5-1973

The Effects of Direction of Grouping, Type of Stimuli, and Class Level on Cognitive Equivalence Transformations

Christopher A. Joseph

Utah State University

THE EFFECTS OF DIRECTION OF GROUPING, TYPE OF STIMULI, AND

CLASS LEVEL ON COGNITIVE EQUIVALENCE TRANSFORMATIONS

by

Christopher A. Joseph

A dissertation submitted in partial fulfillment
of the requirements for the degree

of

DOCTOR OF PHILOSOPHY

in

Experimental Psychology

Approved:

UTAH STATE UNIVERSITY
Logan, Utah

1973

ACKNOWLEDGMENTS

The writer would like to extend much thanks and appreciation to Dr. David R. Stone, chairman of the doctorate committee, for his helpful guidance in suggesting a dissertation topic, his interest and cooperation in developing stimuli and procedures, his ongoing suggestions and feedback during the project, and his suggestions for analysis of the results.

The writer also would like to thank the many committee members for evaluating the project and participating in the doctoral committee. Appreciation and thanks are also extended to all those people who helped in making the writer's academic career an enriching and worthwhile experience.

Finally, the writer extends much warm appreciation to his wife for her cooperation, patience, evaluation of dissertation procedures and manuscript, and encouragement during the progression of this project.

Christopher A. Joseph

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

ABSTRACT

The Effects of Direction of Grouping, Type of Stimuli, and Class Level on Cognitive Equivalence Transformations

by

Christopher A. Joseph, Doctor of Philosophy

Utah State University, 1973

Major Professor: Dr. David R. Stone
Department: Psychology

The major purpose of this investigation was to study the structure, attributes, and supplemental aspects of equivalence classifying of words and pictures made by sixth graders, freshmen college students and junior and senior college students. A particular point of interest was whether or not increasing or decreasing the size of the groups results in different types of equivalence classifying. Other minor goals were to determine the effects of direction of grouping, type of stimuli, and class level on unique reasons produced and recall of stimuli.

The results of the study support the thesis that there is a cognitive developmental progression which supports the works of Piaget, Bruner, Vinacke and others. Children, compared to college levels, use a less efficient grouping structure, lower level simple association and concrete and perceptual grouping attributes, lower quality responses, and more specific reasons for grouping. College levels, compared to six grade, use more representational grouping attributes, have higher quality responses, and have a more general level of specificity. In addition, decreasing grouping structure results in a high level of cognitive performance in all aspects of grouping. There were no main effect differences between the words and pictures. However, there were significant interaction effects involving directions, stimuli, and class levels. There were more stimuli recalled and unique reasons produced by the college students. More pictures than words were recalled by all groups.

One implication of the results is that decreasing the size of groupings apparently results in a higher level of cognitive functioning. One reason ventured for this result is that decreasing group size results in more divergent thinking and allows the individual to contemplate more possibilities for his groupings. Increasing group size is related to convergent thinking in which the subject is hindered by a previous set. Another implication is that there is a cognitive developmental progression which results in an increasingly more sophisticated ability to deal with the complex stimuli of the environment. Also, there is some evidence that different grade levels handle pictures differently than they do words.

More study is needed to clarify the role of different forms of stimuli in classifying. From this study it is clear that there are no main effect differences between words and pictures. However, there certainly appear to be some interaction effects, and these need further clarification.

(407 pages)

CHAPTER I

INTRODUCTION

The cognitive domain is an extremely important realm of activity in human beings. As Hebb (1960) stated, it is "high time" that studies using a scientific analysis of the thought process be conducted. The growth of the mind (Bruner, 1965) and developmental trends in perception and thought processes (Berlyne, 1957) are cognitive areas which have received a great deal of scientific analysis under the stimulation of Jean Piaget's (Phillips, 1969) theories. In recent years studies of the course of cognitive growth (Bruner, 1964) have indicated that growth depends on skills transmitted by the culture as well as on internal aspects.

Recently, a number of unpublished studies (Olver, 1961; Rigney, 1962; Carson, 1965; Low, 1970) have found that children perceive, classify, and organize differently as they grow older. The present study, using a complex experimental design, is an attempt to elaborate on and extend some of these findings to unexplored areas. The major purpose of this investigation is to study the structure, attributes, and supplemental aspects of equivalence classifying of words and pictures made by sixth graders, freshman college students, and junior and senior college students. A particular point of interest is whether or not increasing or decreasing the size of the group results in different types of equivalence classifying.

Need for the Study

As Sigel (1953) and Vinacke (1954) indicated, the human organism becomes increasingly more sophisticated in his ability to form concepts and classify things in his environment as he progresses through childhood. It is evident also that the trends "continue into high school and beyond". (Vinacke, 1954, p. 533; Anglin, 1970, p. 99). There is a need to compare the stability and types of equivalence classifications made by mature young adults as opposed to children of elementary school age. This is one objective of this investigation.

Another objective of this study stems from the studies of Olver (1961) who had children sort words into groups in terms of how they were alike and Rigney (1962) who had children sort pictures into equivalence groups in terms of how they were alike. They found that in both cases the results were the same. Older children were more efficient and sophisticated in their classifying, and as children grow older they progress from arbitrary and perceptual classifications to categories employing superordinate concepts. Another purpose of this study, based on the Olver and Rigney studies, is to compare in the same investigation the classifying of groups of pictures as opposed to words.

Stability of groups (Sigel, 1953, p. 140) made by the individual is also related to age level. While Sigel (1953) tested the limits and stability of concept formation in children by having them reduce the size of groupings, Carson (1965) examined the stability of classification groups made by different age levels by "testing the limits" of their conceptual ability. He had the subjects increase the size of the groupings they made. In another study, Low (1970) investigated the effects of increasing and decreasing group sizes. A purpose of this study is to determine the effects of progressively increasing group sizes from two, to four, to six elements and progressively decreasing group sizes from six, to four, to two elements per group.

Other objectives of this study are to determine the number of unique responses produced under the various conditions, to determine the number of elements that can be recalled after completing the groupings, and to determine the differences in evaluation of stimuli and tasks by the various experimental groups: Low (1970) found that younger students produced more unique reasons for their groupings than did older students. An objective of this study is to determine the number of unique reasons given under various conditions. Rigney (1962, p. 134) and Anglin (1970, p. 58) have shown that the average number of words remembered in free recall increases with age. An objective of this study is to determine what effects the independent variables of grade level, type of stimuli, and direction of grouping have on the number of elements that can be recalled after completing the classifications. Osgood, Suci, and Tannenbaum's (1957) evaluative dimension of the semantic differential has been found to be a useful technique for evaluating concepts. Rhine (1958) has indicated that attitudes are developed during concept formation. One objective of this study is to determine differences in evaluation of stimuli and tasks, hence differences in attitudes developed during classification, by the various experimental groups.

In summary, justification for the study is derived from the need for a complex experimental design to test, in the same study, the effects of many independent variables on several dependent variables in order that main effects as well as interaction effects may emerge.

Organization of the Study

The basic presentation of this study follows Haw's (1970) Handbook for Preparing Dissertations, Reports, and Theses. The outline of the sections is as follows:

I. INTRODUCTION: The introduction briefly explains what the study is about, its delimited scope, the need for the study and its objectives.

II. REVIEW OF LITERATURE: The review of literature acquaints the reader with historical and currently relevant research related to the study. Specifically this review deals with the developmental trends in concept formation, the way in which different forms of stimuli are categorized, and the effects of categorizing stimuli in increasing versus decreasing sized groups.

III. THE RESEARCH DESIGN: This section describes the complex experimental design and identifies the independent and dependent variables. Experimental methods, equipment, instruments, and exact procedures are described here. Techniques for scoring and analysis of the data are also discussed.

V. DISCUSSION: An interpretation and discussion of the findings are contained in this section. The relationship of the current findings to the results of previous research is accomplished. Significant and nonsignificant aspects of the study are pointed out and suggestions for future research are made.

VI. SUMMARY AND CONCLUSIONS: A brief recapitulation of the entire study is summarized here, along with the conclusions of the study.

Summary

This study is an extension and elaboration of a series of research projects which have as their purpose the scientific analysis of the thought processes. The research projects conducted by Olver (1961) and Rigney (1962) at the Harvard Center for Cognitive Development were controlled, scientific inquiries into the developmental theory of Jean Piaget (Phillips, 1969). Further investigation was conducted by Carson (1965) and Low (1970) who developed, elaborated, and extended techniques used in the aforementioned projects. The present study is an attempt to elaborate and extend to unexplored areas the methods and findings of the previous research. To aid in this endeavor, a complex experimental design was created to simultaneously test the effects of several independent variables on several dependent variables. The intention is to observe main and interaction effects as a result of combining different stimuli, several age levels, and different sized groupings. This design is fully described in Chapter III.

CHAPTER II

REVIEW OF LITERATURE

Introduction to Cognitive Development

Approaches to the study of cognition have their historical antecedents in the nineteenth century when the study of the mind was engaged in by Wundt, Kulpe, and Titchener using the technique called introspection. (Boring, 1957). The technique of introspection was discarded because it was too subjective. Subjects trained under different schools and with different mental sets reported different contents of the mind. Because introspection was too subjective and mental set resulted in different experiences being reported, a more fruitful approach was needed. One avenue of protest against the Wundtian tradition was behaviorism; another avenue was Gestalt psychology. A most concise way to characterize Gestalt psychology is to say that it deals with wholes. The elements of perception when put together form a perceptual field which is more than just the sum of its parts. (Boring, p. 587). This can be viewed as one way the mind handles many elements so that the many details are not overwhelming. The Gestaltists spoke of perceptual organization while others spoke of conceptual organization which can be viewed as very much the same thing (Johnson, 1955) except that in conceptual organization the organization stems from internal sources. Whatever term is used, one cannot escape the fact that humans order and classify their cognitive world in some way so as to not be overwhelmed by the details. One purpose of the present study is to gather more information about the way people organize and classify their cognitive world.

As indicated by Carson (1965) and Hearnshaw (1954), in the early years of experimentation in the cognitive realm, two general distinctions were made by Vigotsky, and Goldstein and Scheerer, in the way people classify. One way was the primitive level of classification involving concrete aspects only. The other was a sophisticated level of cognitive functioning in which groupings are based on abstract concepts. Grouping on the basis of an abstract concept means applying a rule or "a label to a set of stimuli that vary in a number of ways but have some common aspect which determines the correct classification of the stimuli." (Kling and Riggs, 1971, p. 945). Piaget (Phillips, 1969) from the early part of the century up to the present, has elaborated on the two aforementioned ways humans behave mentally in order to handle the complex environment. He has developed a theory of cognitive development which indicates man progresses through many stages from the very concrete, egocentric functioning of the child through the very abstract propositional logic of the sophisticated adult. This will be elaborated later.

As a result of many early studies, the idea that sensory dominance was the factor responsible for equating stimuli was discarded and autonomous central processes were credited for rendering stimuli equivalent (Hearnshaw, 1954). If central processes, processes of the mind, do render organization through concept formation and classification of stimuli in an equivalent way for more adequate functioning, it would behoove us to determine the manner in which this is done. The present study attempted to explore the effects of presenting different stimuli (words and pictures), different activities of subjects (grouping 2 to 4 to 6 elements), and different age levels (6th grade vs. college students), on equivalence transformations.

Equivalence Transformations

How do organisms deal with the vast complexity of the world and not be overwhelmed? The answer is that discriminably different things (objects, events, persons, etc.) are treated alike, the same, or equivalent. It is a fact that organisms do treat different objects as if they are equivalent. However, how the organism renders objects equivalent can be disputed.

As Olver (1961) indicated, there are two approaches in explaining how organisms form equivalence groupings, the passive and the active view. The passive view in which the organism has a passive role in equivalence formations indicates that groups are formed because of similarities the objects exhibit, and thus they are associated together and form associative clusters. Any developmental differences in the way groupings are made would be a result of forming new associative clusters. This view may be valid for some groupings but certainly not for all groupings.

The second approach, which gives the organism an active role, indicates that the organism imposes organization on the world. The organism transforms the data and equates elements of the environment by the use of rules of organization. Any developmental changes would be a result of the use of different rules of equivalence transformation. These rules can be viewed as reflecting the history of the organism's experiences, intelligence, personality, and in general his mental development. This second view is more reflective of the human organism's wide flexibility in dealing with his world, and it subsumes the associative view in that organisms may use association as one of their equivalence rules. The present study and its theoretical orientation is based in this second view of the organism as an active party in transforming and imposing structure on its environment through the applications of rules which change as the organism matures.

