point	G	2.917	0.909	2.356	1.232	4.339	1.035
74	93	Histogram*: A bar-graph used to picture a frequency distribution	G	2.917	1.256	2.797	1.338	4.169	1.044
75	3	Mean: The sum of the set number divided by the number of addends	N	2.920	0.935	2.678	1.268	1.814	1.295

Rank	Item No.	Definition	Type	Definition m		Definiendum m	
				Mean	SD	Mean	SD
76	31	Array: An orderly arrangement of elements by rows and columns	G	2.920	1.230	2.831	1.264
77	97	Measurement: A composition process where numbers are assigned to concrete objects	G	2.955	1.186	3.576	1.305
78	90	Exponent: A symbol that indicates the times a number is used as a factor	N	2.958	0.789	3.017	1.384
79	17	Sphere: A set of points in space that each point is equidistant from a given point	G	2.960	0.916	3.288	1.249
80	57	Angle: The set of all points in the union of two rays having a common endpoint	G	3.000	1.058	3.390	1.329
81	53	Circle: A closed plane figure all of whose points are equidistant from a given point	G	3.000	1.470	3.898	1.203
82	33	Uniqueness: There is only one sum that is correct as a sum of any two numbers	N	3.040	0.999	2.220	1.136
83	51	Numbers: Mathematical abstractions associated with sets and are used in describing them	N	3.040	1.399	3.814	0.947
84	94	Pi: The length ratio of the circumference to the diameter of a circle	G	3.083	1.288	3.254	1.243
85	13	Cylinder: A solid figure formed by the edge of a rectangle rotated around the parallel edge	G	3.120	1.366	3.627	1.287
86	88	Trapezoid: A quadrilateral having a single pair of opposite sides parallel but not congruent	G	3.250	0.878	3.898	1.245
87	52	Ordinality: The position of an element within an ordered set	N	3.280	0.826	3.085	1.253

Rank	Item No.	Definition	Type	Definition m		Definien m		Definiendum m	
				Mean	SD	Mean	SD	Mean	SD
88	22	Algorithm: A computational method used in finding the results of an operation upon numbers	N	3.360	1.196	3.153	1.351	4.559	0.671
89	59	Transversal: The line that intersects other two lines, all of them lying in a plane	G	3.440	0.753	3.186	1.321	3.915	1.183
90	81	Vertex*: The common endpoint of two intersecting rays, thus forming an angle	G	3.458	0.865	2.915	1.344	4.186	1.000
91	46	Vertex*: The common endpoint of two line segments which are part of a geometric figure	G	3.520	0.943	3.203	1.412	4.153	1.086
92	72	Endpoints: Two points which are at the extremities of a line segment	G	3.560	1.235	3.525	1.254	3.102	1.311
93	20	Histogram*: The presentation of information in a grouped frequency in a vertical bar-graph	G	3.720	1.114	3.169	1.237	4.305	0.961
94	69	Prism: A closed plane figure composed of polygonal faces and their interiors. Two faces are congruent and parallel, the remaining faces are parallelograms	G	3.769	1.049	3.966	1.0301	2.576	1.393
95	8	Tetrahedron: A pyramid where base and lateral faces are all congruent equilateral triangles	G	3.800	1.233	3.407	1.416	4.661	0.773
96	27	Cone: A solid described by the hypotenuse of a right triangle rotated about either of its axis	G	3.920	1.262	3.983	1.097	1.678	1.199
97	43	Integers: A subset of the rational numbers and is composed of the whole numbers and their additive inverse	N	4.160	1.007	3.898	1.145	4.237	1.047

*Means that the definiendum has been scaled twice

G - Means geometrical definition
N - Means numerical definition

The Meaningfulness Values of Response Words

Rank	Item No.	Word	Meaningfulness	
			Mean	SD
1	17	One	1.066	0.308
2	7	Of	1.091	0.340
3	53	To	1.114	0.427
4	82	Or	1.117	0.391
5	4	Two	1.132	0.497
6	124	All	1.136	0.468
7	15	As	1.149	0.475
8	27	In	1.149	0.525
9	11	Are	1.157	0.481
10	69	On	1.163	0.516
11	93	Plane	1.168	0.455
12	1	Place	1.174	0.439
13	8	Set	1.190	0.565
14	29	Holds	1.198	0.492
15	14	Face	1.198	0.508
16	129	But	1.203	0.546
17	134	Line	1.205	0.481
18	67	Is	1.205	0.586
19	2	Earth	1.207	0.480
20	36	Not	1.207	0.544
21	33	Same	1.208	0.498
22	30	And	1.208	0.515
23	89	Sum	1.210	0.548
24	54	Side	1.211	0.545
25	131	Line	1.212	0.502
26	96	Many	1.218	0.488
27	10	Used	1.225	0.539
28	42	Used	1.230	0.598
29	128	Have	1.231	0.513
30	38	Zero	1.231	0.613
31	87	Single	1.235	0.546
32	141	Base	1.239	0.557
33	3	Number	1.240	0.515
34	9	Point	1.240	0.515
35	20	South	1.242	0.516

Rank	Item No.	Word	Meaningfulness	
			Mean	SD
36	73	From	1.244	0.483
37	60	Right	1.246	0.618
38	13	Empty	1.248	0.534
39	110	Only	1.252	0.557
40	127	Called	1.256	0.557
41	32	Times	1.264	0.600
42	37	Closed	1.264	0.613
43	76	That	1.268	0.639
44	98	Having	1.271	0.592
45	115	Pair	1.272	0.663
46	50	Given	1.276	0.499
47	86	There	1.283	0.608
48	126	Addition	1.291	0.600
49	92	Every	1.294	0.570
50	70	North	1.301	0.583
51	78	Center	1.303	0.585
52	130	Rate	1.304	0.695
53	28	Arithmetic	1.308	0.656
54	43	Picture	1.314	0.617
55	112	Finding	1.325	0.600
56	44	Poles	1.328	0.607
57	19	Circle	1.331	0.635
58	136	Upon	1.336	0.586
59	137	Which	1.336	0.730
60	46	Upon	1.341	0.609
61	74	Hundred	1.344	0.584
62	10	How Many	1.355	0.628
63	12	Another	1.355	0.641
64	49	Between	1.358	0.652
65	5	Sentence	1.364	0.617
66	120	Square	1.372	0.627
67	117	Subtraction	1.400	0.755
68	108	Correct	1.409	0.709
69	84	Whose	1.427	0.683
70	71	Figure	1.430	0.702

Rank	Item No.	Word	Meaningfulness	
			Mean	SD
71	31	Half-Way	1.438	0.726
72	55	Division	1.459	0.679
73	77	Enclosed	1.459	0.691
74	56	Opposite	1.459	0.726
75	132	Thus	1.466	0.724
76	102	Distance	1.470	0.735
77	107	Cube	1.470	0.816
78	94	Symbol	1.483	0.741
79	61	Fraction	1.521	0.772
80	18	Region	1.544	0.796
81	97	Discount	1.551	0.788
82	51	Measured	1.553	0.798
83	6	Method	1.562	0.737
84	140	System	1.590	0.859
85	80	Results	1.592	0.769
86	19	Degree	1.595	0.788
87	26	Opposite	1.597	0.892
88	23	Numerals	1.600	0.768
89	116	Placeholder	1.605	0.885
90	121	Empty Set	1.653	0.867
91	47	Triangle	1.659	0.909
92	68	Contained	1.664	0.902
93	62	Opposite Sides	1.678	0.815
94	21	Single Pair	1.702	0.820
95	34	Operation	1.727	0.945
96	52	Equator	1.730	0.887
97	101	Property	1.735	0.955
98	66	Factor	1.754	0.908
99	91	Process	1.754	0.911
100	113	Number Sentence	1.776	0.948
101	88	Imaginary	1.840	1.012
102	22	Digits	1.983	1.052
103	39	Indicates	2.008	1.029
104	57	Numerator	2.025	1.075
105	138	Constructed	2.103	1.086

Rank	Item No.	Word	Meaningfulness	
			Mean	SD
106	123	Parallel	2.101	1.103
107	100	Bar-Graph	2.178	1.246
108	111	Pyramid	2.226	1.339
109	125	Inverse	2.231	1.128
110	16	Intersecting	2.281	1.108
111	114	Denominator	2.304	1.428
112	122	Horizontally	2.331	1.215
113	103	Prism	2.359	1.237
114	59	Number Property	2.382	1.137
115	109	Addends	2.395	1.226
116	81	Frequency	2.400	1.150
117	99	Reduction	2.407	1.068
118	139	Enumeration	2.419	1.228
119	105	Percentage	2.444	1.380
120	106	Ellipse	2.586	1.390
121	58	Precedes	2.595	1.161
122	72	Exponent	2.650	1.276
123	64	Distribution	2.780	1.328
124	133	Geometric	2.932	1.287
125	136	Vertex	3.009	1.221
126	83	Concentric	2.119	1.158
127	35	Predecessor	3.174	1.251
128	24	Polygon	3.175	1.321
129	85	Congruent	3.303	1.199
130	65	Histogram	3.426	1.234
131	104	Elongated	3.504	1.350
132	90	Abscissa	3.521	1.389
133	41	Cardinality	3.525	1.088
134	48	Modulo	3.557	1.230
135	79	Trapezoid	3.648	1.207
136	25	Computational	3.756	1.277
137	95	Hypotenuse	3.798	1.227
138	45	Algorism	3.811	1.043
139	75	Uniqueness	3.820	1.174
140	119	Equidistant	3.826	1.225
141	63	Quadrilateral	3.837	1.321

APPENDIX E

Methodological Information Concerning the Reliability of the Definition and Vocabulary Meaningfulness Scales

Information	Definition	Vocabulary
Reliability of AD	.9795	
Reliability of ND	.9950	
Reliability of GD	.9670	
Reliability of Vocabulary		.9865
Reliability Method	Split Half	Test Retest
No. of Students	25	61
Mdn. Age in Months	144	150
Grade	6	7
School	B	C
Dates of Administrating the Scale	5/3/65	10/6/65
	--	10/13/65

AD - Arithmetical definitions

ND - Numerical definitions

GD - Geometrical definitions

APPENDIX F

The Relationship Between the Variables of Definition Components

It is known that conclusion about the direction of the correlation must be based on the direction of the scale. For example, all the m values reported in this study are presented in a descending rather than ascending order. The high items get smaller numeral values than the low m items which get higher numeral values. Such descending order of the m value has its effect on explanation of the correlation coefficient. Suppose that the correlation between m of the response and the number of words of the response is $+0.6$. Although the correlation sign is $+ve$, yet because of reversing one of the scales, its interpretation is; as the meaningfulness (m) of the response decreased, the sentence length increased.