Equivalence as a result of rules of transformation

Olver (1961) discussed in much depth the thesis that people render objects equivalent either in a passive or an active way. (Rommetveit, 1960). There are three different theories concerning how concepts and classifications are formed: (1) The theory of identical elements indicates that the more elements objects share in common, the more alike they are. This is rejected by Olver because it fails to include all cases of concept formation and categorization. (2) The Gestalt theory postulates that cognitive equivalence occurs as a result of "like organization" in terms of being in the same position in time or space. This too does not encompass all the cases of concept formation and equivalence. (3) The mediating response theory indicates that equivalence groupings are accomplished through the association of members of a group by the same mediating response. This theory does not allow for the inclusion of new objects.

Olver (1961) concluded that all of these theories are partially correct and postulated that rules of transformation are followed whereby mediating responses can be extended and vertical organization, as Welch (1940) indicated, would become possible. For example, if two objects were grouped together and labeled, a rule of transformation would allow two or more objects to be added to the original and a new concept formed or the old one maintained. How rules of transformation are applied has been studied by Bruner (Rowland and McGuire, 1971), Piaget (Phillips, 1969), Vigotsky (1962), Olver (1961), Rigney (1962), Carson (1965), and Low (1970). How and whether or not objects will be grouped together depends on the subject, the situation, and the task.

The present study also is an attempt to further explore the factors influencing the types of rules of transformations that are used. As indicated by Olver (1961), most early investigators of the development of equivalence groupings, except Piaget and Vigotsky, have not studied the development of rules of transformation, but rather have studied the development of the child's ability to form and use concepts, the concepts the child has, and the learning of particular concepts. The realm of the present study follows the work of those who have been concerned with the development of rules of transformation. It makes provision, in a complex experimental design, for studying the inclusion of different items in pre-established groupings.

Development of rules of transformation

Piaget's view (Phillips, 1969) of the development of rules of transformation indicates a progression from the sensori-motor stage which utilizes rules of action, to the concrete stage in which representation and reversibility are gradually developed, to the formal operations stage in which rules of an abstract nature are acquired to give the mature human a wide flexibility in manipulating his environment.

Vigotsky's (1962) theory of the development of equivalence groupings postulated that there are three phases a child goes through. First, the very young child heaps objects together on the basis of chance occurrence. Later in development the child links objects together on the basis of bonds which are concrete and factual. In the final phase objects are grouped on the basis of abstraction where elements of the objects are viewed apart from the total objects. Vigotsky calls this the formation of true concepts.

In formulating a sketch of the sequential development of the rules of equivalence Olver (1961) combined the results of the works of Piaget and Vygotsky. Olver suggested that the development of equivalence grouping initially is associative in nature with the perceptual impressions dominating the groupings; then, it becomes egocentric functionalistic in nature where the child groups items according to the common action he can impose on the elements. Next, equivalence groupings are formed by reciprocity or interaction by the child with the items to be grouped, and the inherent properties of the objects are considered. Finally, the child enters the formal operations stage in which he achieves the ability to operate on the interactions and perform transformations and form new combinations with the elements to be grouped.

Mental Development and Word Meaning

Anglin (1970), like Piaget and Vygotsky, was also concerned with developmental trends. He indicated that developmental trends among words reflect mental development. Anglin (1970) in his book The Growth of Word Meaning reported a series of experiments involving sorting and free recall tasks which attempted to describe how the internal lexicon evolves. The book is concerned with twenty words which were used in a series of experiments "designed to tap the growth of the appreciation of the relations that exist among the words as the individual matures from childhood through adolescence to adulthood." (Anglin, 1970 p. 1). An important developmental question Anglin was attempting to study was whether or not a child's thought becomes more abstract as he grows (the generalization hypothesis) or whether it only becomes more subtle (the discrimination hypothesis).

The generalization hypothesis (Locke, 1960) describes lexical growth as a generalization process in which the young child sees similarities among small groups of objects but as he matures is able to appreciate similarities among increasingly broader classes. As Anglin (1970) stated:

> At first he might see that roses and tulips are flowers, that oaks and elms are trees and that collies and poodles are dogs, and that diamonds and rubies are stones. Somewhat later he

> might realize that the objects he had classed as flowers are similar to the objects he had classed as trees in that both are plants. Later still he might form even more general concepts of living things, objects and finally entities which would apply to most nouns. Development in the other parts of speech would proceed in a similar manner." (Anglin, 1970, p. 14).

The discrimination hypothesis (McNeill, 1968) views lexical growth as a process of differentiation and the growth of the ability to make finer and finer discriminations. As Anglin (1970) stated:

> According to this view the child first appreciates the very broad semantic distinction among words, perhaps the semantic correlates of the form classes. Things are distinguished from acts, qualities from relations. Growth is accompanied by a gradual differentiation of classes. For example, things may be divided into those which are living and those which are nonliving; later the class of animate objects might be divided into those which are human and nonhuman. Very fine distinctions are thought to be acquired last. (Anglin, 1970, p. 15).

The results of the diverse tasks which Anglin reported in his book support the generalization hypothesis. There appears to be a concrete-abstract progression. As Anglin (1970) stated:

> Analysis of proximities from the diverse tasks reported in the previous chapters results in a picture of lexical growth that has several features of interest. Very young children tend to be idiosyncratic in their organization of words, and when there is uniformity among these subjects it often appears to be the result of what might be called a thematic principle. Adults, on the other hand, are more homogeneous and more often group words that belong to the same conceptual category.
>
> Between these two age extremes there appears to be a gradual transition from one mode of organization to the other which can be described in detail. Locke (1960) appears to have been right. The subjective lexicon is restructured from the ground up. In the two sorting tasks, in the free recall study, and in the Bruner-Olver experiment young children treat words bound by concrete relations as do adults. However, they do not appear to appreciate, as adults do, the more abstract features that relate words, whether this appreciation is reflected in proximities defined by word piles, free recall

> clusters, or verbalized equivalence relations. There does appear to be a concrete-abstract progression whether such a progression is defined intuitively or empirically. Thus, in spite of the questioning of the notion of a feature, the variability that resulted from using different techniques, and the shift of emphasis in our definition of abstractness, the generalization hypothesis has stood relatively unmarred. (Anglin, 1970, p. 98-99).

Here we have additional evidence that there are developmental changes in the way people deal with the complexities of the environment. Rather than movement in stages, lexical generalization as presented by Anglin appears to be a gradual progress which continues into adulthood and may never be complete. As Anglin indicated the sorting, free recall, and Bruner-Olver experiments indicate that important semantic growth continues at least until the college level, and that even some college subjects do not acknowledge abstract relations.

Another book which represents an approach to the study of structures in the subjective lexicon is by Fillenbaum and Rapoport (1971), Structures in the Subjective Lexicon. Their studies are based on the assumption that the meaning of a lexical item is a function of the meaning relations obtained between that item and other items in the same domain; they sought to determine how people "reckon" in assessing similarity relations among terms in a given domain. These experimenters gathered similarity data using a variety of techniques from a variety of domains in an attempt to study procedures for gathering and analyzing data in order to reveal how domains are structured and organized.

These studies can be viewed as further justification for the present project and its use of sixth graders as opposed to college freshmen, and juniors and seniors. Under the many experimental conditions, more evidence concerning developmental changes can be accumulated.

Concept Formation

If the mind develops through many different stages, concept formation, the way in which organisms render many different stimuli equivalent may also develop through many stages. There are many ways in which concept formation can be studied. A fruitful approach has been to determine different age patterns in concept usage (Vinacke, 1954; Phillips, 1969). This approach is particularly worth-while because as Werner (1937) indicated, concept formation is present at every age.

Definition of the term "concept"

The term "concept" has been defined in different ways by different experimenters. For example, Smoke (1935) defined a concept as a "symbolic response (usually but not necessarily linguistic) which is made to the members of a class of stimulus patterns but not to other stimuli." (Smoke, 1935, p. 277). Cohen (1944) regarded concepts as signs pointing to invariant relations which enable people to order together diverse phenomena. Rhine (1958) stated that a concept is "a mental principle through which an individual can classify a number of objects in his stimulus world." (Rhine, 1958, p. 362). Vinacke indicated "that concepts are cognitive organizing systems which serve to bring pertinent features of past experience to bear upon a present stimulus-object." (Vinacke, 1954, p. 527). All of these definitions involve categorizing stimulus material which, as Bruner (1957) indicated, is a set of specifications for grouping or rendering items equivalent.

Carson (1965) equates cognitive equivalence with categorization of objects into classes. Rather than storing all raw information as solitary elements, categorization is an efficient way to store and then reproduce information.

There is no doubt that cognitive equivalence or classification of stimulus material does occur. However, more information is needed to determine the effects of different stimuli, the effects of different ways of grouping stimuli, and the effects of age level on cognitive equivalence transformations.

Similarities and differences between perception and cognition when forming concepts

There are some similarities and differences between perception and cognition when forming concepts. Harper, et al. (1964) and Bruner (1957) make little distinction between perception and cognition as regards to information processing and categorization; the processes are similar. As Carson (1965) suggested, stimuli may be perceived, categorized, cognized, and given meaning almost simultaneously.

As Bruner (1957) indicated, cognition and perception share many of the same characteristics: decision processes, utilization of cues and inference, categorization and rendering items equivalent, influences of expectancies and needs, predictive verdicality (coding of stimuli in appropriate categories so that correct inferences or prediction of other properties of the object categorized can be made), and more information leads to greater verdicality. Berlyne (1957) on the other hand, indicated that perceptual and cognitive processes are different because perceptions, in contrast to concepts, vary with arrangement or pattern, are more variable, are more centered (figure-ground relationships), and become more prominent the larger they are.

Category formation

Bruner (Rowland and McGuire, 1971, p. 45-63) indicated that man categorizes, and learning and categorization are the most elementary forms of cognition. Two types of categories can be distinguished, identity categories and equivalence categories. Identity categories classify a wide variety of stimuli as forms of the same thing; equivalence categories classify a variety of stimuli as the same kind of thing. There are three types of equivalence categories (although it is recognized that immediate perceptual cues may alter category types): (1) affective or categorization by common affect, (2) functional or categorization of interpolative or extrapolative fulfillment of a specific task requirement, and (3) formal or categorization by specifying intrinsic attribute properties required. Bruner indicated that the basic processes of categorization are the same for both perceptual and conceptual attributes and that categorization reflects the culture.

The role of the person in category formation

Sigel (1953) indicated that there are two ways that classifications are made. One, perceptual classification, occurs when the demands of the situation and the nature of the stimuli do the classifying for the individual. The other, conceptual classification, occurs when the individual labels, organizes, or transforms the data rather than yielding to the perceptual nature of the stimuli. Heidbreder (1948) indicated that the more situational support that is provided the less the organism has to draw on its own abilities to form the category or classification. It appears from the aforementioned discussion that if subjects were presented one word labels as opposed to an elaborated word association descriptions of objects (simple vs. complex words) the subjects would have to draw more on their own resources to establish groupings with the "simple words." They would have more situational support and more salient cues to use to aid in forming categorizations with the elaborate words; thus, there may be more perceptual classifications. As a future supplementary part of the present study a comparison of simple versus complex word groupings will be made. This is discussed further in later chapters.

Hierarchical order in concept attainment

There have been many investigations to determine if concepts develop according to a hierarchy. Experiments by Heidbreder (1946-49) and Komachiya (1957) concluded that concepts were formed hierarchically with things (objects) being developed first, followed by spatial forms (i.e. circles), and finally number concepts. Dattman and

Israel (1951) in a more controlled study than Heidbreder's concluded that there was no order of dominance in attainment of concepts.

Whether or not there is a hierarchy in concept formation is debatable (Kling and Riggs, 1971); in any case much study, as has been done by Piaget, is needed in the area of the growth of the various types and levels of concepts.

Developmental States, Levels or Stages in Concept Formation

There are several authorities who indicate that there is a definite sequence in cognitive development. Piaget (Phillips, 1969) views cognitive development as progressing through many invariant stages. Church (1961), Brown (1958), Rommetveit (1960) and Vinacke (1954) are in agreement with Piaget, that a cognitive progression resulting in abstract reasoning at maturity does occur.

Piaget's views

Piaget (Berlyne, 1957; Carson 1965; Phillips, 1969; Muuss, 1967; Wadsworth, 1971) views cognitive development as progressing through several stages: (1) The first stage is the sensori-motor period (0-2 years). (2) The second stage is the preoperational period (2-7 years). The preoperational period has two substages: (i) The first substage is the period of pre-conceptual thought (2-4 years). (ii) The second substage is the period of intuitive thought (4-7 years). (3) The third major stage is the period of concrete operations (7-11 years). (4) The fourth stage is the period of formal operations (11-15 years).

The period of sensori-motor intelligence extends from approximately birth to two years. Cognitive development in this period begins as egocentric and with no awareness of a distinction between the self and the environment. Near the end of this period the child becomes slightly more objective, begins to distinguish between himself and his environment, and begins to respond and interact with the environment. This socialization with the environment, along with the imagery which grows out of imitative processes, initiates symbolization.