1: Description of the Frequency Distribution of m Values

The m values of the stimuli, responses, and definitions have been reported in Appendix D. Table 18 shows the frequency distributions of the previous m values in case of numerical, geometrical and arithmetical items.

Figure 4 represents the frequency distributions of Table 18. Parts (a) and (c), Figure 4, shows that the distribution of definitions and responses of the numerical items are shifted toward the higher level of m , while the corresponding curves of geometrical items are shifted towards the lower level of m . The distributions of the stimuli m , as shown in part (b) of the figure, are bimodal in the case of numerical and geometrical items.

TABLE 18: The Frequency Distribution of Meaningfulness of Definitional Components

m	Definition			Stimulus			Response		
	A	N	G	A	N	G	A	N	G
1.0 - 1.499	12	7	5	23	15	8	6	5	1
1.5 - 1.999	27	18	9	19	7	12	12	9	3
2.0 - 2.499	20	12	8	11	6	5	27	19	8
2.5 - 2.999	20	6	14	12	6	6	24	9	15
3.0 - 3.499	11	4	7	7	3	4	18	4	14
3.5 - 3.999	6	0	6	6	4	2	10	2	8
4.0 - 4.499	1	1	0	15	5	10	0	0	0
4.5 - 4.999	0	0	0	4	2	2	0	0	0
Total	97	48	49	97	48	49	97	48	49

A = Arithmetical items

N = Numerical items

G = Geometrical items

Since arithmetical items are the combination of numerical and geometrical items, the frequency of arithmetical items appears in Fig. 4, parts (a), (b) and (c) as the sum of the frequencies of the other two types of items. Moreover, it is clear from these parts that the distribution of arithmetical items has the general shape of both the numerical and geometrical items.

The distribution of m for definitions, stimuli and responses that correspond to arithmetic items are plotted in part (d) of Fig. 4.

Frequency

(a)

Definition

Numerical
Geometrical
Arithmetical

(b)

Stimulus

Numerical
Geometrical
Arithmetical

(c)

Response

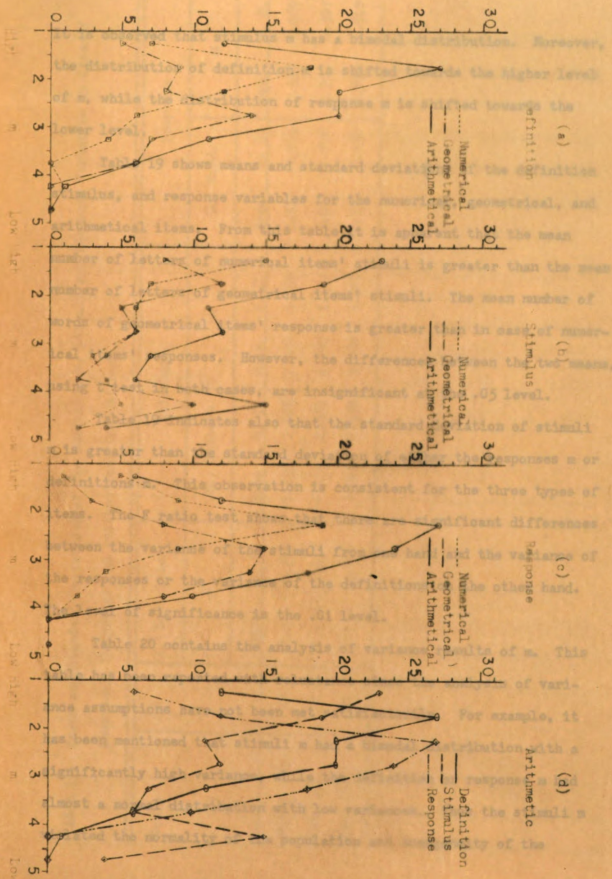
Numerical
Geometrical
Arithmetical

(d)

Arithmetic

Definition
Stimulus
Response

Figure 4: The frequency distribution of arithmetical values of definitional elements



It is observed that stimulus m has a bimodal distribution. Moreover, the distribution of definition m is shifted towards the higher level of m, while the distribution of response m is shifted towards the lower level.

Table 19 shows means and standard deviations of the definition stimulus, and response variables for the numerical, geometrical, and arithmetical items. From this table it is apparent that the mean number of letters of numerical items' stimuli is greater than the mean number of letters of geometrical items' stimuli. The mean number of words of geometrical items' response is greater than in case of numerical items' responses. However, the differences between the two means, using t test in both cases, are insignificant at the .05 level.

Table 19 indicates also that the standard deviation of stimuli m is greater than the standard deviation of either the responses m or definitions m. This observation is consistent for the three types of items. The F ratio test shows that there are significant differences between the variance of the stimuli from one hand and the variance of the responses or the variance of the definitions on the other hand. The level of significance is the .01 level.

Table 20 contains the analysis of variance results of m. This table has been reported with reluctance since the analysis of variance assumptions have not been met satisfactorily. For example, it has been mentioned that stimuli m had a bimodal distribution with a significantly high variance, while the definition or response m had almost a normal distribution with low variances. Thus the stimuli m violated the normality of the population and homogeneity of the

TABLE 19: Means and Standard Deviations of the Definitions, Stimuli and Response Variables in Case of Numerical, Graphical and Arithmetical Definitions

Scale	N	Definition		Stimulus				Response			
		m		No. Letters		m		No. Words		m	
		Mean	S. D.	Mean	S. D.	Mean	S. D.	Mean	S. D.	Mean	S. D.
Airth. Def.	97	2.236	0.748	7.557	2.606	2.554	1.199	8.876	3.844	2.599	0.669
Num. Def.	48	2.010	0.650	7.875	2.663	2.409	1.181	8.021	3.778	2.302	0.597
Geo. Def.	49	2.459	0.778	7.245	2.538	2.696	1.212	9.714	3.758	2.889	0.610

variances' assumptions. However, some studies (Lindquist, 1956) mentioned that heterogeneity in form or variance or both must be quite extreme to be of any serious consequence. Otherwise the effect upon the F distribution will probably be negligible. The results on Table 20 are then reported on the basis that stimuli m distribution is not extremely deviant.

TABLE 20: Analysis of Variance of Meaningfulness Values

Source of Variation	S.S.	d.f.	M.S.	F
Definition Types	14.1687	1	14.1687	18.400
Definition Components	7.5693	2	3.7846	4.915
Interaction	1.1792	2	.5896	.765
Between	22.9172	5		
Within	219.4455	285	.7700	
Total	242.3627	290		

In addition, the results reported in Table 20 are limited to the numerical and geometrical items. Statistics on the arithmetical items have been excluded, because of their dependence on the other two types of items, in order to meet the analysis of variance assumption of independence.

Inspection of Table 20 reveals that types of items as well as definition components, using F test, are significant sources of variance at the .01 level. The interaction of the two factors contributed no significant variance at the .05 level; moreover, the results showed

that the mean m of the numerical items is significantly higher than the mean m of geometrical items at the .01 level. The same test also indicated that the mean m of definitions is significantly higher than the mean m of the responses at the .01 level, and the mean m of the stimuli at the .05 level. However, the mean m of the stimuli is not significantly different from the mean m of responses at the .05 level.

The results suggest the acceptance of the following hypotheses:

1. The variance of the stimuli m are significantly greater than the variances of either definitions or responses m .
2. The m of geometrical items has greater variance than geometric items.
3. In case of arithmetical as well as numerical items; there is a significant difference between the mean of definitions m on one side and the mean of either response m or stimuli m on the other side.
4. In case of geometrical items, there is a significant difference between the means of definitions ' m ' and responses ' m '.

2: The Relationship Between Word Length and Its Meaningfulness

Table 21 presents the correlation coefficients between meaningfulness and the length of either the stimuli or the vocabulary. It might be noticed that the correlation coefficient is not significant from zero in case of the arithmetical as well as numerical items for α equals .05. However, in case of geometrical items the correlation coefficient is significantly different from zero when α equals .01.

TABLE 21: The Correlation Coefficients Between Stimuli and Vocabulary.
Number of Letters and Their Meaningfulness.

Types of Items	N	r
Arithmetical Items	97	.192
Numerical Items	48	-.046
Geometrical Items	49	.467**
Vocabulary	141	.656**

**Significant at the .01 level

The table also shows that the correlation of vocabulary length and m is not zero at the .01 level. The significant correlations which are found in case of the vocabulary and the geometrical items suggest that the shorter words were highly meaningful than the longer ones.

It has been mentioned that each item is reported with two values, i.e., m and its standard deviation. When the number of letters is correlated with the standard deviation of m , in case of arithmetical, numerical, and geometrical items, the coefficients are as follows: -.138, -.180 and -.032. While the previous correlations are not far from zero at the .05 level, it was found that the corresponding value in case of the vocabulary (+.733) is not zero, for α equals .01. The latter correlation suggests that the vocabulary which was widely dispersed with respect to m was longer. However, the inconsistency of this notion in case of the other kinds of items might be due to differences in the sampling process.

The results of this part of the analysis made the following hypothesis acceptable:

1. There is a significant correlation between stimuli m of geometric items and the length of the item.
2. The correlations of the number of letters with either vocabulary m, or vocabulary standard deviation are significant.

3: The Relationship Between Response Length and Its Meaningfulness

TABLE 22: The Correlation Coefficients Between the Response Number of Words and Response Meaningfulness

Types of Items	N	r
Arithmetical Items	97	.538**
Numerical Items	48	.409**
Geometrical Items	49	.595**

**Significant at the .01 level

An investigation of Table 22 reveals that the correlation coefficient between the response number of words and response m is far from being a zero at the .01 level. These high positive correlations showed that the shorter the response the higher was the response m.

The correlation is smaller in the case of numerical items than in that of geometrical items. This observation suggested testing the hypothesis that the numerical items' correlation is equal to or less than the geometrical items' correlation with α equal to .05. The

results of z test showed that this hypothesis, although it is accepted at the .1 level, is not acceptable at the .05 level.

The correlation between the standard deviation of responses and the number of words of the response was computed for the three types of items. The coefficients .189, .182, and .085 were found for arithmetical, numerical and geometrical items respectively. These coefficients are not significant at the .05 level.

The results of this section suggest the acceptance of the hypothesis which states that there is a significant correlation between the number of words in the response and response m in case of the arithmetical, numerical and geometrical items. In addition, the hypothesis which states that there is significant correlation between response standard deviation and response m is rejected.

4: The Relationship Between Stimulus Variables and Response Variables

Investigation of Table 23 reveals that each of the reported correlation coefficients is nearly equal to zero at the .05 level. Thus the hypothesis which states that there is significant relationship between stimulus variables and response variables is rejected.

TABLE 23: The Correlation Coefficients Between Stimulus Variables and Response Variables

		Stimulus Variables			
		m	S. D.	No. of Letters	Type of Items
Response Variables	m	.103	.045	-.129	Arithmetical Items
		.090	-.007	-.107	Numerical Items
		.023	-.076	-.061	Geometrical Items
	S. D.	.047	.116	-.052	Arithmetical Items
		.070	.088	-.071	Numerical Items
		.180	.046	.070	Geometrical Items
	No. of Words	.142	.034	.017	Arithmetical Items
		.149	.051	.032	Numerical Items
		.090	-.086	.060	Geometrical Items

5: The Relationship Between Definition Variables and Stimulus Variables

Table 24 shows that there are significant correlations between m of the definition and m of the stimuli at the .01 level. It shows also that m of the definition correlates significantly with the stimuli's standard deviation for arithmetical and numerical items at the .05 level, while it is insignificant with geometrical items. Meaningfulness of the definitions does not correlate with the stimuli's number of letters at the .05 level.

TABLE 24: The Correlation Coefficients Between Definition Variables
and Stimulus Variables

		Stimulus Variables			
		m	S. D.	No. of Letters	Type of Items
Definition Variables	m	.524**	.206*	.033	Arithmetical Items
		.527**	.304*	-.061	Numerical Items
		.509**	.009	.189	Geometrical Items
	S. D.	.328**	.097	-.042	Arithmetical Items
		.376**	.209	-.218	Numerical Items
		.281*	-.054	.120	Geometrical Items

* Significant correlation at the .05 level

**Significant correlation at the .01 level

The standard deviations of the definitions have been found to correlate significantly with m of arithmetical and numerical items' stimuli at the .01 level, and with geometrical items' stimuli at the .05 level. However, the standard deviation of the definition is found to correlate significantly at the .05 level with neither the stimuli standard deviation nor the stimuli number of letters.

The reported correlations indicate that when m of the definitions was high, the m of the stimuli was also high. They also suggest that when m of the definition was high the standard deviation of arithmetical and numerical items' stimuli were low. In addition,

when standard deviation of definitions increased, the m of the stimuli were found to decrease.

The following hypotheses have been accepted in accordance with the preceding results:

1. For the arithmetical, numerical and geometrical items, the m of the definitions correlates significantly with m of the stimuli.
2. For the arithmetical and numerical items, the m of the definitions correlates significantly with the stimuli's standard deviation.
3. For the arithmetical, numerical and geometrical items, the standard deviation of the responses correlates significantly with stimuli m .

6: The Relationship Between Definition Variables and Response Variables

Investigation of Table 25 reveals that definition m has significant correlations with response m and number of words at the .01 level. Definition m shows also significant correlation at (a) .01 level with the standard deviation of arithmetical items and (b) .05 level with the standard deviation of geometrical items. Furthermore, it shows insignificant correlation at the .05 level with the standard deviation of numerical items.

At the .01 level, it is found that definition standard deviation correlates significantly with (a) response m for the three types of items, (b) standard deviation of arithmetical responses, and (c) response number of words of arithmetical and geometrical items. It also correlates with the standard deviation of the geometrical responses at the

.05 level. In case of numerical items, there is no significant correlation between definition standard deviation and either response standard deviation or response number of words.

TABLE 25: The Correlation Coefficients Between Definition Variables and Response Variables

		Response Variables			
		m	S. D.	No. of Words	Type of Item
Definition Variables	m	.730**	.306**	.715**	Arithmetical Items
		.696**	.222	.663**	Numerical Items
		.703**	.346*	.732**	Geometrical Items
	S. D.	.460**	.271**	.390**	Arithmetical Items
		.400**	.246	.270	Numerical Items
		.536**	.340*	.477**	Geometrical Items

* Significant correlation at the .05 level

**Significant correlation at the .01 level

The previous correlations might mean that when definition m was high (a) response m was also high, (b) response standard deviation was small, and (c) response number of words was few. This statement holds for the three types of items except in case of the correlation between definition m and response standard deviation of arithmetical items. Moreover, when definition standard deviation was high (a) the response m was low, (b) response standard deviation was also high and (c) the

response number of words was high. While this observation is valid for the three types of items, it still has an exception, for in the case of numerical items the relationships between definition standard deviation and either response standard deviations or response number of words are not quite significant.

The accepted hypotheses on the basis of information presented are as follows:

1. There is a significant correlation, for the three types of items, between definition m and either response m or response number of words.
2. In case of arithmetical and geometrical items, there is correlation between definition m and response standard deviation or response number of words.
3. In case of arithmetical and geometrical items, there are no correlations between definition standard deviation and response m , response standard deviation and response number of words.
4. In case of numerical definitions, there is significant correlation between definition standard deviation and response m .

7: The Relationship Between Definition Variables

The correlation coefficients between definition m and definition standard deviation for arithmetical, numerical and geometrical items are .519, .450, and .568 respectively. All three correlations are significant at the .01 level. The null hypothesis which says that there is no significant correlation between definition m and definition

standard deviation is not accepted. Rather, it is suggested that the preceding correlations might mean that when the definition *m* was high, the definition standard deviation was low.

8: The Relationship Between Definitions, Stimuli, and Responses When a Part of Their Variables is Partialled Out

Table 26 shows the zero order correlation coefficient of definition *m* with another variable. Following this zero order correlation are a number of higher order correlation coefficients where some variables, other than the correlated ones were partialled out. The higher order correlation coefficients have been compared with their order correlation coefficient. If the comparison revealed a significant difference between the two correlations, this might be the result of ruling out the partialled variables.

Investigation of the previous table shows that partialling any group of variables out of the correlation of definition *m* with the other variables does not contribute significant change of the zero order correlation coefficient at the .05 level. Actually this result suggested seeking the result of ruling the definition *m* out of the stimulus and response variables. Table 27 contains the results of this step, and some unique observations will be shown below.

It has been mentioned that response *m* and response number of words correlate significantly. However, when definition *m* alone, or other variables beside definition *m* were partialled out, all the new correlations dropped to a value which is not far from zero at the .05 level. In addition, there were significant differences between the new correlations and the zero order correlation coefficient. The levels of significance are shown in Table 27.

TABLE 26: Partial Correlation Coefficients Between Definition and
Stimulus or Response Variables

Zero Order Corr. Coef.	Partialled Variables	A	N	G
Definition m and Response m		.730	.696	.703
	Response no. of words	.586	.622	.489
	Stimulus m	.798	.766	.803
	Stimulus m, and stimulus num- ber of letters	.802	.798	.766
	Response no. of words and stimu- lus m	.716	.739	.678
	Stimulus m, response no. of words, stimulus no. of letters	.712	.737	.673
Definition m and No. of Response Words		.715	.663	.731
	Response m	.560	.577	.540
	Stimulus m and response m	.659	.658	.673
	Stimulus m, response m, and no. of letters of stimulus	.657	.657	.675

TABLE 26--Continued

Zero Order Corr. Coef.	Partialled Variables	A	N	G
Definition and Stimulus m		.524	.527	.509
	Response m	.661	.645	.693
	Response m, and response length	.731	.713	.770
	No. of letters of stimulus	.528	.526	.484
	Response m, response no. of words, and no. of letters of stimuli	.724	.713	.742
Definition and No. of Letters of Stimulus		.033	-.061	.189
	Stimulus m	-.081	-.043	-.063
	Stimulus m, response m, and no. of words in response	.015	-.002	-.074

TABLE 27: Correlation Coefficient Between Response and Stimulus Variables While Partialling Definition m

Zero Order Corr. Coeff.	Partialled Corr. Coeff.	Arith.	Num.	Geom.
Response m and response number of words				
	Definition m	.538	.409	.595
	Definition m and stimulus m	.034**	-.097**	.166
	Definition m, stimulus m and stimulus number of letters	-.192**	-.283	-.133**
		-.183**	-.275**	-.128**
Response m and Stimulus m				
	Definition m	.103	.090	.023
	Definition m and response number of words	-.481**	-.453**	-.546**
	Definition m, response number of words and stimulus number of letters	-.508**	-.512**	-.540**
	Definition m and stimulus number of letters	-.483**	-.512**	-.489**
		-.456**	-.456**	-.492
Response m and stimulus number of letters				
	Definition m, and stimulus m	-.129	-.107	-.061
	Definition m, stimulus m and response number of words	-.145	-.110	-.051
		-.132	-.087	-.036

* Significant difference between the reported correlation and its zero order correlation at .05 level

**Significant difference between the reported correlation and its zero order correlation at .01 level

Again, response *m* and stimulus *m* have been found to have an insignificant correlation. Once the definition *m* or other variables beside definition *m* were partialled out, all the new correlations became significant at the .01 level. Moreover, the new correlations differ significantly from their zero order correlations.

In the case of partialling definition *m* out of the zero order correlation coefficient of response *m* and stimulus number of letters, the new correlations are still insignificant. Nor are there any significant differences between the zero order correlations and their higher order ones at the .05 level.

It has been noticed (Table 27) that the correlations after the process of partiallization might or might not be different from the zero order coefficients. The following are the hypotheses which are accepted thus far:

1. The correlation of response *m*, and response number of words, does change significantly when definition *m* or definition *m* plus other variables are partialled out.
2. The correlation of response *m* and stimulus *m* does change significantly when definition *m* or definition *m* with other variables are partialled out.