The next stage, the period of preoperational thought, extends from age two to age seven. A substage of this period is the period of pre-conceptual thought which extends from age two to four. The pre-conceptual thought processes are characterized by transductivity of thought as opposed to inductivity of thought evidenced in adults. This means that the child does not go from the particular to the general as adults do, but rather goes from the particular to the particular and assumes that if things are similar in some ways they are similar in all ways.

Perception dominates children's thought processes in the second substage of the preoperational stage, the period of intuitive thought, which extends from approximately age four to age seven. In the period of intuitive thought, if there is a conflict between what the child sees and what is logical, the child will believe his perceptions, whereas adults generally believe what is logical. In this period the child considers each aspect separately, whereas the adult can simultaneously consider many aspects.

From approximately the ages of seven to eleven the period of concrete operations characterizes the thought processes. It is in this period that the beginning of organized cognitive systems (classes, relations, and numbers) emerge. The type of system called classes consists of internalizing the processes used in grouping things together that are viewed as similar. Relations is a system for ordering, arranging, and sequencing items along a common dimension. The system called numbers refers to the process of classifying and ordering objects according to their position in a group of objects that are similar.

The period of formal operations designates maturity in the thought processes. This period of conceptual maturity emerges between approximately the ages of eleven to fifteen. In this period of abstract thought the individual is capable of reversibility in his thinking, able to employ principles of logic, and able to conjecture and hypothesize about the probable and how these may affect the future.

Bruner (1966) in his book Studies in Cognitive Growth discusses his developmental categories which are similar to Piaget's: Bruner's "enactive" representation period is very similar to Piaget's sensorimotor stage; Bruner's "ikonic" period resembles Piaget's concrete stage; and Bruner's "symbolic representation" period resembles Piaget's formal operations stage.

Piaget's terms

As Muuss (1967) indicated, Piaget's theory of development can be viewed as having two dimensions, a stage dependent theory and a stage independent theory. The stage dependent theory consists of the sensori-motor stage, the preoperational stage, the concrete operational stage and the formal thought stage. Piaget has also developed a system of interrelated developmental concepts, the stage independent theory, which he calls schema, structure, operation, assimilation, accommodation, adaptation, equilibrium and equilibration. These concepts are discussed by Piaget in relation to early motor development as well as the logical thought processes of mature development. Piaget divides his stage dependent theory into preoperational and operational thought eras. After age seven the child is presumed to enter the operational stage of development. Operations are seen as interiorized actions which constitute a system of organized and related responses which corresponds to the operations of mathematics and logic. As the child matures, cognitive adaptation to the environment takes place by way of assimilation and accommodation. The child assimilates new objects or experiences encountered in the environment by structuring and restructuring them to fit into the present intellectual organization of the child. Accommodation of new experiences refers to the process in which existing cognitive structure changes in order to incorporate the new object or the new experience. The primary focus of the present study is on operational thought processes. We are concerned with comparisons of the preadolescent child, who is near the end of the concrete stage or at the beginning of the formal stage, and the young adult who is well into the stage of formal operations.

An operation is an action which occurs internally and has reversibility as one of its essential characteristics. Thought processes are operational when they acquire the flexibility such that an action or transformation can be cancelled by an inverse reasoning. The ability to reverse operations, to return to the starting point of an operation, is an important gain in the intellectual growth of the child. The operational child can use many different approaches to the solution of a problem without becoming committed to any one as the only one. As indicated by Piaget's theory, the child in the concrete stage is able to, for example, order objects according to their size or their weight as long as they are presented to him concretely; it is not until he is older in the stage of formal operations that he could perform such an operation mentally on an abstract level.

Another illustration to contrast the contretely operational child with the formal operational adult is that a preadolescent child could arrange a series of pictures of people according to their size in photographs. He could even perform operations in reverse order. But it is not until the formal operations stage that the child could very easily solve a similar but verbal problem. "Henry is taller than Mary; Sandy is shorter than Peter; who is shortest of the three?" This is related to the present study in that the subjects were required to perform operations of assimilation or accommodation (increasing the sizes of grouping) and reversibility (decreasing the size of grouping) using verbal as opposed to pictorial stimuli. If Piaget's theory holds true, differences in the way the materials are handled should be evident between the sixth graders and college students.

A presentation of Piaget's major developmental periods, the characteristics of the periods, and the major changes, have been adequately summarized by Wadsworth (1971, p. 114):

Summary of the Periods of Cognitive Development*

Period	Characteristics of the Period	Major Change of the Period
Sensori-motor (0-2 years)		Development proceeds from reflex activity to representation and sensori-motor solutions to problems
Stage 1 (0-1 months)	Reflex activity only No differentation	
Stage 2 (1-4 months)	Hand-mouth coordination Differentiation via sucking reflex	
Stage 3 (4-8 months)	Hand-eye coordination Repeats unusual events	
Stage 4 (8-12 months)	Coordination of two schemata Object permanence attained	
Stage 5 (12-18 months)	New means through experimentation follows sequential displacements	
Stage 6 (18-24 months)	Internal representation New means through mental combinations	

Preoperational (2-7 years)	Problems solved through representation-language development (2-4 years) Thought and language both egocentric Cannot solve conservation problems	Development proceeds from sensori-motor representation to prelogical thought and solutions to problems
Concrete Operational (7-11 years)	Reversability attained Can solve conservation problems--logical operations developed and applied to concrete problems Cannot solve complex verbal problems	Development proceeds from pre-logical thought to logical solutions to concrete problems
Formal operations (11-15 years)	Logically solves all types of problems--thinks scientifically Solves complex verbal problems Cognitive structures mature	Development proceeds from logical solutions to concrete problems to logical solutions to all classes of problems

*Adopted from Wadsworth, (1971, p. 115)

Additional views of mental development

Many experimenters have postulated cognitive developmental stages similar to Piaget's. For example, Church's (1961) physignomic perception in which objective properties are submerged under a global identity is similar to the sensori-motor stage. Brown (1958) indicated that children learn global and diffuse abstractions, such as dog as a label for all four footed animals, before they focus on concrete properties of objects. Rommetveit (1960) indicated that concept attainment progresses through at least three levels, the perceptual level, a level in which perceptual stimuli and response categories are associated called the integration level, and the representational level in which a label or verbal concept is attained. This third stage in which the ability to verbalize a concept is viewed by Rommetveit as the attainment of a representational level of concept attainment but it is not the terminal stage in concept formation.

Another experimenter, Vinacke (1954), also postulated that concept formation follows a developmental sequence. He indicated that if age and experience are held constant, concept formation varies with intelligence, otherwise age level is the most important variable in concept formation. He also indicated that learning concepts is continuous and cumulative, and that early concept learning, which involves concrete perceptual experiences, provides a preparation for later development which involves grouping and abstract, symbolic behavior. Vinacke further indicated that concept changes occurring with age progress from the simple to the complex, from the diffuse to the differentiated, from the egocentric to the objective, from the concrete to the abstract, from the variable to the more stable, and from the inconsistent to the consistent.

In summary, there are many experimenters and much theoretical evidence in support of the proposition that concept formation progresses through several stages as the human organism matures.

Empirical Evidence in Support of a Developmental Sequence in the Ability to Form Concepts

Evidence that thinking develops sequentially from simple to complex, from the concrete to the abstract, and from the empirical to the propositional, comes from studies by Sigel (1953), L'Abate

(1962), Braine (1959), Olver (1961), Rigney (1962), Carson (1965) and Low (1970).

Sigel's experiment

Sigel (1953) had children aged 7, 9, and 11, group 24 familiar items into as many or as few piles as they wanted to. Their groupings were to be based on "belonging together" or "being alike in some way." Sigel was interested in determining age changes in abstraction ability. He scored the groupings according to the number of objects placed in perceptual, conceptual, and miscellaneous groups. He defined a perceptual classification as yielding to the nature of the stimuli. Conceptual groupings were defined as placing structure upon the stimuli. When the objects did not fit under conceptual or perceptual, they were called miscellaneous. Results indicated that as children grow older there is a decrease in the use of perceptual and miscellaneous classifications, and an increase in the use of conceptual classifications. When the children were stressed by having them repeat the groupings using larger sized groups, the young children continued to use lower level perceptual groupings and the older children also used more perceptual and miscellaneous groupings. This indicated their cognitive functioning was lowered or impaired when they had to increase the size of the groups they used in classifying.

L'Abate's and Braine's experiments

L'Abate (1962) tested the hypothesis that children younger than age seven perceive in global, concrete, syncretic terms, while those above age seven shift to an analytic frame of reference. Using a master picture and a story, she had students in several grades select, from a group of pictures, the correct one which would go with the master picture and the story. Below grade two the responses were random; above grade two the correct match was made. She concluded that Piaget's theory of development was supported and that maturity beyond a certain point was necessary for certain concepts to be achieved.

Braine (1959) supported Piaget's contention that progression through cognitive stages occurs. However, he was in disagreement concerning the age at which inferences and logical operations in measurement occur. Braine found these abilities emerged around age 4 to 5, two years earlier than Piaget's theory.

A major study by Olver

The results of Olver's (1961) dissertation adds additional support to the proposition that there is a developmental sequence in concept formation. Olver presented students from grades 1, 4, 6, 8, 10 and 13 an array of progressively more diverse items (words) by adding items to ones already presented to the subjects.

In the presentation of the stimuli, first two words were presented, for example Bell and Horn, and the child was asked in what way they were alike. Then a third word was presented and he was asked how the third word differed from the first two and how all three of them were alike. A fourth word was then presented and the child was asked how it differed from the first three, and then how all four were alike. This was repeated until nine words were presented. The "difference" instructions as well as the "similarity" instructions were attempts to stimulate the child into seeing as much likeness in the groups as possible. Unlike the present study which makes provisions for scoring many reasons for grouping together stimuli, the Olver (Bruner and Olver, 1970) study did not press for further responses, indeed only the first responses were used in the analysis, and additional responses were excluded from the analysis.

Olver analyzed the results according to the rules of transformation that the subjects used for the groupings, the types of attributes on which the groupings were made, and the level of specificity of the groupings. The scoring for rules of transformation involved whether the groupings were based on a superordinate, a complex (several different attributes), or a thematic sequence (a story). The type of attribute on which a grouping was based was scored according to whether it was perceptual, functional, emotional, fiat or linguistic convention. The level of specificity score was derived according to whether the reason for grouping was general or specific.

Findings of Olver's study supported Piaget's theory. A developmental pattern was found which indicated that as children grow older there is an increase in the use of superordinates, a decrease in the use of functional attributes, a decrease in the use of perceptual attributes, and there are more general reasons given by older children than specific reasons. In addition, with more diverse items (larger groups), level of specificity becomes more general. In all grade levels functional attributes were used in the majority of superordinate groupings. No differences were found in the use of emotional or fiat equivalence attributes.

Rigney's contribution

Rigney's (1962) study was intended to more fully explore the findings of Olver (1961). Olver's subjects were perhaps forced to use complex strategies because of the way the items were presented by Olver, and perhaps they were unable to think of appropriate single bonds for such diverse elements to be grouped. Rigney postulated that a more complete understanding of the nature of children's equivalence groupings may be gained by allowing the children to group items in the way they wished. In addition, Rigney used pictures rather than verbal stimuli with the intention of determining if her results would parallel Olver's, which would add support to the findings of the general development of equivalence transformations. If a developmental trend exists, groupings with pictures and words may yield similar results. This was what occurred.

Students from grades one, three, and six were instructed by Rigney to group together as many pictures as they wished and to give reasons for their groupings. The task was repeated ten times. The results indicated that among older children more superordinate structures and fewer complex structures were used. Where complexes were used they were of a more economical kind with fewer elements to carry around cognitively in order to reproduce the concept. It was also found that older children used fewer perceptual attributes and the use of functional attributes increased. Larger groupings were also made by older children --three to six pictures per group for older children as compared to two per group for younger children. As repeated groupings were made the older children reduced the size of their groups. This may be viewed as a result of testing the limits of the subjects by having them regroup repeatedly, and the resulting impairment due to the cognitive stress of having to find more reasons for grouping resulted in smaller groups.

Another highly relevant attempt by Rigney was to study the relationship between equivalence grouping and memory. Following the groupings, she had her subjects attempt to verbally recall as many of the 46 items in the array as they could. She found significant differences in the groups she used in her study, grades one, three, and six. From grade to grade the subjects progressively remembered more items. Grade one remembered an average of 13 items, grade three 17 items, and grade six 25 items. It was expected that the older subjects with more efficient clusters would remember categories and be able to regenerate more items. The present study attempted to determine if this same trend occurs among older subjects after they have grouped words and pictures in different ways. As in the Rigney study, the subjects were not forewarned that they would be required to recall the items.