The preceding results emphasize the role of definition *m* and its relation with response *m* or stimulus *m*. When definition *m* correlates with either stimulus *m* or response *m*, the resultant correlation will not be affected by the process of partiallization of either the response *m* or stimulus *m* respectively. Contrary to this, when definition *m* is partialled out, the zero correlations of either stimulus *m* or response *m*

or both will change considerably. For example, the new higher order correlations while partiallizing definition m might mean: (1) When the response m was high the length of the response was not necessarily high or necessarily low. (2) When responses m were high, the stimuli were also high.

9: Meaningfulness of the Composite Definition and Its Relation to the Other Variables

TABLE 28: Means and Standard Deviation of Composite Definition m , and Definition m of Arithmetical, Numerical and Geometrical Items

Type of Items	Mean m	S. D.	Type of Item
Arithmetical	5.153 2.236	1.432 .748	Composite Definition Definition
Numerical	4.711 2.010	1.370 .650	Composite Definition Definition
Geometrical	5.586 2.459	1.370 .778	Composite Definition Definition

Investigation of Table 28 shows that the means and standard deviations of composite definitions' m are significantly greater than their equivalents of definitions m at the .01 level. The increase of m came from adding two m values together--one for the stimuli m , and the other for the response m . Thus the maximum value of m for the composite definition is ten rather than five (the maximum scaling point) for definition m . Also, because of the nature of the composite definition m , its range, i.e. variation might be nine (which is greater than the range of definition m that equals four).

TABLE 29: The Correlation Coefficients of Each of the Composite Definition m, and Definition m with Stimuli, Responses and Definitions' m

		Arith.	Num.	Geom.	Type of Item
Stimulus	m	.885**\$\$	.901**\$\$	.895**\$\$	Composite Definition Definition
		.524	.527	.509	
	No. of Letters	.101	-.087	.386**	Composite Definition Definition
		.033	-.061	.189	
Response	m	.553**	.513**	.466**\$\$	Composite Definition Definition
		.730	.696	.703	
	No. of Words	.370**\$\$	.306**\$\$	.344*\$\$	Composite Definition Definition
		.715	.663	.732	
Definition	m	.780**	.757**	.764**	Composite Definition

* Significant correlation at the .05 level

**Significant correlation at the .01 level

\$\$Significant difference between this correlation and the one right below it

Table 29 indicates significant correlation between m of the composite definition and m of either the stimuli or responses at the .01 level. While the composite definition correlates with geometrical stimuli number of letters, it also correlates with response number of words for the three types of items at the .05 level. The stimulus m correlates higher with composite definitions than in case of definition m at the .01 level. On the other hand, response m correlates higher

with definition m than in case of composite definition. The difference is significant only in the case of geometrical response at the .05 level.

The composite definition m correlates high with geometrical stimuli number of letters. However, in case of definition m , it correlates higher with response number of words than with the composite definition m at the .01 level.

These results indicate that the composite definition's relation with definition components is somewhat similar to that of the actual definitions. However, there are some differences between them. For example, the correlation of composite definition m with stimulus m is greater than its corresponding correlation with response m at the .01 level of significance. But in case of definition m , the entire preceding statement is reversed except that the difference is not significant at the .05 level.

The results of Table 30 will be speculated on the basis of the previous results. When the composite definition m is correlated with definition m , the process of partiallization did not show a significant change. However, there is a decrease in the value of the correlation when response m is partialled, and an increase when stimulus m is also partialled out. If the composite definition is considered as stimulus m plus response m , then any partiallization of either one of them will leave the other to correlate alone with the other variable. Also, if both stimulus m , and response m are partialled out of a zero order correlation containing a composite definition, the result is zero. Then the increase of the correlation as a result of partialling

TABLE 30: Partialled Correlation Coefficients of the Composite Definition m with Other Variables

Zero Order Corr. Coeff.	Partialled Variables	Arith. Num.	Geo.	
C. D. and Definition m		.780	.757	.764
	Response m	.661	.649	.693
	Stimulus m	.798	.766	.803
	Response m and response no. of words	.732	.713	.770
	Stimulus m and stimulus no. of letters	.798	.766	.802
C. D. and Response m		.553	.513	.466
	Definition m	.038	.029	-.154
	Definition m and response no. of words	-.026	.075	-.085
C. D. and Stimulus m		.885	.901	.895
	Definition m	.894	.904	.912
	Definition m and stimulus no. of letters	.895	.905	.896
C. D. and Response No. of Words		.370	.306	.344
	Definition m and response m	-.429	-.404	-.474
C. D. and Stimulus No. of Letters		.101	-.087	.386
	Definition m and stimulus m	-.145	-.110	-.051

C. D. - Means composite definition m

stimulus m. However the decrease in case of partialling response m, is due to the previous results which state that definition m correlates high with response m rather than with stimulus m.

The partiallization of definition m caused the correlation between the composite definition m and response m to drop significantly to about zero, and the correlation between the composite definition m and stimulus m to increase an insignificant amount. The level of significance is .05. The same relation is valid in case of partialling definition m, response m, or definition m and stimulus m out of the zero order correlation of the composite definition and response number of words, or the correlation of the composite definition and stimulus number of letters respectively.

Hence, it could be said that the composite definition m correlated higher with stimulus m than with response m. But the definition m correlated higher with the response m than with stimulus m. Thus when definition m was partialled out the considerable change brought about the correlation of response m with the composite definition m while less change caused the correlation of stimulus m with the composite definition m.

10: Meaningfulness of the Composite Response and Its Relation to the Other Variables

The m value of the composite response is obtained by adding up the m of the individual words which compose the response. The responses used in this part are thirty sentences. Occasionally a comparison will be held between the m of response and composite response.

The composite response m has a mean of 1.828 and standard deviation of 2.338. The corresponding values for response m are 2.540 for the mean and .710 for the standard deviation. Comparing the means and standard deviations of both types of response, one might notice that there is no significant difference between the means, but the variances are very significantly different. The level of significance is the .05.

Table 31 shows that the composite response m correlates significantly at the .1 level, only with the standard deviation of either stimuli m or response m. The other composite response m correlations are not far from zero for α equal .1.

TABLE 31: The Correlation Coefficients of Definitional Variables With Composite Response m and Response m

Definitional Variables		Composite Response	Response
m	Stimuli	-.186	-.018
	Responses	.075	1.000
	Definitions	-.154	.566***
S. D.	Stimuli	-.322*	.022
	Responses	.337*	.564***
	Definition	-.123	.433**
Length	Stimuli	.026	-.246
	Responses	-.095	.313*

* Significant at the .1 level

** Significant at the .05 level

***Significant at the .01 level

It has been shown in Table 30 that the definition m and the composite definition m correlate significantly at the .01 level. However, the results are different in the case of response m and composite response m . Their correlation is almost zero at the .05 level. The response m seems to correlate highly at the .01 level with definition m , but the composite response m correlation with definition m is not significant from zero. Furthermore, there is a significant difference between the correlations of definition m with composite response m and the response m at the .01 level.

The two significant correlations can be explained as follows:

- (1) When the composite response meaningfulness was high, the standard deviation of the stimuli m was also high.
- (2) The composite response m increased as the standard deviation of response m was decreased.

APPENDIX G

Lists of Definitions Representing Each Type of Definition

H-H List

- Percentage: A given proportion in every hundred
- Division: The process of finding how many times a number is contained in another number
- Face: A side of a pyramid
- Latitude: The distance north or south of the equator measured in degrees

L-H List

- Predecessor: A number that precedes another number
- Uniqueness: There is only one sum that is correct as a sum of any two numbers
- Abscissa: The distance measured horizontally to a point
- Hypotenuse: The side opposite the right angle in a triangle

H-L List

- Discount: The rate of reduction
- Placeholder: A symbol that holds a place for a numeral in a number sentence
- Face: A region of a plane enclosed by a polygon
- Circle: A closed plane figure all of whose points are equidistant from a given point

L-L List

- Cardinality: The number property of the set
- Algorism: A computational method used in finding the result of an operation upon a number
- Ellipse: An elongated circle
- Trapezoid: A quadrilateral having a single pair of opposite sides parallel but not congruent

APPENDIX H

Instructions and the Familiarization Materials

Instructions: I shall show you one sentence which expresses the meaning of each word you have just seen (in the pre-test). You are going to see the word (stimulus) try to guess its meaning in one sentence. Then you will see a sentence which tells the meaning of this word. Read this sentence carefully, because you are going to write it down, exactly as it is, without any change. Again, read the word, guess its meaning in one sentence, then read the sentence carefully since you shall rewrite it again without any change in its words.

(In order to make it easy for you to remember the sentence exactly, I shall explain it by using three other sentences. These sentences are just to help you understand the one sentence which will be shown to you later. Read these sentences carefully and try to understand their common meaning. But remember, you are not going to write any of these sentences again. They will just help you to understand the meaning of the sentence.

Remember again, read the three sentences and try only to understand their common meaning. Second, when you see the word, guess its meaning, then read the one sentence carefully. Third, when you are asked to write down the meaning of the word, try to write exactly the same one sentence which will be shown to you, without making any change in this sentence.)

() - Instructions for the Ss of the familiarization treatments

Verbal Familiarization Material:H-H List

Percentage: Jack improved in his job as a salesman. The president gives him a proportion of his sales products. He takes ten dollars for every hundred dollars.

Division: Jim has eighteen marbles. He wanted to know how many groups of three marbles there are in the eighteen marbles. He divided the marbles into groups of three and counted the number of groups.

Face: A pyramid has many sides. One side is called a base. Other sides have other names.

Latitude: Jim learned that the weather is different in different cities. The weather of the city almost depends on its distance from the equator. The distance of the city North or South of the equator is measured in degrees.

L-H List

Predecessor: We count upward by adding one to each number. We can also count downward. In this case we get the lower number by subtracting one from each number.

Uniqueness: The teacher asked the pupils to get the sum of two numbers. There is only one sum that is a correct result of this problem. Any other sum is wrong.

Abscissa: Bill drew two perpendicular lines at the middle of the page. One line is a horizontal line and the second is a vertical line. Any point has a distance away from the vertical line.

Hypotenuse: Jack drew a right triangle. Two sides form the right angle. The third side is opposite in position to the right angle.

H-L List

Discount: Jack will buy a new suit. The store will make a ten percent reduction in price. He will buy his new suit at a lower price because of the ten percent off.

Placeholder: We use numbers in sentences. In some cases one might not know what the number is. Then it is possible to use a letter that takes the place of the unknown number.

Face: Suppose you have a piece of paper. You draw a closed figure using straight lines. Then there will be a part of the paper surrounded by the lines of the figure.

Circle: Suppose you have a piece of paper. Then you draw a closed figure using a compass. The distance from the point where the sharp end of the compass is placed, to any point on the figure will be equal.

L-L List

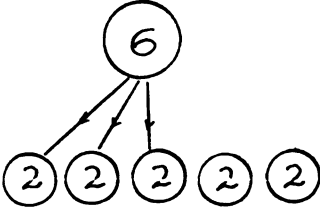
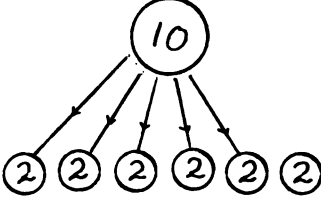
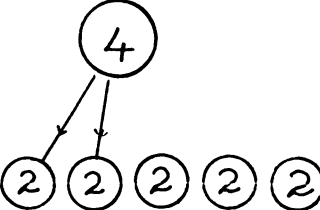
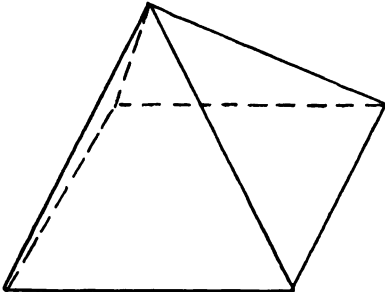
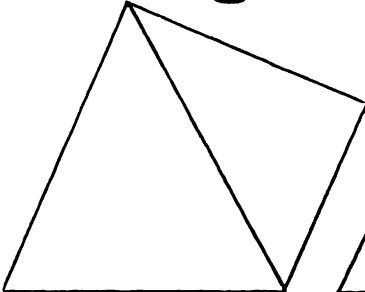
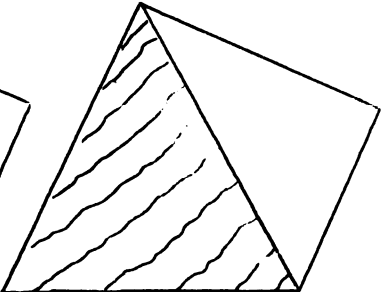
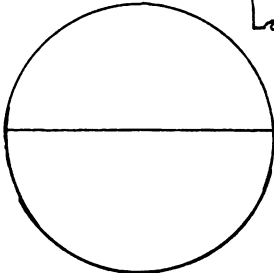
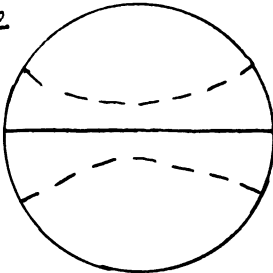
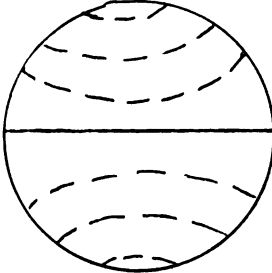
Cardinality: Jim has many pencils of different colors. The pencils which have the same color are called a set. To describe this set is to count the number of pencils in it.

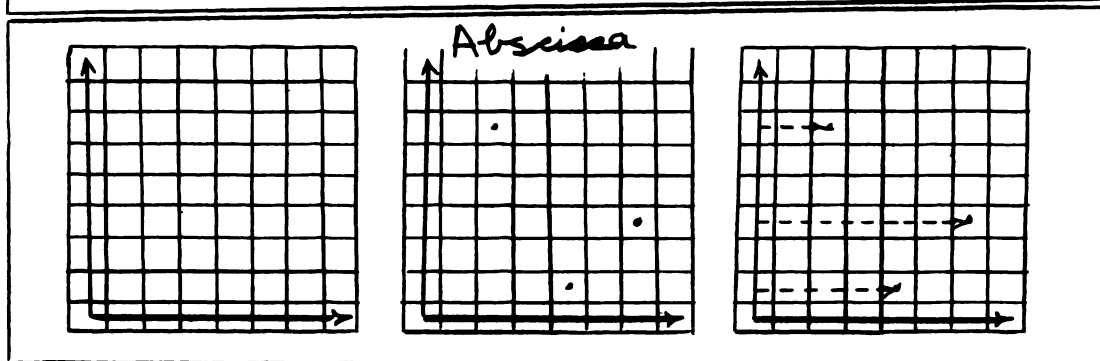
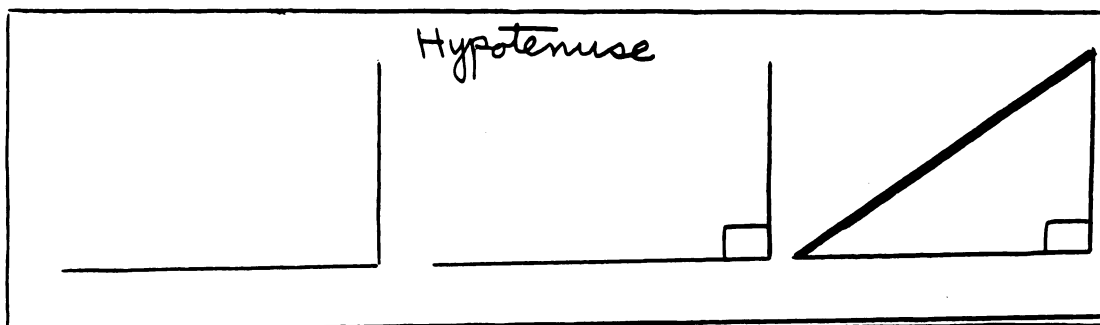
Algorism: Bill is a bright student. The teacher asked him to show his method in solving the division problem. He explained, step by step, how he found the result of the operation.

Ellipse: Jim has a circle of wire. He changed the shape of the circle by stretching it. The new shape is not a circle.

Trapezoid: An area has four sides. Two sides are parallel. These two sides are not equal in length.

Picture Familiarization Material:

Percentage		
$100 \times \frac{1}{2} = 50$ 50 %	$100 \times \frac{1}{4} = 25$ 25 %	$100 \times \frac{1}{10} = 10$ 10 %
Division		
		
Face		
		
Latitude		
		
Predecessor		
$5 \longrightarrow 4$	$17 \longrightarrow 16$	$9 \longrightarrow 8$
Uniqueness		
$5 + 3 = (2, 15, 8, 7)$	$5 + 3 = (2, 15, 8, 7)$	$5 + 3 = 8$

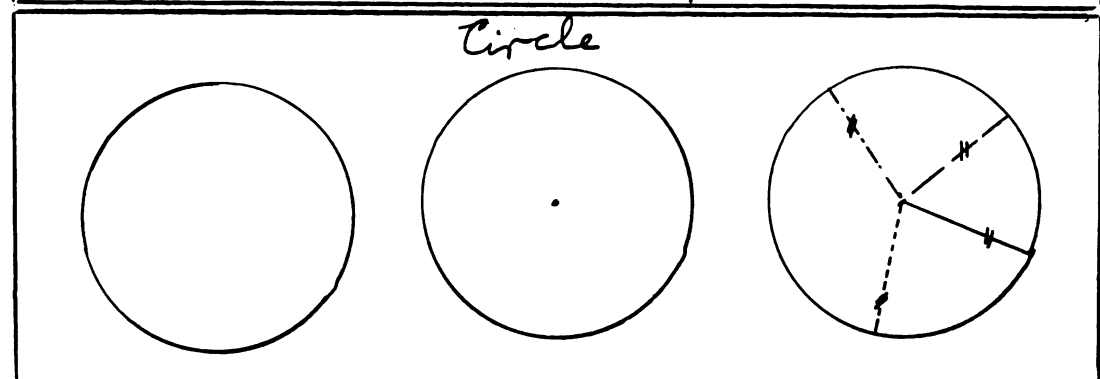


Discount

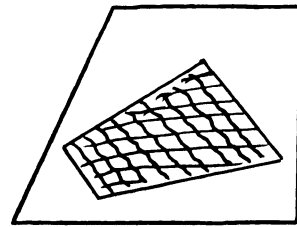
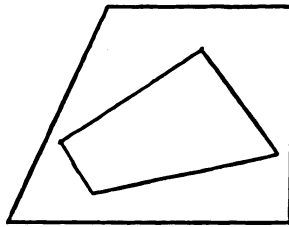
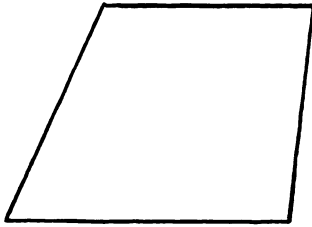
$300 \rightarrow -15$	$100 \rightarrow -5$ $100 \rightarrow -5$ $100 \rightarrow -5$	-5%
-----------------------	--	--------

Placeholder

$5 + 3 = 8$	$5 + \quad = 8$	$5 + X = 8$
-------------	-----------------	-------------



Face



Cardinality

			$(1+1+1+1+1)(1+1)(1+1+1+1)$			$(5) \quad (2) \quad (4)$		
A	B	C	A	B	C	A	B	C

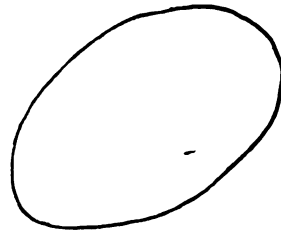
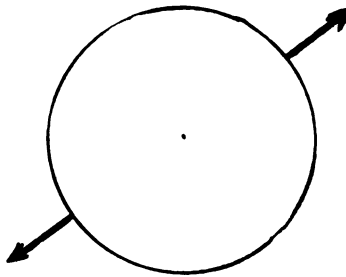
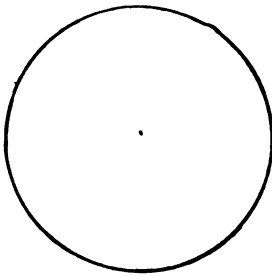
Algorithm

$$\begin{array}{r} 10 \\ 35 \overline{) 595} \\ \underline{350} \\ 245 \end{array}$$

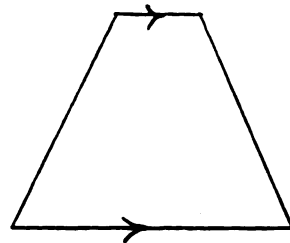
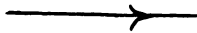
$$\begin{array}{r} 10 \\ 35 \overline{) 595} \\ \underline{350} \\ 245 \\ \underline{245} \\ 000 \end{array}$$

$$\begin{array}{r} 17 \\ 35 \overline{) 595} \\ \underline{245} \\ 350 \\ \underline{350} \\ 0 \end{array}$$