Combined conclusions of the Olver and Rigney studies

Olver and Rigney (1970) made an interesting point about the change in the use of "language frames" (attributes for grouping) as a function of the difficulty of the task. As more and more stimuli are added to the original word groupings "the going gets rougher" and the young children shift from their preferred mode of dealing with the surface attributes as a basis of grouping, and either fail to group or adopt the frame of extrinsic functional grouping, fiat equivalence groupings, and affective groupings. A similar lowering in grouping efficiency takes place among other age levels up to grade five. It was only the oldest age group in this particular study, sixth grade, in which a high level of functioning, the intrinsic functional mode of grouping, held up under the increasing stress of adding more and more words to their groupings. The present study extended the age groups to the late college age to determine if this ability to maintain high level of functioning under stress increases with continued maturation.

In chapter three called "On Equivalence" of Bruner's, et al. book Studies in Cognitive Growth (1967), Olver and Rigney discussed the combined results of their two theses carried out at the Center for Cognitive Studies. In comparing groupings of pictures as opposed to words, they concluded that although picture materials produced a greater reliance at all ages (up to age eleven) on perceptible properties, the six year old made far more groupings on the way things looked than did older children. Olver and Rigney further indicated that although there was an increase in the use of functional attributes for groupings among older children, the use of functional attributes was less evident in picture groupings as opposed to word groupings.

To summarize the Olver and Rigney combined findings, it can be stated that the same pattern of cognitive growth is evident whether subjects group words or pictures, or whether subjects are given items in a fixed order or are free to group as they choose. However, it does appear from the data that pictures do result in an increased use of perceptual attributes in groupings. The present study attempts to elucidate any differences in groupings resulting from the use of words versus pictures as stimuli.

Studies involving pictures and words

In a dissertation by Futterman (1971), in which some subjects were shown objects and some subjects were read pairs of words which were the names of the objects, the theory that there is a developmental cognitive progression in grouping from perceptual to the functional and abstract was supported. However, unexpectedly, it was found that young children (aged 5, 7 and 9) performed higher, conceptually, with concrete (visual) as opposed to abstract (words) material.

Other evidence in support of the thesis that pictures evoke more perceptual groupings than do words comes from a study by Stephens and Nopar (1971). They compared equivalence formations by mentally retarded and nonretarded children using pictorial and printed word stimulus items. The results showed that both groups of children used perceptual groupings more frequently with pictorial than with word stimulus items.

Carson's elaboration of the Olver and Rigney studies

Carson (1965) designed his study to extend the work by Olver (1961) and Rigney (1962). He added an age group, the ninth grade, which enabled the relating of concept formation to the formal operations stage of thinking; Rigney's study included only age groups to the concrete operational stage of thinking. Carson also added to his study additional attributes at what was termed a representational level that would test the ceiling of this age group. He also attempted to divide the attributes into levels so that a hierarchical order could be established among and within these attribute levels. Major concerns were to test the limits of applications of rules for rendering stimulus items as cognitively equivalent and to test the ability to use the processes of assimilation and accommodation. Carson used subjects from kindergarten, third, sixth, and ninth grades in 17 different tasks involving the use of 54 colored pictures:

> First, subjects were asked to find two pictures that were alike or went together in some way. This task was repeated six times. Second, subjects were asked to find three pictures that were alike or went together in some way. This task was repeated four times. Third, subjects were asked to pick four pictures that were alike or went together in some way and to set them apart from the main body of pictures. This was repeated twice. Fourth, from the latter two groupings, subjects were asked to find as many as possible that were alike or went together in some way. Fifth, after pictures were returned to their numbered positions in the array, subjects were asked to find as many as they would like that were alike or went together in some way. Sixth, subjects were asked to find as many as they could that were alike or went together in some way. To this last grouping subjects were asked to add one picture, which they could imagine to exist on a blank card, and two pictures from those remaining in the original 54 picture array. These last two tasks, involving the addition of one picture and two pictures to the as many as possible grouping, were intended to test assimilation and accommodation respectively.
>
> Responses to each of the 17 tasks were then scored in terms of the structure, attribute and supplemental aspects used. (Carson, 1965, p. 123).

The results of the Carson study showed that there was a developmental trend such that older children used the more efficient grouping structure (superordinate) more often, older children used fewer complexes and themas, older children were able to maintain use of efficient structures under "limit testing" conditions, older children used fewer level one and level two attributes, and older children used more level three attributes (highest attribute level). All of these major age differences were found between kindergarten and grade three. Carson stated:

> A significant finding involving differences between the upper most grades was found when the frequency of use of perceptual attributes was compared to the frequency of use of functional attributes. Within the second or concrete level of attributes, there was a trend for the use of perceptual attributes to dominate the use of functional attributes until grade nine; then the trend was reversed.
>
> Within the third or representational level, a major difference was again found between kindergarten and grade three in the use of linguistic convention or the inclusion of pictures into a class. This was termed the simple representational category. The compound representational category required inclusion of pictures that represented a state, condition, or process. Major differences were indicated between third and sixth grade on this category. (Carson, 1965, p. 127).

Furthermore, it was found that there was a general trend for higher grades (between kindergarten and grade three) to maintain more of the high attribute levels in their reasons for grouping the pictures when they were exposed to conditions to test this ability. Although there were no grade differences in the supplemental aspects used for grouping, the ninth graders appeared to have greater ability to broaden grouping structure and attributes to accommodate new items.

The Carson study does appear to support the thesis that there are developmental trends in the structure and attributes used for grouping pictures. It appears that the ability to deal with things in a meaningful manner grows progressively with age. In addition, there appears to be a spurt in the growth between kindergarten and grade three, between Piaget's preoperational stage of thinking and his operational or concrete stage of thinking. This rather drastic difference may be evidence in support of stages of development. There was also evidence of a difference between the ninth grade (formal stage of thinking) and the third and sixth grades (operational or concrete stage of thinking). Perceptual attributes dominated the use of functional attributes up until the ninth grade. The trend was notably reversed by the ninth grade.

As Carson stated:

> Also, ninth graders were the only group to use a substantial number of accommodative responses on the task designed to elicit the less sophisticated assimilative response. They were also the only group to approach 50 per cent use of the accommodation process on the item intended to check this ability -- and this in spite of the fact that they used more pictures on the as many as possible grouping than any other grade. These facts suggest that there are some notable changes between sixth and ninth graders. Ninth graders seem better able to adjust grouping structures and rationale for grouping in order to accommodate new items. They are also able to recognize the functional aspects of pictures to a greater extent than lower grades. This includes the highest frequency of use of the attribute involving the interaction of things independent of the subject. Such behavior seems to be more characteristic of a formal operations stage of thinking, which includes emphasis on operations and hypothetical reasoning, than is found in any of the lower age groups. (Carson, 1965, p. 129-130).

It appears from the trends evidenced in the Carson study that if an older group of subjects was compared with the sixth graders, more differences would emerge --that is, if the assumption is true that developmental trends continue on into adulthood. It was partly with this in mind that the present study used college freshmen, as well as groups of juniors and seniors in comparison with groups of sixth graders.

Carson, in summarizing the developmental trends in thinking, quite aptly stated:

> It might be concluded from these findings that kindergarten children are somewhat dominated by stimuli and simple associations between them. As children grow, within the operational stage of thinking, they become better able to operate upon the stimuli presented to them. This in turn may make them capable of seeing a greater variety of similarities in a larger number of stimuli. This is in keeping with the growth of ability during this stage to mentally transform data so that it can be organized and used in thinking. As children enter the formal operations stage of thinking, their increased, or developed ability to think in terms of the possible -- often times independent of their own ego -- enables them to focus on the utility of things rather than the perceptual attributes possessed by items. This extension to formal operations also permits them to be more flexible -- they are better able to adjust or enlarge their thinking to include new items or ideas. They have developed the ability to accommodate. It thus seems possible that, with increases in age, children develop faculties, perhaps at given stages, that enable them to become more efficient and effective in their thinking. (Carson, 1965, p. 130).

<u>The Low contribution</u>

A study by Low (1970), a follow-up to Carson's study, used ten-year-old (fifth grade) and fourteen-year-old (ninth grade) subjects to determine developmental trends in concept formation as a result of categorizing 45 colored pictures. Low had subjects group the pictures in different ways. One set of subjects categorized the pictures in groups of five, then regrouped to three; another set of subjects made their own sized groups, then regrouped to three;

another set of subjects grouped five pictures, then regrouped to eight. Finally, another set of subjects made their own sized groups, then regrouped to eight. Following the groupings the subjects were to write reasons for their groupings. The results were analyzed in terms of the number of unique reasons for grouping, the types of superordinates (abstract, representational, perceptual, functional, or simple association) used, and similarities and/or differences in categorizing under conditions of set-breakup.

The results indicated that younger students consistently produced more unique reasons for their groupings than did older students. In addition, the fourteen-year-olds generally produced higher superordinates (abstract representational groupings) than the ten-year-olds as a basis for equivalence. There was no difference in the two groups in the use of simple association attributes. However, there was a significant difference in the use of functional attributes used for equivalence grouping, with the younger children using more of these. In addition, ten-year-old subjects produced more groupings based on perceptual attributes than older children when going from their own groupings to groups having three pictures or fewer. Also, when groups were restructured, there was a trend for younger students to use more divergent patterns.

There is a need for further study of the effects of categorization under conditions of set-breakup. In the present study, using a more rigorous design than Low's, the effects of increasing or decreasing the size of groupings (set-breakup) was more thoroughly studied.

Sex differences in cognitive development

There are some differences between the sexes in the way they made cognitive equivalence transformations. L'Abate (1962) found no sex differences when attempting to determine an age for shifting from global, syncretic perception to analytic perception. However, Olver (1961) did find a sex difference. Although in both sexes the number of superordinates increased and the number of complexes decreased in use among older as compared with younger subjects, the trend was more consistent for boys. Girls in grade one used more superordinates and fewer complexes than boys; in grades four to six the sexes were equal in their use; in grades eight, girls decreased in their use of superordinates and increased in their use of complexes; in grades ten to thirteen grouping structures among both boys and girls were equal again.

In the present study, the subjects used were from grades six and above grade ten (college students). The experimental evidence indicates that there are no sex differences in these age ranges in equivalence transformations; therefore, in the present study, there was no attempt to control for sex differences in the experimental groups. However, caution should be used in grouping sexes in cognitive studies. Sigel (1963) warns against grouping sexes together in cognitive studies simply because no statistical significance is found when testing some dependent variables. When other dependent variables are tested other than the ones which were found to be statistically not different there may be some true differences emerge between the sexes.

Criticism of the Theory of Developmental Levels of Concept Formation

Piaget's theory of development has been criticized because of its absence of experimental control. Hood (1962) indicated that Piaget failed to cite the number of subjects on which his conclusions were based. He also neglected to relate the performance of his subjects to their mental age, and chronological age was all that was used to establish developmental age levels. Braine (1959) criticized Piaget for not controlling for vocabulary, not controlling for motivational effects, and not controlling for measurement error. Generally the criticisms of Piaget's theories are not that developmental stages do not exist, but that better and more sensitive experimental designs are necessary to identify the different stages or developmental changes. The present study attempts to help in accomplishing this.

Flavell (1971) criticized Piaget's stage theory from the point of view that items that define a stage develop gradually rather than abruptly. Moreover, as Vinacke (1954) also alluded, the typical item that defines a stage probably does not achieve its final level of "functional maturity" (functional maturity is defined in terms of the item's evocability and utilizability as a solution procedure) until after the termination age of the stage in which it began its development. For example,

> Consider a random example of sensory-motor acquisition: the ability to discover new means for achieving a concrete goal through active experimentation e.g., to discover that a stick can be used to fetch an out of reach object... It is surely

> true that this sort of ability continues to be refined and perfected long after the child has left the sensory-motor period; indeed, its development probably persists well into adulthood for many individuals. The reason one stops referring to the child as "sensory-motor" after age two, is that the most homo sapiens type "intelligent" things he can do are now of a different sort, not because sensory-motor skills have reached functional maturity. To put it more generally, what really determines the agreed-upon terminal date for any cognitive developmental stage is the beginning emergence of new skills, skills which impress us as the best, highest-level cognitive act the subject can now put on; the fact that we now turn our attention to the new act does not mean that the old one has stopped being perfected. (Flavell, 1971, p. 431).

The major emphasis of Flavell's article is not that stages do not exist, but that development is very gradual, more gradual than most theorists have previously supposed. Flavell contends that his intent is not to deny or reject the concept of cognitive developmental stages but rather to seek a clearer picture of developmental reality and to facilitate an understanding concerning how development actually proceeds. The spirit of the present project is certainly in keeping with Flavell's views.

Summary

The study of cognitive processes had its beginnings in the nineteenth century when the technique of introspection was utilized by Wundt and his contemporaries. It was found that introspection was too subjective and other scientific movements such as Behaviorism and Gestaltism emerged. Scientists realized that the human organism was capable of handling the diverse complexities of the environment by some type of cognitive process and studies and theories were advanced to explain how. Some scientists postulated that humans, using a cognitive process, classify and group objects together and thus render them equivalent, in order to reduce the number of elements in the environment for more efficient handling. This grouping, or classifying, has come to be known as cognitive equivalence transformations. When the process of equivalence is utilized, the end result is the formation of a concept. Scientists such as Vygotsky (1962) and Piaget (Phillips, 1969) have studied how the developing human organism becomes more efficient in the use of cognitive equivalence transformations as it grows older.