Ellipse



Trapezoid



A P P E N D I C E S

APPENDIX I

The Number of Subjects From Each School Tested in the 12 Treatments

Definition Type	Familiarization	School D		School E		School F		Total
		Male	Female	Male	Female	Male	Female	
H-H	C	8	11	2	8	--	--	29
H-H	V	14	5	5	5	--	--	29
H-H	P	8	10	--	--	7	17	42
L-H	C	10	9	5	10	--	--	34
L-H	V	9	11	--	--	13	8	41
L-H	P	9	8	--	--	14	14	45
H-L	C	11	9	10	5	--	--	35
H-L	V	9	7	--	15	--	--	31
H-L	P	10	8	--	--	6	7	31
L-L	C	6	11	2	15	--	--	34
L-L	V	11	7	--	--	13	13	44
L-L	P	5	14	--	--	12	8	39
C - Control treatment		V - Verbal familiarization				P - Picture familiarization		

APPENDIX J

Percentage of Correct Responses Per Test Trial for the Control Treatment

Definition type	Percentage of Correct Responses Per Test Trial					Total % of Correct Responses	Mean % of Correct Responses
	1	2	3	4	5		
Combined:							
H-H	49.1	75.8	87.8	93.9	94.0	400.6	80.1
L-H	22.8	43.8	64.7	79.4	79.5	290.1	58.0
H-L	20.1	44.3	47.5	56.4	68.5	236.8	47.4
L-L	19.1	34.5	45.2	58.1	56.0	212.9	42.6
Short:							
H-H	51.7	77.5	93.1	96.5	96.6	415.4	83.1
L-H	25.2	60.2	77.9	88.2	88.2	339.7	67.9
H-L	31.4	60.0	71.4	71.4	78.6	312.8	62.6
L-L	38.2	63.2	75.0	76.4	76.5	300.3	65.9
Long:							
H-H	46.2	74.1	82.7	91.3	91.3	385.9	77.2
L-H	10.2	36.7	51.4	70.6	70.6	239.5	47.9
H-L	8.6	28.5	28.6	41.6	58.5	165.6	33.1
L-L	00.0	5.8	16.2	39.4	35.3	96.7	19.3
Numerical:							
H-H	43.1	63.7	81.0	89.1	91.4	368.3	73.7
L-H	23.5	52.9	74.9	75.0	77.9	304.2	60.8
H-L	35.7	68.6	68.6	78.6	82.8	334.3	66.9
L-L	4.4	32.3	38.2	57.4	47.1	179.4	35.9
Geometrical:							
H-H	55.1	87.9	94.8	98.3	96.5	432.6	86.5
L-H	22.0	44.1	54.1	83.8	80.9	284.9	57.0
H-L	4.3	20.0	31.4	34.2	54.3	144.2	28.8
L-L	33.9	36.8	52.9	58.8	64.7	247.0	49.4

APPENDIX K

Percentage of Correct Responses Per Test Trial for the Verbal Familiarization

Definition Type	Percentage of Correct Responses Per Test Trial					Total % of Correct Responses	Mean % of Correct Responses
	1	2	3	4	5		
Combined:							
H-H	34.5	54.3	75.0	82.7	84.5	331.0	66.2
L-H	10.35	56.1	41.5	32.9	29.3	170.2	34.0
H-L	20.4	47.0	59.7	76.0	78.2	281.3	56.2
L-L	13.7	40.8	51.7	51.7	63.6	221.5	44.3
Short:							
H-H	48.1	63.8	84.4	91.3	94.3	381.9	76.4
L-H	13.4	45.1	48.8	54.9	59.6	221.8	44.4
H-L	27.4	59.7	69.4	88.7	88.7	333.9	66.8
L-L	23.9	76.1	85.2	88.6	87.4	361.2	72.2
Long:							
L-L	3.4	5.6	18.2	14.8	39.7	81.7	16.3
H-H	20.6	44.8	65.5	74.1	74.1	279.1	55.8
L-H	7.3	20.7	26.8	51.7	46.1	152.6	30.5
H-L	13.0	32.3	50.0	62.9	67.7	225.9	45.2
Numerical:							
H-H	8.6	34.4	63.8	74.1	79.3	260.2	52.0
L-H	12.2	32.9	36.6	60.2	51.9	193.8	38.8
H-L	38.7	71.0	80.6	91.9	93.5	375.5	75.1
L-L	11.3	36.3	55.7	51.1	67.0	221.4	44.3
Geometrical:							
H-H	60.3	74.1	86.1	91.4	89.4	401.3	81.3
L-H	8.5	32.9	39.0	46.4	54.8	181.6	36.3
H-L	1.6	21.0	38.8	59.7	62.9	184.0	36.8
L-L	15.9	45.4	47.7	52.3	60.2	221.5	44.3

APPENDIX L

Percentage of Correct Responses Per Test Trial for the Picture Familiarization

Definition Type	Percentage of Correct Responses Per Test Trial					Total % of Correct Responses	Mean % of Correct Responses
	1	2	3	4	5		
Combined:							
H-H	58.0	74.98	85.1	91.65	91.1	400.8	80.2
L-H	15.5	34.45	38.3	55.5	71.7	215.5	43.1
H-L	14.6	36.3	45.2	51.6	58.9	206.6	41.3
L-L	17.3	39.1	55.1	68.6	71.15	251.3	51.3
Short:							
H-H	69.0	75.0	84.0	96.0	92.9	416.9	83.4
L-H	26.6	58.9	58.9	71.1	80.0	295.5	59.1
H-L	19.4	51.6	58.2	67.7	74.2	271.1	54.2
L-L	32.05	71.8	78.7	87.2	84.6	354.4	70.9
Long:							
H-H	47.65	74.9	85.6	86.9	89.2	384.3	76.9
L-H	4.9	10.0	17.8	40.0	63.4	136.1	27.2
H-L	9.7	20.9	32.2	35.5	43.6	141.9	28.4
L-L	2.6	6.4	32.05	50.0	57.7	148.8	29.8
Numerical:							
H-H	40.5	61.9	76.1	89.2	88.0	355.7	71.1
L-H	22.2	28.9	38.9	54.4	72.2	216.6	43.3
H-L	22.6	59.7	66.7	69.4	79.0	297.4	59.5
L-L	5.6	32.05	47.4	66.6	69.2	220.9	44.2
Geometrical:							
H-H	76.2	88.0	94.0	94.0	94.0	446.2	89.2
L-H	8.9	40.0	37.8	56.6	71.1	214.4	42.9
H-L	6.5	12.9	24.2	33.9	38.7	116.2	23.2
L-L	29.5	46.1	62.8	70.5	73.05	282.0	56.4

APPENDIX M

Percentage of Exact Responses Per Test Trial for the Control Treatment

Definition Type	Percentage of Exact Responses Per Test Trial					Total % of Exact Responses	Mean % of Exact Responses
	1	2	3	4	5		
Combined:							
H-H	18.7	42.2	60.3	62.9	75.9	260.0	52.0
L-H	8.8	27.9	36.8	58.8	66.9	199.2	39.8
H-L	12.2	29.3	35.7	40.0	52.9	170.1	34.0
L-L	11.0	16.2	18.4	26.5	12.5	84.6	16.9
Short:							
H-H	24.1	50.0	72.4	75.8	82.7	305.0	61.0
L-H	16.1	44.1	52.9	69.1	83.8	266.1	53.2
H-L	22.8	48.6	54.3	57.1	70.0	252.9	50.6
L-L	22.0	32.3	30.9	32.3	17.6	135.1	27.0
Long:							
H-H	12.0	34.5	48.2	50.0	69.0	213.9	42.8
L-H	1.5	11.8	20.5	48.5	132.3	132.3	26.5
H-L	1.5	10.0	17.1	22.8	35.7	87.1	17.4
L-L	00.0	00.0	5.8	20.6	7.3	33.7	6.7
Numerical:							
H-H	8.6	15.5	37.9	43.2	63.8	168.9	33.8
L-H	11.7	39.7	45.5	48.5	61.7	207.3	41.5
H-L	24.3	51.4	58.6	64.3	71.4	270.0	54.0
L-L	1.4	8.8	8.8	17.6	7.3	43.9	8.8
Geometrical:							
H-H	27.5	68.9	82.7	82.7	87.9	350.0	70.0
L-H	5.8	16.1	27.9	69.1	72.1	191.1	38.2
H-L	00.0	7.1	12.8	15.7	34.3	70.0	14.0
L-L	20.6	23.5	27.9	35.3	17.6	124.9	25.0

APPENDIX N

Percentage of Exact Responses Per Test Trial for the Verbal Familiarization

Definition Type	Percentage of Verbal Responses Per Test Trial					Total % of Verbal Responses	Mean % of Verbal Responses
	1	2	3	4	5		
Combined:							
H-H	21.5	36.2	51.5	56.9	62.1	228.1	45.6
L-H	3.6	9.9	12.2	20.7	27.4	73.8	14.7
H-L	11.3	28.2	43.5	59.7	58.8	201.4	40.3
L-L	5.1	32.2	36.4	41.5	48.2	163.5	32.7
Short:							
H-H	36.2	50.0	67.2	72.4	75.8	302.7	60.3
L-H	6.1	13.4	15.8	30.5	32.9	98.8	19.8
H-L	19.3	38.7	58.6	72.6	71.9	259.7	52.0
L-L	10.2	64.5	71.6	80.7	85.2	312.2	62.5
Long:							
H-H	6.8	22.4	35.8	41.3	48.2	154.6	30.9
L-H	1.2	6.1	8.5	11.0	21.9	48.8	9.8
H-L	3.2	17.7	29.0	46.5	46.8	143.3	28.7
L-L	00.0	00.0	1.2	2.3	11.3	14.8	2.0
Numerical:							
H-H	1.7	15.5	34.5	41.3	51.7	144.7	29.0
L-H	4.9	10.0	8.5	20.7	24.4	68.3	13.7
H-L	22.7	53.1	67.7	74.2	74.4	292.0	58.4
L-L	00.0	25.0	35.2	38.6	50.0	148.9	30.0
Geometrical:							
H-H	41.3	56.9	68.5	72.4	72.4	311.6	62.3
L-H	2.4	9.7	15.8	21.2	30.4	79.6	15.9
H-L	00.0	3.7	19.4	45.1	43.5	111.3	22.3
L-L	10.2	39.5	37.0	44.3	46.5	178.1	35.6

APPENDIX O

Percentage of Exact Responses Per Test Trial for the Picture Familiarization

Definition Type	Percentage of Exact Responses Per Test Trial					Total % of Exact Responses	Mean % of Exact Responses
	1	2	3	4	5		
Combined:							
H-H	35.1	55.3	66.7	77.4	79.2	313.7	62.7
L-H	4.4	18.9	23.9	36.1	47.8	131.4	26.2
H-L	8.1	25.8	29.0	34.7	43.5	141.2	28.2
L-L	13.5	27.6	37.2	44.8	48.1	171.2	34.2
Short:							
H-H	50.0	63.1	73.8	85.7	84.5	357.1	71.4
L-H	8.9	34.4	38.9	48.8	58.9	190.1	38.0
H-L	12.5	45.2	43.5	50.0	61.3	228.0	45.6
L-L	26.9	55.1	70.5	71.8	74.3	298.7	60.0
Long:							
H-H	20.2	47.6	59.5	69.0	73.8	270.2	54.0
L-H	00.0	3.3	8.9	23.3	36.6	72.2	14.5
H-L	3.7	6.4	14.5	19.4	25.8	69.4	13.9
L-L	00.0	00.0	3.8	17.8	21.8	43.6	8.7
Numerical:							
H-H	11.9	36.9	51.1	63.1	72.6	235.6	47.1
L-H	8.9	14.4	20.0	35.5	48.9	127.8	25.6
H-L	12.9	41.9	50.0	54.8	62.9	222.6	44.5
L-L	1.3	21.8	29.5	41.0	43.6	147.2	29.4
Geometrical:							
H-H	58.3	73.8	82.1	91.6	85.7	391.7	78.3
L-H	00.0	23.3	27.8	36.6	46.6	134.4	26.9
H-L	3.2	9.7	8.0	14.5	24.2	59.7	11.9
L-L	25.6	33.3	44.8	48.7	52.5	204.8	41.0

APPENDIX P₁

Proportional Distribution of Pre-Test Scores With Definition Variables in Case of Control Treatment

Definition Variable	Level	N	Pre-Test Score Distribution					χ^2	r
			0	1	2	Mean	St. Dev.		
Types of Definitions	H-H	116	.56	.40	.04	.48	.58	127.02	-.254
	L-H	136	1.00	.00	.00	.00	.00		
	H-L	140	.67	.31	.01	.34	.51		
	L-L	136	.99	.01	.00	.01	.12		
Stimulus m	H	260	.62	.35	.03	.40	.54	115.81	-.454
	L	268	.99	.01	.00	.01	.09		
Response m	H	252	.80	.18	.02	.22	.46	1.90	-.047
	L	276	.83	.17	.01	.18	.40		
Subject Matter	Num.	264	.80	.18	.02	.22	.46	1.39	-.035
	Geo.	264	.82	.17	.01	.19	.41		
Length	Short	264	.90	.09	.01	.11	.34	25.18	.210
	Long	264	.73	.25	.02	.29	.50		

APPENDIX P₂

Proportional Distribution of Post-Test Scores With Definition Variables in Case of Control Treatment

Definition Variable	Level	N	Post-Test Score Distribution				
			0	1	2	Mean	St. Dev. χ^2
Types of Definitions	H-H	116	.16	.16	.68	1.53	.75
	L-H	136	.37	.26	.37	1.00	.86
	H-L	140	.26	.36	.37	1.11	.79
	L-L	136	.29	.35	.36	1.07	.81
Stimulus m	H	260	.22	.28	.51	1.29	.80
	L	268	.33	.30	.37	1.03	.84
Response m	H	252	.27	.22	.51	1.24	.85
	L	276	.28	.36	.37	1.09	.80
Subject Matter	Num.	264	.24	.31	.45	1.21	.80
	Geo.	264	.31	.27	.42	1.11	.85
Length	Short	264	.25	.27	.48	1.24	.82
	Long	264	.30	.31	.39	1.08	.83
Pre-Test Score	0	429	.31	.29	.40	1.08	.84
	1	92	.10	.32	.59	1.49	.67
	2	7	.14	.00	.86	1.71	.76
							24.87
							.201

APPENDIX Q₁

Proportional Distribution of Pre-Test Scores With Definition Variables in Case of Verbal Familiarization

Definition Variable	Level	N	Pre-Test Score Distribution					r
			0	1	2	Mean	St. Dev.	χ^2
Types of Definitions	H-H	115	.70	.17	.12	.42	.70	149.58
	L-H	164	1.00	.00	.00	.00	.00	
	H-L	124	.56	.35	.08	.52	.64	
	L-L	176	.97	.01	.02	.06	.32	
Stimulus m	H	320	.72	.20	.08	.35	.62	68.32
	L	260	.98	.01	.01	.04	.26	
Response m	H	280	.88	.07	.05	.17	.49	9.55
	L	300	.80	.15	.05	.25	.53	
Subject Matter	Num.	290	.84	.10	.06	.21	.53	1.13
	Geo.	290	.83	.12	.04	.21	.50	
Length	Short	290	.88	.08	.04	.17	.47	6.39
	Long	290	.80	.14	.06	.26	.55	

APPENDIX Q₂

Proportional Distribution of Post-Test Scores With Definition Variables in Case of Verbal Familiarization

Definition Variable	Level	N	Post-Test Score Distribution						
			0	1	2	Mean	St. Dev.	χ^2	r
Types of Definitions	H-H	115	.30	.21	.49	1.19	.87	3.84	.031
	L-H	164	.35	.20	.46	1.11	.89		
	H-L	124	.29	.26	.45	1.16	.85		
	L-L	176	.28	.20	.52	1.23	.87		
Stimulus m	H	320	.32	.22	.46	1.15	.87	1.011	.035
	L	260	.30	.20	.50	1.21	.87		
Response m	H	280	.33	.20	.47	1.14	.88	1.30	.035
	L	300	.29	.22	.49	1.20	.86		
Subject Matter	Num. Geo.	290	.28	.20	.52	1.24	.86	3.92	-.081
		290	.34	.22	.44	1.10	.88		
Length	Short	290	.28	.16	.57	1.29	.87	18.90	-.129
	Long	290	.33	.27	.40	1.06	.85		
Pre-Test Score	0	486	.35	.21	.45	1.10	.89	36.22	.197
	1	66	.09	.33	.58	1.48	.66		
	2	28	.14	.00	.86	1.71	.71		

APPENDIX R₁

Proportional Distribution of Pre-Test Scores With Definition Variables in Case of Picture Familiarization

Definition Variable	Level	N	Pre-Test Score Distribution				
			0	1	2	Mean	St. Dev. χ^2 r
Types of Definitions	H-H	168	.51	.36	.14	.63	.71 165.71 --.273
	L-H	180	1.00	.00	.00	.00	.00
	H-L	124	.68	.28	.03	.35	.54
	L-L	156	.94	.04	.03	.09	.37
Stimulus m	H	292	.58	.33	.09	.51	.66 142.17 --.433
	L	336	.97	.02	.01	.04	.25
Response m	H	348	.76	.17	.07	.30	.59 5.87 --.093
	L	280	.83	.15	.03	.20	.47
Subject Matter	Num.	314	.80	.15	.05	.26	.55 .81 .003
	Geo.	314	.78	.17	.05	.26	.53
Length	Short	314	.85	.11	.04	.19	.49 16.16 .133
	Long	314	.73	.22	.06	.33	.58

APPENDIX R₂

Proportional Distribution of Post-Test Scores With Definition Variables in Case of Picture Familiarisation

Definition Variable	Level	N	Post-Test Score Distribution				
			0	1	2	Mean	St. Dev. χ^2 r
Types of Definitions	H-H	168	.11	.18	.71	1.60	.69 19.49 --.108
	L-H	180	.22	.16	.62	1.40	.83
	H-L	124	.25	.27	.48	1.23	.83
	L-L	156	.21	.19	.60	1.39	.82
Stimulus m	H	292	.17	.22	.61	1.44	.77 3.43 --.029
	L	336	.22	.17	.61	1.40	.82
Response m	H	348	.17	.17	.66	1.49	.77 8.47 --.108
	L	280	.23	.22	.55	1.32	.82
Subject Matter	Num.	314	.17	.19	.64	1.47	.76 3.72 --.072
	Geo.	314	.23	.19	.59	1.36	.83
Length	Short	314	.18	.18	.64	1.46	.78 2.03 --.056
	Long	314	.21	.20	.59	1.37	.81
Pre-Test Score	0	496	.24	.18	.59	1.35	.84 41.10 .182
	1	101	.05	.32	.63	1.58	.59
	2	31	.03	.00	.97	1.94	.36

APPENDIX S₁

Proportional Distribution of Pre-Test Scores of H-H With Definitional Variables Under Different Familiarization Treatments

Familiarization	Variable	Level	N	Pre-Test Score Distribution					χ^2	r
				0	1	2	Mean	St. Dev.		
Control	Sub. M.	Num.	58	.50	.45	.05	.55	.60	1.74	-.119
		Geo.	58	.62	.34	.03	.41	.56		
	Length	Short	58	.81	.19	.00	.19	.40	30.46	.506
		Long	58	.32	.60	.09	.78	.59		
Verbal	Sub. M.	Num.	58	.72	.12	.16	.43	.75	3.05	-.020
		Geo.	58	.68	.23	.09	.40	.65		
	Length	Short	58	.83	.14	.04	.21	.49	10.02	.294
		Long	58	.59	.21	.21	.62	.81		
Picture	Sub. M.	Num.	84	.51	.35	.14	.63	.72	.122	.000
		Geo.	84	.50	.37	.13	.63	.71		
	Length	Short	84	.70	.23	.07	.37	.62	26.14	.368
		Long	84	.31	.49	.20	.89	.71		

APPENDIX S₂

Proportional Distribution of Post-Test Scores of H-H With Definitional Variables Under Different Familiarization Treatments