There are two approaches in explaining how organisms form equivalence groupings -- the passive and the active view. The passive view indicates that groups are formed because of similarities the objects exhibit, thus they are associated together. The active view indicates the human organism, using rules of transformation, actively imposes structure on its world. The active view is conceived to be the most reflective of the human organism's wide flexibility in dealing with his world.

As indicated by Olver (1961), when equivalence groupings are made, there has been disagreement among theorists concerning what characteristics are used for the basis of similarity among the elements of the group. Some theorists, James, Hull, and Guthrie, have indicated that identical elements are the basis of equivalence groupings. But this view does not account for groupings of objects which have no identical elements in common. Other theorists, Gestalt psychologists, indicate things are similar to the extent that there are common perceptual relations among them. This position has also been criticized from the tenet that some groups have no common perceptual relations. Another view is that groups are formed as equivalent on the basis that elements in the group have the same mediating response. This can be criticized because it does not allow for newly encountered elements to be included into the group. As indicated by Olver (1961), none of these theoretical views would predict any difference in equivalences grouping under different instructions and tasks.

A more plausible approach to the interpretation of equivalence groupings is that advocated by the experimenters Bruner (Rowland and McGuire, 1971), Piaget (Phillips, 1969), Vigotsky (1962), Olver (1961), Rigney (1962), Carson (1965), and Low (1970). All of these view cognitive equivalence groupings as occurring as the result of the application of rules of transformation. How, and whether or not, objects will be grouped depends on the subject, the situation, and the task.

The development of the rules of transformation are seen by Olver (1961), Piaget (Phillips, 1969) and Vygotsky (1962) as progressing through many phases as the child matures. The very young child forms groups based on association; later in development the child links objects on the basis of bonds which are perceptual, concrete, and factual; when the child matures, objects are grouped on the basis of abstraction, where elements of the objects are viewed apart from the total objects.

Anglin (1970), in his studies concerning how the internal lexicon evolves, gave further evidence that there are developmental changes in the way people deal with words and the complexities of the environment. Lexical growth proceeds very gradually from a mode which is idiosyncratic in nature, through one which is concrete in nature, to a mode which is very abstract in nature. This gradual progression in the way the human organism develops lexically continues into adulthood and may never be complete.

Cognitive development is reflected in the way people at different ages form concepts. Concept formation involves categorization of stimulus material. As indicated by Bruner (1957), categorization occurs when people use a set of specifications for grouping or rendering items equivalent; thus, cognitive equivalence is equated with categorization. There are differences as well as similarities between perception and cognition when forming concepts. Bruner (Rowland and McGuire, 1971) indicated that there are several types of equivalence categories: affective, functional, and formal. Sigel (1953) indicated there are two ways classifications are made, perceptual and conceptual. Whether or not there is a hierarchy in concept formation is debatable (Kling and Riggs, 1971).

There are several authorities who view cognitive development as progressing through definite sequences. One of these authorities, Piaget (Phillips, 1969; Berlyn, 1957) views cognitive development as progressing through several stages: Before age seven the child is in a time of preoperational thought and emphasizes the concrete and perceptual aspects of his environment. After age seven the child is in a time of operational thought, and interiorized actions are possible. These two broad time periods contain several stages through which the child progresses. The child from birth to year two is in the sensori-motor stage. The child from age two to seven is in the preoperational stage which incorporates the pre-conceptual period (ages 2 to 4) and the period of intuitive thought (ages 4 to 7). The stage of concrete operations is from age 7 to 11. The final stage, formal operations, develops in ages 11 to 15. Church (1961), Brown (1958), Rommetveit (1960), and Vinacke (1954) have views similar to Piaget's.

There is much evidence in support of a developmental sequence in concept formation. Sigel (1953) found that when different aged subjects grouped objects together, younger children favored perceptual groupings, while older children favored conceptual groupings. Other experimenters, L'Abate (1962) and Braine (1959) also supported the cognitive developmental theory. Studies by Olver (1961) using words, Rigney (1962) using pictures, Stephens and Nopar (1971) as well as Futterman (1971) using words and pictures, also supported a cognitive developmental progression. Experiments extending the Olver (1961) and Rigney (1962) studies conducted by Carson (1965) and Low (1970) using pictures also found a cognitive progression from the concrete perceptual orientation of the child to the abstract functioning of the mature individual.

There appear to be some differences in the cognitive development of females and males in the middle childhood years, but apparently none in the more mature years. Criticisms of the cognitive development theory do not deny that there are differences, but rather that the progression is very slow and continuous to old age (Flavell, 1971) and that perhaps the stage theory of Piaget is inaccurate as indicated by Hood (1962) and Braine (1959).

CHAPTER III

RESEARCH DESIGN

The design of this study is three dimensional (Lindquist, 1956). This three-factor (A x B x C) design (Lindquist, 1956, p. 243) is represented in Figure 1. Basically there are two categories in A and B and three categories in C (2 x 2 x 3). Factor A exposes each of its subjects to three conditions in each of its two categories. Factor A refers to the direction of forming groups by the subjects. In category A_1 the subjects form groups by progressively increasing the sizes of their groupings from 2 to 4 to 6. In category A_2 the subjects progressively decrease the size of their groupings from 6 to 4 to 2. Factor B is the form of the stimuli used in the groupings made by the subjects. Category B_1 is pictures; B_2 is words. Factor C is the grade level of the subjects. Category C_1 is sixth grade students; C_2 is freshmen college students; C_3 is college juniors and seniors.

The Relation of this Design to Previous Studies

Undoubtedly it is an established fact that children's concepts change with age (Vinacke, 1951; Sigel, 1953; Bruner, 1964; Phillips, 1969). As Vinacke (1954) has stated, the ability to form concepts and classify things progresses through childhood and the trends continue into high school and beyond. In this study the grade levels

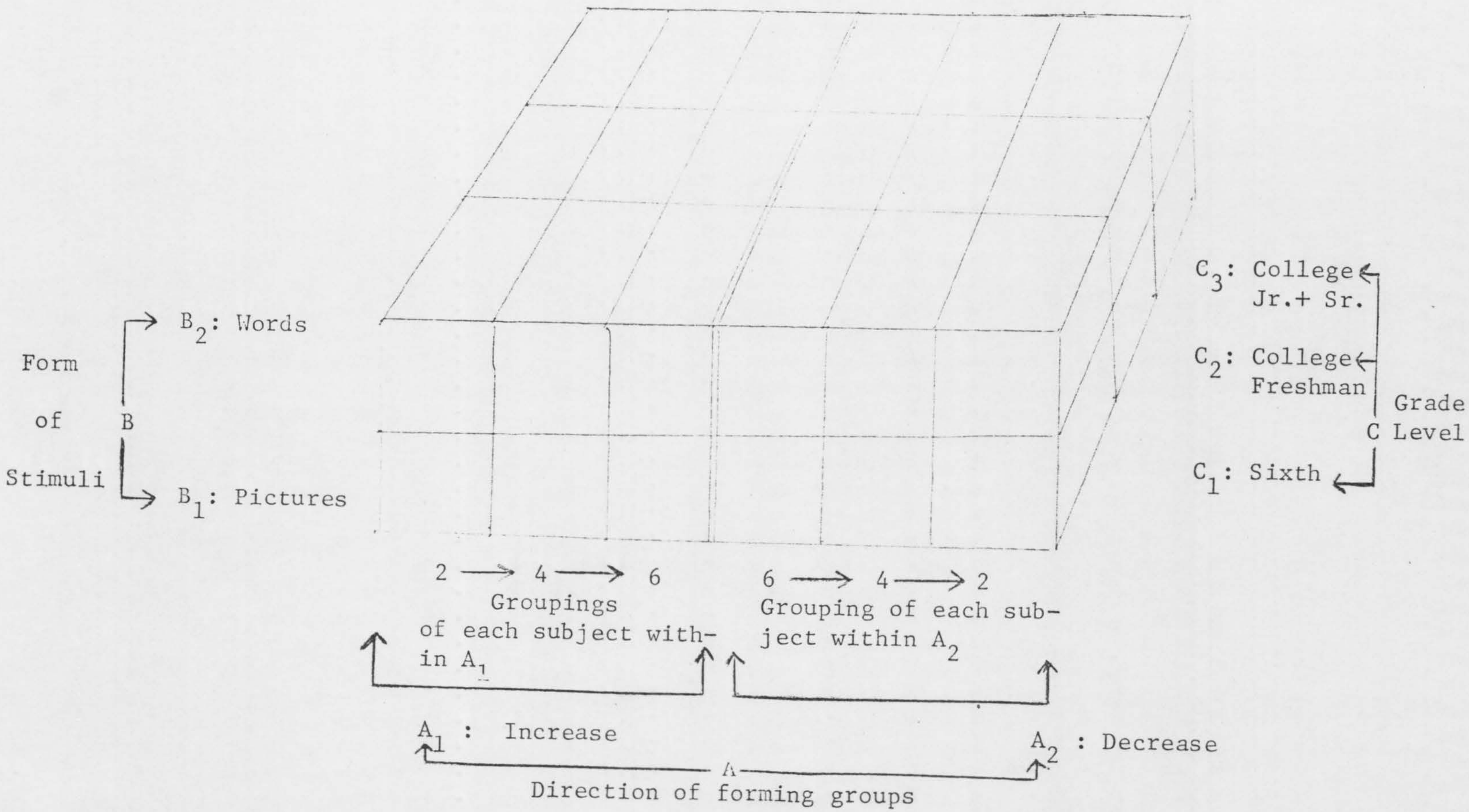

Figure 1. Three dimensional design of study.

(Factor C) are the sixth grade and college levels. One objective is to determine what differences there are in concept formation and the ability to maintain sophisticated levels of concept formation under conditions designed to test the limits of concept formation ability.

The types of stimuli used in forming groups in research are varied (Davidon, 1952). Sigel (1953) used miniature objects (a metal soldier, a plastic truck, etc.) as stimuli to be classified in groups by children. Olver (1961) used words and Rigney (1962) used pictures as stimuli to be classified into groups in terms how they are alike. Carson (1965) and Low (1970) used colored pictures. In the present study factor B has two categories of stimuli. At B_1 there are drawn, black and white pictures and at B_2 there are words. Thus, a comparison can be made, in the same experiment, of the effects of the different stimuli, of the effects of direction of forming groups, and the effects of grade levels.

The direction of forming groups, factor A, has also been of interest in previous studies. Sigel (1953) asked children to put objects as well as black and white pictures together in as many or as few piles as they desired. Then he asked them to use fewer piles. Rigney (1962) repeatedly asked children to form groups, using the same objects over a period of several days in order to test the upper limits of concept formation. Carson (1965, p. 44) in order to test the limits of concept formation varied the number of pictures. He asked his subjects to find three pictures that went together in some way; then he asked them to group four pictures, then as many as desired, and finally to group as many as possible. Low (1970) asked some subjects to form groups of 5 and then reduce the groups to 3; other subjects first made groupings of 3 and then increased the groupings to 5. In the present study one group of subjects, A_1, formed groups of 2 and then increased the size of the groups to 4, then to 6 by adding two elements each time to the previously formed groups. Another group, A_2, first formed groups of 6 elements and then reduced the group size to 4, then to 2 by removing 2 elements each time. Thus, the effects of direction of groupings could be determined.

To summarize some of the innovations in the present study, it can be stated that the three dimensional design allows us to compare the effects of direction of forming groups, grade level, and form of stimuli on the ability to form concepts. In addition, we are able to determine if there are any A x B x C interaction effects as well as trend effects as a result of progressively changing the sizes of the groups.

Selection of Subjects

This study utilized sixth grade students (average age 11.8 years) selected from elementary schools in the area of Emporia, Kansas, and freshmen (average age 18.9 years) and junior and senior (average age 22.1 years) college students from Kansas State Teachers College. All the subjects were administered the Lorge-Thorndike Verbal Test of Intelligence in convenient groups. These intelligence scores were used in an analysis of covariance to equate the experimental groups; the groups of subjects were assigned randomly to the experimental conditions.

Pilot Study

A pilot study was conducted to obtain information concerning the procedures, instructions, analysis and scoring method, feasibility, and other aspects related to conducting the study.

Results of the pilot

During the pilot, questions by the subjects were recorded so that particular recurring questions could be incorporated into the instructions. As a result, the instructions were modified for clarity. An adequate "starting sheet" (Appendix A) and large response sheets (Appendix B) were also developed as a result of the pilot. The "starting sheet" was used by the subject to place the twenty-four stimulus words or pictures in an array before the groupings were to begin. The response sheets were used by the subjects to make their groupings and record their answers. An adequate semantic differential attitude scale was also developed to test the subjects' attitudes toward the tasks and stimuli.

As a result of the pilot, it was found that the subjects could be handled in fairly large groups when the experimenter had the help of an assistant. It was also found that three different sessions were needed with the groups to complete the study. One hour session was needed for completion of the intelligence test. On a different day another hour was needed for completion of the groupings by the subjects. A third 20 minute session, one and a half to two days following the grouping session was needed for the long-term recall of the words or pictures used in the study, and completion of the semantic differential which measured the subjects' attitudes. It was found in the pilot study that subjects could immediately recall almost all of the words or pictures they used in their groupings and that not enough time was available to have subjects group, recall, and complete the semantic differential in one session.

Methods and Procedures

The groups of subjects used in this study were first administered the Lorge-Thorndike Verbal Test of Intelligence and assigned randomly to experimental conditions. Approximately a week later they were asked to group words or pictures and write their reasons for their groupings. About two days following the groupings the subjects were asked to recall as many of the words or pictures as they could, and then they were asked to respond to a semantic differential which tested their attitudes.

Grouping instructions to the subjects

The experimental instrument and procedures were administered to the subjects in convenient small groups. To aid the experimenter in giving instructions a display board was constructed with the material to be used by the subjects prominently arranged. Nearly identical instructions were given to the subjects except which sized groups were to be made (increasing or decreasing), and which stimuli were to be used (words or pictures). Appendix C contains the instructions given to the different experimental groups. The following is an example of the instructions which were given for subjects in condition A_2 B_2 C_{123} (decreasing the size of the classification groups, words as the stimulus material to be classified, and sixth graders or college students as subjects). The words were presented as an array of twenty-four typed words on small squares. Below the array was a response sheet.

Instructions for decreasing groups (words)

Write your name on these sheets. Do not begin until told to do so. In front of you is an envelope containing twenty four words. They are numbered one to twenty four. Take them out of the envelope and place them in the numbered squares on the top sheet that is in front of you. For example, place the word that is numbered one in the number one square and so forth with the others.

I would like you to choose six words from the twenty four above that you think are alike or go together in some way and put them together in this rectangle (first one). There are no right or wrong reasons for grouping the words together. You can put together whatever words you want to. When you put them together in the rectangle, leave them there in that rectangle.

Below the rectangle where you put together the words, there is a space called Card Numbers. Here you are to write the numbers of the words you grouped together. Below that you see Reasons for Grouping. Here I would like you to write at least one reason, and as many reasons as you can for grouping the words together. Remember, you are to write at least one reason, and as many reasons as you can for grouping the words together.

When you have finished with this one, leave the words in the rectangle. Go on to do the same thing with this rectangle (#2). That is, choose six more words that you think are alike or go together in some way, and put them into this rectangle. Write the card numbers here, and write at least one reason, and as many reasons as you can for grouping the words together. When you are finished with that one, do the same thing here and also here (pointing). When you are done with this first section you should have four rectangles with six words in each one. At that time raise your hand and I will tell you what to do next. Do not write in these down here until told to do so later on.

Now go ahead and start here. Choose your six words; place them in the rectangle; write the numbers and the reasons. If you have any questions or problems at any time raise your hand and I will answer them individually.

(The experimenter will then circulate to be sure the instructions are being followed.)

(When the subject is finished with his groupings of six and raises his hand, the following instructions are read to him):

Now that you have groups of six I would like you to take two words away from this group and put them in the envelope. You will then have four words left in this group. Write the numbers of the four words that you have left here. Then write at least one, and as many reasons as you can for grouping these four together. Do the same thing here, here, and here (pointing) until you have only four words left in each group. Then raise your hand and I will tell you what to do next.

(When the subject is finished with his groupings of four and raises his hand, the following instructions are read to him):

Now that you have groups of four I would like you to take two words from this group and put them in the envelope. Write the numbers of the two words here. Then write at least one, and as many reasons as you can, here, for grouping the two together. Do the same thing here, here, and here (pointing) until you have two words in each group. Then raise your hand.

(When the subject is finished, his work is checked to see if everything is in order.)

Increasing groups (words)

The increase groups had instructions similar to the decrease groups except that the first classifications formed were groups with two words in each group. Then the subjects were asked to add two words each time to increase the groups sizes from two to four and finally to six. After forming each group, as in the decrease example, the subjects were asked to record the numbers of the words remaining in the groups and write reasons for the groupings.

The procedures used in the picture classifying were identical to those used in the word classifying. The instructions given to subjects forming classifications from pictures were similar to the instructions previously given to the subjects using words. The only difference was that the term "picture" was substituted for the term "word."

The stimuli recall and the attitude measures

Approximately a day and a half to two days following the groupings the experimenter returned to the experimental groups and asked them to recall as many of the words or pictures as they could. They were given about five minutes to complete their recall. Prior to this time they were not told that they were going to have to recall these items. Following this, the subjects were given the semantic differential attitude questionnaire and were told to read the instructions on the front to themselves while the experimenter read them aloud. They were then given as much time as they needed to complete this.

Rationale for the Procedures and Tasks

One task for some subjects was to increase groups sizes from 2 to 4 and to 6 elements. Other subjects decreased groups sizes from 6 to 4 to 2 elements. This procedure of increasing or decreasing classification groups was used to determine if direction of grouping had any effect on the quality and type of reasoning given for the classifications (the structure, attributes, supplemental aspects and level of specificity used for grouping) and other dependent variables, and to determine if there were any different effects for grade level and form of stimuli.

Another task was to write at least one, and as many reasons as they could, for each of the classification groups. This was designed to determine if the number of reasons given differs in the experimental groups, if the level and limits of concept attainment differ, and to determine if there are any differences in the number of unique responses produced in the experimental groups.

Another task was to complete final forms involving the following: (1) The subjects listed as many of the stimuli as could be recalled. This was to determine if there are any differences in the experimental groups in the ability to recall the stimuli. (2) Subjects were asked to complete a semantic differential (evaluative bipolar adjectives) to determine if there are any differences in the experimental groups in the evaluation of the stimuli and tasks.

Statement of Hypotheses

Grouping structure

1. It was hypothesized that under conditions designed to test the trends and limits of cognitive efficiency there would be no differences among the experimental groups, in the grouping structure used in classifying.

Grouping attributes

2. It was hypothesized that under conditions designed to test the level of abstractness used in classifying there would be no differences among the experimental groups in the grouping attributes used in classifying.

Supplemental aspects

3. It was hypothesized that under conditions designed to test the quality used in grouping there would be no differences among the

experimental groups in the supplemental aspects used in classifying.

Level of specificity

4. It was hypothesized that there would be no differences among the experimental groups in the level of specificity used in classifying.

Unique reasons

5. It was hypothesized that there would be no differences among the experimental groups in the number of unique reasons used in the classifying.

Memory

6. It was hypothesized that there would be no differences among the experimental groups in the number of stimuli (words or pictures) they could recall after classifying.

Stimuli attitude

7. It was hypothesized that there would be no differences among the experimental groups in their attitudes toward the stimuli after classifying.

Task attitude

8. It was hypothesized that there would be no differences among the experimental groups in their attitudes toward the tasks after classifying.

Limitations of the Study

1. The study was limited in that only students attending Kansas State Teachers College and students in elementary schools in the Emporia, Kansas area were used.

2. Another limitation of the study was that responses that were scored on the basis of structure, attribute, supplemental aspects, and level of specificity, were done so subjectively.

Definition of Terms

The definitions of structures, attributes, and supplemental aspects used for grouping were the same as those used by Carson (1965) who adapted them from Olver (1961). Described below are the definitions of those terms which were used to analyze and score the groupings in this study. They are the same as those used by Carson (1965, pp. 47-51) except for the supplemental aspects of assimilation and accommodation which were not used:

CLASSIFICATION SCORING CHART

Grouping structure

Type	Description	Schematic Representation	Example
Superordinate	Items are perceived and grouped as equivalent because of one or more common attributes.	0 0 0 0	They are all red. All things that fly.

Complex	Items are perceived and grouped as equivalent on the basis of several different or changing attributes. Subgroups are often used.	0---0 - 0---0	These are people and these are things they wear. This chair is red like the apple and the apple is round like the circle.
Thema	Items are grouped because of some way in which they go together in a thema or story created by the student.	0 0 0 0	You could go for a ride in the car and see a tree and a butterfly and when you come home you find your cat waiting.

Attributes

Level-name	Description	Item Numbers* (*Carson 1965)	Example
Level I			
Simple association			
Heaping	No attribute seems apparent. Items seem to be grouped fortuitously or on the basis of juxtaposition.	39-40	Student groups items from an array but can't give a reason as to why they should be together.
Itemized naming	Items are grouped without rationale other than that each can be named or labeled. Response may show knowledge of directions and a common attribute may be implicit.	24-29	A picture of an apple and a monkey are grouped-- ". . . cause this is an apple and this is a monkey."
		22-46	It's a bee and a butterfly. Cause
		26-30	that one's a wagon train and that one is a cowboy.
Fiat	Items are grouped but rationale fails to adequately explain the basis.	24-49	Cause they look like each other.
		12-43	They are both the same.
		6-16-31	They match together.

Edge matching	The attribute used for grouping changes from item to item. Occurs frequently in conjunction with thematic structure.	50-45 43-2 24-14 22-46	He is reading, then go gets gun, puts on glove and hat and goes hunting. The bee likes flowers, the circle has the shape of the flowers and the little circles in the butterfly.

Level-name	Description	Item Numbers	Example
Level II			
Concrete			
Perceptual labeling	Essentially identical items are grouped on the basis of the same label applying to all of them.	24-49 6-16-31 12-43	Both monkey. All trees. Both gloves.
Perceptual attributes	Items are grouped on the basis of some observable attribute or physical property.	33-26-4 20-48-8 46-52-22 13-48-54 23-49-24-5	They all have wheels on. They all have fur. All something small.
Perceptual location	Items are grouped on the basis of going together in time or space.	44-19-28 11 3-48-8-49 51-42-13 20-52-22 46	Something you might find in a house. These animals live on the land or in the sea.
Functional association	Items are grouped on the basis of a bond between them. This "goes with" this is a common phrase.	29-31-6 48-30 44-50-23 54	The apple comes off from trees. Cats go with people. Mother and father go together, plus the baby and she could have a doll.

Functional dependence (Extrinsic)	Items are grouped on the basis of the common way they can be used or acted upon by the subject. Usually involves using the pronoun you or I in the stated reason for grouping.	17-35 29-41-25	You use them both to do something to work with. Cause you eat 'em all.
Functional dependence (Intrinsic)	Items are grouped on the basis of the common way they act. Their action is independent.	22-46 48-49-20-24 8-3-13	Both fly. All walk and crawl on the ground.
Functional dependence (situational)	Items are grouped on the basis of a bond between them. Two or more items interact independent of the subject. Rationale contains some form of the "they do to they" phrase.	49-41-24 30-26	Monkeys can eat the bananas. The bandit robs the stagecoach.

Level-name	Description	Item Numbers	Example
Level III			
Representational			
Simple representational	The rationale for grouping is the application of an abstract label which is quite perceptually based.	17-35 37-25-18 48-20-49 13	Both tools. Food sources. All animals.
Compound representational	The rationale for grouping refers to a state, condition, or process.	6-16-31 33-26 1-34-40-14 6-16-31	All grown or living. Two ways of transportation. All different things to do with shapes and mathematics. Change in seasons on a tree.

Relational	The rationale for grouping is identified by a type of "This is to this--as this is to this" connection. Or, a causal relational connection is made.	54-23-44 49-24-41	The little kid likes the doll and the mother likes the little kid. Two monkeys and three bananas. Each get a banana and a half.
Symbolic	Items used in the grouping serve as symbols.	50-7-30 21-10-19 1-40	Man read in the news that the judge tried a crook for causing a car wreck. The crook was sent to jail for a long time. Both could be used as numerals - triangle is delta.
Affective represen-tational (Simple)	Items are grouped on the basis of a value judgment.	10-30 38-31-5	This one in jail and this one are both bad guys. All in winter -- all cold.
Affective represen-tational (Abstract)	Items are grouped on the basis of feeling aroused in the subject.	30-45-8	They are all dangerous.

Supplemental aspects

Nature	Description	Item Numbers	Example
Partial use of stimuli	Grouping is based on the use of a part of the stimuli other than the primary aspect of the stimuli.	2-30 11-50 41-53	Both pictures have hats in. Because it is a man sitting in a chair. Some of this is yel-low and all of this is yellow.
Exceptional quality of response	The response is scored as usual and a plus is added if additional clarification is pro-vided, or if one of several subgroups is high level.	6-16-29 31 27-15-2 46-39-20 12	'Cause apples hang on a tree. A daddy goes to work in a shirt, a coat, and a hat. This is an animal, this is something like a home, this is a lion, and this is a glove.