Familiarization	Variable	Level	N	Post-Test Score Distribution				
				0	1	2	Mean St. Dev.	χ^2 r
Control	Sub. M.	Num.	98	.14	.22	.64	1.50 .73	3.12 .035
		Geo.	98	.17	.10	.72	1.55 .78	
	Length	Short	98	.26	.12	.62	1.36 .87	9.94 .219
		Long	98	.05	.21	.74	1.69 .57	
Verbal	Pre-Test	0	65	.15	.09	.33		15.10 .269
		1	46	.00	.20	.80		
	Sub. M.	2	5	.20	.00	.80		
		Num.	98	.33	.29	.38	1.05 .85	7.39 .159
Picture	Length	Geo.	98	.28	.12	.60	1.33 .89	
		Short	98	.40	.16	.45	1.05 .93	5.396 .159
	Pre-Test	Long	98	.21	.26	.53	1.33 .80	
		0	81	.29	.18	.23		27.64 .404
Picture	Sub. M.	1	20	.00	.03	.15		
		2	14	.01	.00	.10		
	Length	Num.	84	.11	.27	.62	1.51 .69	10.48 .122
		Geo.	84	.12	.08	.80	1.68 .68	
Picture	Pre-Test	Short	84	.13	.19	.68	1.55 .72	.82 .070
		Long	84	.10	.17	.74	1.64 .65	
	Sub. M.	0	85	.10	.10	.32		16.68 .256
		1	60	.01	.08	.26		
Picture	Length	2	23	.00	.00	.13		
		Num.	84	.11	.27	.62	1.51 .69	10.48 .122

APPENDIX T₁

Proportional Distribution of Pre-Test Scores of L-H With Definition Variables Under Different Familiarization Treatments

Familiarization	Variable	Level	N	Pre-Test Score Distribution				
				0	1	2	Mean	St. Dev. χ^2 r
Control	Sub. M.	Num. Geo.	68	1.00	.00	.00	.00	.000
			68	1.00	.00	.00	.00	.000
	Length	Short Long	68	1.00	.00	.00	.00	.000
			68	1.00	.00	.00	.00	.000
Verbal	Sub. M.	Num. Geo.	82	1.00	.00	.00	.00	.000
			82	1.00	.00	.00	.00	.000
	Length	Short Long	82	1.00	.00	.00	.00	.000
			82	1.00	.00	.00	.00	.000
Picture	Sub. M.	Num. Geo.	90	1.00	.00	.00	.00	.000
			90	1.00	.00	.00	.00	.000
	Length	Short Long	90	1.00	.00	.00	.00	.000
			90	1.00	.00	.00	.00	.000

APPENDIX T2

Proportional Distribution of Post-Test Scores of L-H With Definition Variables Under Different Familiarization Treatments

Familiarization	Variable	Level	N	Post-Test Score Distribution					r
				0	1	2	Mean	St. Dev.	χ^2
Control	Sub. M.	Num.	68	.35	.26	.38	1.03	.86	.160
	Length	Geo.	68	.38	.26	.35	.97	.86	
		Short	68	.28	.37	.35	1.07	.80	8.40
		Long	68	.46	.16	.38	.93	.92	
	Pre-Test	0	136	.37	.26	.37			.00
		1	000	.00	.00	.00			.000
		2	000	.00	.00	.00			
Verbal	Sub. M.	Num.	82	.33	.18	.49	1.16	.90	.62
	Length	Geo.	82	.37	.21	.43	1.06	.89	
		Short	82	.27	.20	.54	1.27	.86	5.22
		Long	82	.43	.20	.38	.95	.90	
	Pre-Test	0	164	.35	.20	.46			.00
		1	000	.00	.00	.00			.000
		2	000	.00	.00	.00			
Picture	Sub. M.	Num.	90	.14	.13	.72	1.58	.73	8.36
	Length	Geo.	90	.30	.18	.52	1.22	.88	
		Short	90	.19	.18	.63	1.44	.79	1.51
		Long	90	.26	.13	.61	1.36	.87	
	Pre-Test	0	180	.22	.16	.62			.00
		1	000	.00	.00	.00			.000
		2	000	.00	.00	.00			

APPENDIX U₁

Proportional Distribution of Pre-Test Scores of H-L Definition Variables Under Different Familiarization

Treatments

Familiarization	Variable	Level	N	Pre-Test Score Distribution					r
				0	1	2	Mean	St. Dev.	χ^2
Control	Sub. M.	Num. Geo.	70	.67	.30	.03	.36	.54	2.09
			70	.67	.33	.00	.33	.47	-.028
	Length	Short Long	70	.79	.19	.03	.24	.49	12.09
			70	.56	.44	.00	.44	.50	.198
Verbal	Sub. M.	Num. Geo.	62	.52	.37	.11	.60	.69	2.21
			62	.61	.34	.05	.44	.59	-.126
	Length	Short Long	62	.68	.23	.10	.42	.67	9.02
			62	.45	.48	.06	.61	.61	.151
Picture	Sub. M.	Num. Geo.	62	.71	.24	.05	.34	.57	1.82
			62	.66	.32	.02	.35	.52	.015
	Length	Short Long	62	.79	.16	.05	.26	.54	9.42
			62	.58	.40	.02	.44	.53	.164

APPENDIX U2

Proportional Distribution of Post-Test Scores of H-L Definition Variables Under Different Familiarization Treatments

Familiarization	Variable	Level	N	Post-Test Score Distribution						
				0	1	2	Mean	St. Dev.	χ^2	r
Control	Sub. M.	Num.	70	.17	.39	.44	1.27	.74	6.67	-.208
	Length	Geo.	70	.36	.34	.30	.94	.81		
		Short	70	.29	.26	.46	1.17	.85	7.42	-.081
		Long	70	.24	.47	.29	1.04	.73		
	Pre-Test	0	94	.21	.22	.24			6.54	.123
	1	44	.06	.14	.11					
		2	2	.00	.00	.01				
	Verbal	Sub. M.	Num.	62	.21	.16	.63	1.42	.82	15.92
Length		Geo.	62	.37	.35	.27	.90	.80		
		Short	62	.37	.13	.50	1.13	.98	11.42	.038
		Long	62	.21	.39	.40	1.19	.76		
	Pre-Test	0	70	.23	.10	.23			22.60	.278
	1	44	.05	.15	.15					
		2	10	.01	.00	.07				
	Picture	Sub. M.	Num.	62	.19	.21	.60	1.40	.80	6.33
Length		Geo.	62	.31	.32	.37	1.06	.83		
		Short	62	.31	.23	.47	1.16	.87	2.41	.088
		Long	62	.19	.31	.50	1.31	.78		
	Pre-Test	0	85	.23	.14	.32			16.47	.199
	1	35	.02	.13	.13					
		2	4	.00	.00	.03				

APPENDIX V₁

Proportional Distribution of Pre-Test Scores of L-L Definition Variables Under Different Familiarization

Treatments

Familiarization	Variable	Level	N	Pre-Test Score Distribution					
				0	1	2	Mean	St. Dev.	χ^2 r
Control	Sub. M.	Num. Geo.	68	1.00	.00	.00	.00	.00	2.03 .122
			68	.97	.03	.00	.03	.17	
	Length	Short Long	68	.99	.01	.00	.01	.12	.00 .000
			68	.99	.01	.00	.01	.12	
Verbal	Sub. M.	Num. Geo.	88	1.00	.00	.00	.00	.00	6.21 .181
			88	.93	.02	.05	.11	.44	
	Length	Short Long	88	.93	.02	.05	.11	.44	6.21 --.181
			88	1.00	.00	.00	.00	.00	
Picture	Sub. M.	Num. Geo.	78	.94	.94	.02	.09	.37	.00 .000
			78	.94	.94	.02	.09	.37	
	Length	Short Long	78	.90	.05	.05	.15	.49	4.91 --.176
			78	.97	.03	.00	.03	.16	

APPENDIX V2

Proportional Distribution of Post-Test Scores of L-L Definition Variables Under Different Familiarization Treatments

Familiarization	Variable	Level	N	Post-Test Score Distribution					r	
				0	1	2	Mean	St. Dev.		χ^2
Control	Sub. M.	Num.	68	.28	.37	.35	1.07	.80	.31	-.009
		Geo.	68	.31	.32	.37	1.06	.83		
	Length	Short	68	.16	.31	.53	1.37	.75	19.43	-.374
		Long	68	.43	.38	.19	.76	.76		
Verbal	Pre-Test	0	134	.29	.35	.35			1.10	-.010
		1	2	.01	.00	.01				
		2	0	.00	.00	.00				
	Sub. M.	Num.	88	.24	.19	.57	1.33	.84	2.20	-.112
Geo.		88	.33	.20	.47	1.14	.89			
Picture	Length	Short	88	.15	.14	.72	1.57	.74	28.44	-.388
		Long	88	.42	.26	.32	.90	.86		
	Pre-Test	0	170	.28	.20	.49			3.19	.077
		1	2	.00	.00	.01				
	2	4	.01	.00	.02					
Picture	Sub. M.	Num.	78	.23	.17	.60	1.37	.84	.58	.024
		Geo.	78	.19	.21	.60	1.41	.80		
	Length	Short	78	.12	.14	.74	1.63	.69	13.66	-.292
		Long	78	.31	.23	.46	1.15	.87		
Picture	Pre-Test	0	146	.21	.17	.55			4.84	.141
		1	6	.00	.01	.03				
		2	4	.00	.00	.03				

APPENDIX W

The Letter Sent to the Schools That Participated in This Study

December 23, 1965

Dear :

The purpose of this letter is to express my appreciation for the fine cooperation that I received from you and your staff while conducting my doctoral dissertation research at your school. Without such cooperation, such a study would not have been possible.

I would like to be in a position to discuss my findings with you and your staff. However, it is necessary for me to return at this time to the United Arab Republic. My major professor, Dr. Clessen Martin, has kindly informed me of his willingness to discuss the study with any interested persons. If there is any interest in this research, Dr. Martin may be contacted at Michigan State University.

May I again thank you, your staff, and the students for their cooperation.

Sincerely,

Salah A. Hotar

jl

- A - Red Cedar Elementary School, East Lansing
- B - Baily Elementary School, East Lansing
- C - Dwight Rich Junior High School, East Lansing
- D - Waverly Junior High School, Lansing
- E - Mason Junior High School, Mason
- F - Holt Junior High School, Holt
- G - Springfield Junior High School, Battle Creek