Poor quality of response	The response is scored as usual and a minus is appended to indicate that the rationale applied to the items does not hold for each item.	39-14-1 1-2 1-14-39	They are all kinds of circles. Both hats. They are opposite.
No supplemental aspect	Self explained. Used in the scoring process for the purpose of computing the frequency of "regular" groupings.		

Level of specificity

Following the examples specified by Olver (1961) three levels of specificity were defined: specific, middle and general. The technique for scoring very much resembles a linguistic technique of constructing hierarchies or "trees of inclusion." The specific category would be a least inclusive response; the general category would be a most inclusive response; the middle category would fall in between in inclusiveness. An example by Olver (1961, p. 111) of this scoring technique is as follows:

Level of Specificity Hierarchies

Bell-horn array:

General	Middle	Specific
"things"	"make noise" -------	"make a ringing noise"
"objects"	"same shape" -------	"at the front the horn is like a bell"
"in the world"		
"all found"	"same color" -------	"horn is blue, telephone is red"
"can hold them"	"communication" ----	"musical means of communication"
"have value"		
"interesting"	"give information" -	"tell if there's a fire"
	"learn from them" --	"could be studying about bells"
	"same material" ----	"newspaper and book are both paper"

Banana-peach array:

General	Middle	Specific
"natural products"	"you eat them" -----	"you eat them at one meal"
"people confuse them"		
	"same color" -------	"they're yellow"
"you need them"		
	"go into body" -----	"go into body through the mouth"
"use them"		
"found in world"	"they grow" --------	"they grow off a tree"
"exist"	"they have skin" ---	"have skin to peel"
"can feel (also touch, see, etc.) them"		

Unique reasons

The unique reasons score was derived by counting the total number of different reasons a subject gave for all his groupings.

Memory

The memory score was derived by counting the total number of correct responses when the subjects were asked to recall as many of the words or pictures as they could that were used in the groupings. This memory response sheet can be seen in Appendix D.

Sources of Data

Data for this study was collected by the experimenter using college subjects from psychology classes at Kansas State Teachers College and elementary students from sixth grade classes in the Emporia, Kansas area. The Lorge-Thorndike Verbal test of intelligence was administered by the experimenter to conveniently sized groups of the subjects prior to exposure to the experimental instrument. The experimental instruments were also administered to the subjects in conveniently sized groups.

Measuring Instruments

The experimental instruments were pictures, words, a response sheet, the Lorge Thorndike Verbal Test of Intelligence, and the semantic differential. The first experimental instrument mentioned above consists of an array of 24 drawn pictures. (See Figure 2)

The words were an array of 24 words (see Figure 3) printed on similar sized squares as the pictures and accurately describe the pictures. The response sheet was designed by the experimenter and is shown in Appendix B. The Lorge-Thorndike Verbal Test of Intelligence was used because it provides for testing at the sixth grade as well as the college level. The semantic differential (Osgood, Suci and Tannenbaum, 1957, pp. 50 to 62) was constructed from bipolar adjectives found to be indicative of an evaluation factor when they were used to rate concepts. This device is presented in Appendix E.

An "elaborate word description" of the pictures was developed during the pilot study and was used with college students in the same way as those in Figure 2. This word array is contained in Appendix F. The results of this "elaborate word groupings" were intended to be an exploratory analysis, supplementary to the main project.

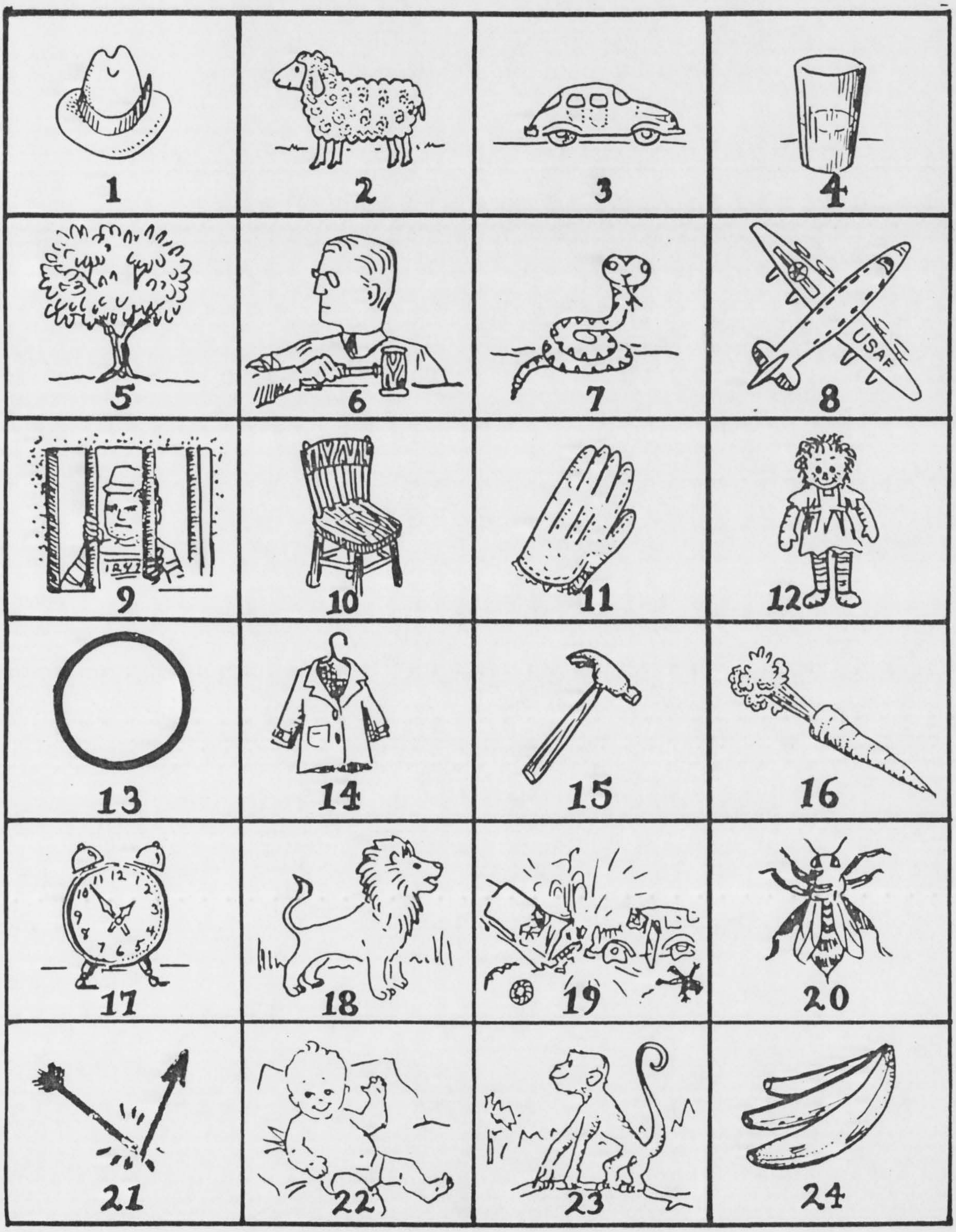

Figure 2. Pictorial stimuli used in picture groupings

HAT -1-	SHEEP -2-	CAR -3-	GLASS OF WATER -4-
TREE -5-	JUDGE -6-	SNAKE -7-	AIRPLANE -8-
PRISONER -9-	CHAIR -10-	GLOVE -11-	DOLL -12-
CIRCLE -13-	COAT -14-	HAMMER -15-	CARROT -16-
CLOCK -17-	LION -18-	CAR WRECK -19-	BEE -20-
BROKEN ARROW -21-	BABY -22-	MONKEY -23-	BANANAS -24-

Figure 3. Verbal stimuli used in word groupings

Data Analysis

The scoring of responses was conducted subjectively by the experimenter by adhering to the previously defined operational definitions. The categorization and scoring of the structure, attribute, supplemental aspects, and level of specificity categories was conducted twice by the experimenter to insure consistency from beginning to end in the way responses were scored. It was felt that a single expert scorer adhering as strictly as possible to the operational definitions for scoring would be superior to a panel of judges whose individual differences may result in a great deal of variability.

Scoring of the subjects' responses was done on the response sheets. Then, each subject's scores were transferred to a data sheet (Figure 4) in preparation for statistical analysis of the results of the study. As indicated in the fourth chapter, the scores were analyzed by computer at Kansas State University using appropriate analysis of variance techniques which were able to control for differences in intelligence among the experimental groups. There were many different ways the data was ordered on the data sheet for analysis.

Number two on the data sheet

Number two on the data sheet subsumes the criterion scores for the categorizing of stimuli in groups of 2, 4, and 6. For example, under grouping structure, the total number of superordinate responses were summed for groupings of two stimuli and recorded on the data sheet. Some students gave more than one reason for their groupings and all the reasons are represented in these scores. The total number

1. I.Q. ☐

	2			3	4	5			6	7			8	9			10
GROUPING STRUCTURE	2	4	6			2	4	6		2	4	6		2	4	6	
Superordinate (A)																	
Complex (B)																	
Thema (C)																	
11. Total																	
ATTRIBUTES																	
Simple Assoc. Heaping (D)																	
Itemized (E) Naming																	
Fiat (F)																	
Edge Matching (G)																	
12. Total																	
Concrete Perceptual (H) Labeling																	
Perceptual (I) Attributes																	
Perceptual (J) Location																	
Functional (K) Association																	
Functional (L) Dependence (Extrinsic)																	
Functional (M) Dependence (Intrinsic)																	
Functional (N) Dependence (Situational)																	
13. Total																	
Representational Simple (O)																	
Representational Compound (P)																	
Representational Relational (Q)																	
Symbolic (R)																	

Figure 4. Data sheet for statistical analysis of the results of the study

	2			3	4	5			6	7			8	9			10
	2	4	6			2	4	6		2	4	6		2	4	6	
Affective (S) Representational (Simple)																	
Affective (T) Representational (Abstract)																	
14. Total																	
15. Total: 12+13+14																	
Supplementary Aspects																	
Partial Use of Stimuli (U)																	
Exceptional Quality of (V) Response																	
Poor Quality (W) of Response																	
Regular of No (X) Extra Supplemental Aspects																	
16. Total																	
Level of Specificity																	
Specific (1)																	
Middle (2)																	
General (3)																	
17. Total																	

18. ☐ Unique reasons

19. ☐ Memory

20. ☐ Stimuli attitude

21. ☐ Task attitude

Figure 4. (continued)

of superordinate responses for groupings of four stimuli were summed and recorded on the data sheet and likewise for groupings of six. All the categories under grouping structure, attributes, supplementary aspects, and level of specificity were scored on the data sheet in the same manner as discussed above. The rationale for listing the data in this manner was to determine differences in the categories used by the experimental groups when they made groupings of two stimuli, four stimuli or six stimuli. This analysis would be sensitive to the number of reasons given by the subjects for each of their groupings. As was indicated earlier, the subjects were asked to give at least one, and as many reasons as they could for grouping together the words or pictures.

An analysis conducted on the data organized in this manner would reveal any differences among the experimental groups in the numbers and types of grouping structure, attributes, supplementary aspects and level of specificity that were used.

Number three on the data sheet

Number three on the data sheet subsumes the total score of each category. For example, in the superordinate category a subject may have criterion scores for his groupings of 2 and 4 and 6. These criterion scores would be summed and listed under number three on the data sheet. Therefore, all the categories under grouping structure, attributes, supplemental aspects, and level of specificity would be summed horizontally and listed under number three on the data sheet. The rationale for this was to have a more sensitive measure of any differences in the experimental groups. Under number two on the data sheet the number of responses made for groupings of 2, 4, and 6 might not reveal any significant differences, but when summed together they might. This is what number three on the data sheet would accomplish.

Number four on the data sheet

Number four on the data sheet lists the total score, by category, of all first reasons given for grouping. As previously indicated, the subjects were asked to give as many reasons as they could for each of their groupings. The pilot study indicated that college students give more reasons than do sixth graders. It was for this reason that it was deemed desirable to determine whether there was any difference in the experimental groups in the first reasons given. It was thought that first responses may be most representative of the initial response of the different subjects to the different experimental conditions.

Number five on the data sheet

Numbers five through ten on the data sheet list criterion scores based on the cognitive level of functioning represented by each category under grouping structure, attributes, supplementary aspects, and level of specificity. An individual whose cognitive functioning is mature would have a higher score than one who is less mature. Figure 5 is a classification scoring chart which lists quantitatively what each scoring category is worth on a cognitive continuum. This

Grouping Structure

Type

A. Superordinate (3 Points)
B. Complex (2 Points)
C. Thema (1 Point)

Attributes

Level I (1 Point)

Simple Association
D. Heaping (1 Point)
E. Itemized naming (1 Point)
F. Fiat (1 Point)
G. Edge matching (1 Point)

Level II (2 Points)

Concrete
H. Perceptual labeling (2 Points)
I. Perceptual attributes (2 Points)
J. Perceptual location (2 Points)
K. Functional association (2 Points)
L. Functional dependence (Extrinsic)(2 Points)
M. Functional dependence (Intrinsic)(2 Points)
N. Functional dependence (Situational) (2 Points)

Level III (3 Points)

Representational
O. Simple representational (3 Points)
P. Compound representational (3 Points)
Q. Relational (3 Points)
R. Symbolic (3 Points)
S. Affective representational (Simple) (3 Points)
T. Affective representational (Abstract) (3 Points)

Supplemental Aspects

Quality of Response

U. Partial use of stimuli (1 Point)
V. Exceptional quality of response (3 Points)
W. Poor quality of response (0 Points)
X. Regular or no extra supplemental aspects (2 Points)

Level of Specificity Hierarchies

1. Specific (1 Point)
2. Middle (2 Points)
3. General (3 Points)

Figure 5. Classification scoring chart by points

continuum is based on the work of Olver (1961), Rigney (1962), Carson (1965), and Low (1970). Number five on the score sheet subsumes scores on all the reasons given for all of the groupings, scored by the quantitative level of their cognitive functioning. Scored this way scores under number five on the data sheet would be the same as multiplying the scores under number two on the score sheet by their designated cognitive level (i.e. by the points they are worth) as illustrated in Figure 5. The rationale for scoring the data in this way was to determine whether there were any differences on a continuum of cognitive functioning, among the experimental groups. This technique was thought to be a sensitive method for ascertaining this.

Number six on the data sheet

Number six on the data sheet lists the total of all the reasons for all the groupings by their category cognitive level scores. This would be the same as summing the scores horizontally across number five of the score sheet. The rationale for this was to have a more sensitive measure of cognitive functioning from the cumulative scores of repeated groupings plus cumulative scores from the many reasons given for grouping.

Number seven on the data sheet

Number seven on the data sheet subsumes cognitive level scores for the first reasons given for grouping 2, 4 and 6 words or pictures. The rationale for this scoring technique was to test the difference between experimental groups without having the scores contaminated or inflated by the tendency of older subjects to give more reasons. Furthermore, by using only first reasons given for groupings we could determine whether there was any differences among experimental groups, in their initial responses, on a continuum of cognitive functioning.

Number eight on the data sheet

Number eight on the data sheet lists the total of the first reasons for all the groupings by their category cognitive level scores. This would be the same as summing the scores horizontally across number seven on the score sheet. The rationale for this was to have a more sensitive measure of differences in cognitive functioning among the experimental groups in the initial reasons given for grouping.

Number nine on the data sheet

Number nine on the data sheet subsumes cognitive level scores for reasons given for grouping 2, 4, and 6 words or pictures together. As previously indicated, occasionally many reasons were given for grouping a set of items together. Each reason was scored separately according to its grouping structure score, etc. The scores under number nine represent a collapsing together into one score all of the reasons given for grouping a set of items together. For example, a subject may have given several reasons for grouping together items; all the reasons would be viewed by the scorer as one reason, and the most predominant grouping structure, attributes, supplemental aspects, and level of specificity scores would be recorded. If there was just one reason given this was scored in the ordinary manner. The rationale for scoring the items in this manner was to control for the tendency of older subjects to give more responses. If all the responses were added together, their level of cognitive functioning scores would be inflated due to the number of responses. Scored according to our specifications, a single highest score was recorded which may be a more accurate evaluation of the level of cognitive functioning. This allows us to compare the single, highest reasons the subjects could give for grouping.

Number ten on the data sheet

Number ten on the data sheet lists the total of all the highest scores in groupings of 2, 4, and 6 stimuli made by the subjects in grouping structure, etc. It was thought that the totals would be a sensitive way to reveal any differences among the experimental groups in their highest level of cognitive functioning.

Number eleven through seventeen on the score sheet

Numbers eleven through seventeen on the score sheet list the totals summed vertically of the scores listed in grouping structure, attributes, supplementary aspects, and level of specificity.

Numbers eighteen through twenty-one on the score sheet

Number eighteen lists the number of unique reasons given by the subjects. Number nineteen, memory, lists the total number of stimuli the subjects could recall. Numbers twenty and twenty-one list the subjects' attitudes toward the stimuli and tasks as measured by the semantic differential.

Hypotheses generated by the data sheet

Appendix G contains a listing of the hypotheses generated by the data sheet.

Several computer analyses

The data was analyzed in several ways. First the data was analyzed comparing the two ways of grouping the stimuli and the two types of stimuli and the three different grade levels as illustrated in the three dimensional design in Figure 1. Secondly, in a future supplementary analysis the data will be analyzed comparing the experimental groups of sixth graders alone and comparing the experimental groups of college students alone. A third future exploratory analysis will be conducted using college students who grouped elaborate word descriptions as discussed previously.

Statistical methods used in the data analysis

The least squares analysis of variance and covariance computer program (Kemp, 1972) from the Kansas State University computer center was used to analyze the results of this study. It was used because it was the only available computer procedure appropriate for analyzing data with unequal subclass numbers, a covariant, and a three dimensional design. The computer analysis of covariance program for unequal subclasses yields a computer printout of an inverse matrix, an analysis of covariance source table for a three dimensional design with the degrees of freedom, sums of squares, mean squares, F ratio, and the probability. The source table is followed by a printout of the adjusted means (adjusted for differences in I.Q.) of the experimental groups. Appendix H contains an example of a printout of a thema analysis. If the source table shows a significant difference between direction or stimuli, all one need do to determine which is significantly higher is to look at the adjusted means printout. Because there are only two directions (increase versus decrease) and only two types of stimuli (words versus pictures) one may readily determine which of the two means are higher and significantly different. For example, in Appendix H direction 1, increasing, is significantly higher than direction 2, decreasing.

If significant interactions are present while a main effect involved in the same interaction is also significant, one must usually base his inferences on the interaction and disregard the main effect. With no interaction the effects of the two factors are additive. For example, the mean is uniformly increased or decreased by some constant for each factor, thus the effect of one factor is an increase or decrease in the mean. However, when there are interactions the effects are not additive and the mean is not uniformly changed by the factor (Snedecor and Cochran, 1967, pp. 344-346).

The inverse matrix elements must be used to compute the standard error term for the least significant differences for the class, direction by stimuli interaction, direction by class interaction and stimuli by class interactions because the arithmetic means are biased by the unequal cell sizes or other factors not in the interaction.

The bias may result from some of the means having more observations than other means do from one of the treatments. "The only way two means may be meaningfully compared is to adjust them to the values they would have if they had the same frequency of all treatment effects." (Kemp, 1972, p. 44). The correct standard error term is obtained by using elements of the inverse matrix (Kemp, 1972, pp. 44-47). The inverse matrix is the solution of a set of simultaneous equations which may be used to estimate the parameters of the analysis model (Snedecor and Cochran, 1967, pp. 389-391 and pp. 488-493; Kemp, 1972, pp. 33-36).

An example of the least significant differences (LSD) calculations using the inverse matrix formula for the significant class interactions from the printout in Appendix H is presented in Appendix I.

The least significant difference equations for calculations involving the inverse matrix with the class, direction by stimuli, direction by class, and stimuli by class interactions are presented in Appendix J.

When testing for significant differences between adjusted means in significant three-way interactions (direction by stimuli by class), the regular least significant difference test may not be used with the analysis of covariance because the subclass means have been adjusted for the covariant and this must be taken into account by the following formula:

$$\text{L.S.D} = t_{\alpha, n} \sqrt{MS_E \quad \frac{1}{n_1} + \frac{1}{n_2} + \frac{(\bar{x}_1 - \bar{x}_2)^2}{SS_{co}}}$$

MS_E is the error mean square from the analysis of covariance table of the variable.

$t_{\alpha, n}$ is the t statistic with n = error mean square degrees of freedom at the α level.

n_1 and n_2 are the subclass cell sizes for the two means being compared.

$\bar{x}_1$ and $\bar{x}_2$ are the subclass means for the covariate.

SS_{co} is the error sum of squares for the covariate analysis of variance.

We can use this least significant difference test for the three way interactions because the three-way means are not biased by unequal cell sizes or any other factors since there are no other factors (Snedecor and Cochran, 1967, pp. 429-432).

In summary, the analysis of the dependent variables in this study utilized the least squares analysis of variance and covariance and the appropriate least significant differences tests as previously discussed. All tests were set at the 0.05 level of significance.

Summary

The design of this study is three dimensional. Basically there are two categories in A and B and three categories in C (2 x 2 x 3). Factor A exposes each of its subjects to three conditions in each of its two categories. Factor A refers to the direction of forming groups by the subjects. In category A_1 the subjects form groups by progressively increasing the sizes of their groupings from 2 to 4 to 6. In category A_2 the subjects progressively decrease the sizes of their groupings from 6 to 4 to 2. Factor B is the form of the stimuli used in the groupings made by the subjects. Category B_1 is pictures; B_2 is words. Factor C is the grade level of the subjects. Category C_1 is sixth grade students; C_2 is freshmen college students; C_3 is college juniors and seniors. To summarize some of the innovations in the present study it can be stated that the three dimensional design allows us to compare the effects of direction of forming groups, grade level, and form of stimuli on equivalence classifying. In addition, we are able to determine any A x B x C interaction effects as a result of progressively changing the sizes of the groups.

The study utilized sixth grade students from elementary schools in the area of Emporia, Kansas, and freshmen and junior and senior college students from Kansas State Teachers College. Before the main study was conducted a pilot study was conducted to obtain information concerning the procedures, instructions, analysis and scoring method, feasibility, and other aspects related to conducting the study.

The group of subjects used in this study were first administered the Lorge-Thorndike Verbal Test of Intelligence and assigned randomly to experimental conditions. Approximately a week later they were asked to group words or pictures and write their reasons for their groupings. About two days following the groupings the subjects were asked to recall as many of the words or pictures as they could, and then they were asked to respond to a semantic differential which tested their attitudes.

The following hypotheses, stated in the null form, were proposed:

1. It was hypothesized that under conditions designed to test the trends and limits of cognitive efficiency there would be no differences among the experimental groups in the grouping structure used in classifying.

2. It was hypothesized that under conditions designed to test the level of abstractness used in classifying there would be no differences among the experimental groups in the grouping attributes used in classifying.

3. It was hypothesized that under conditions designed to test the quality used in grouping there would be no differences among the experimental groups in the supplemental aspects used in classifying.

4. It was hypothesized that there would be no differences among the experimental groups in the level of specificity used in classifying.

5. It was hypothesized that there would be no differences among the experimental groups in the number of unique reasons used in classifying.

6. It was hypothesized that there would be no differences among the experimental groups in the number of stimuli (words or pictures) they could recall after classifying.

7. It was hypothesized that there would be no differences among the experimental groups in their attitudes toward the stimuli after classifying.

8. It was hypothesized that there would be no differences among the experimental groups in their attitudes toward the tasks after classifying.

Two limitations of the study were that only students from the Emporia, Kansas, location were used in the study, and the responses that were scored on the basis of structure, attribute, supplemental aspects, and level of specificity were done so subjectively. The definitions of structure, attribute and supplemental aspects used for grouping were the same as those used by Carson (1965) who adopted them from Olver (1961). The definitions of the levels of specificity were adopted from Olver (1961).

The experimental instruments were pictures, words, a response sheet, the Lorge Thorndike Verbal Test of Intelligence, and the semantic differential. The pictures were an array of twenty-four black and white drawn pictures. The words were an array of twenty-four words printed on similar sized squares as the pictures and accurately describing the pictures. The semantic differential (Osgood, Suci and Tannenbaum, 1957, pp. 50-62) was constructed from bipolar adjectives found to be indicative of an evaluation factor when used to rate concepts.

Scoring of the subjects' responses was done on the response sheets. Then, each subject's scores were transferred to a data sheet in preparation for statistical analysis of the results of the study. The scores were analyzed by computer at Kansas State University using appropriate analysis of variance techniques which were able to control for differences in intelligence among the experimental groups. The data was scored and ordered on the data sheet for analysis in numerous ways. The analysis of the dependent variables in this study utilized the least squares analysis of variance and covariance and the appropriate least significant differences tests. All tests were set at the 0.05 level of significance.

CHAPTER IV

RESULTS

Introduction

The results of the experiment were scored in many ways to maximize the sensitivity of the measuring instrument as was discussed in Chapter Three. Some preliminary analyses of the data were conducted to determine which of the scoring techniques would be appropriate, and which statistical techniques would be valid for the statistical analyses. Following the preliminary analyses the results of the statistical analyses are presented.

Preliminary analyses of the data

In order to determine if the analysis of covariance technique was necessary, an analysis of variance was conducted to determine if there were any differences in intelligence between the experimental groups. The summary of the analysis of variance for differences in intelligence among experimental groups is given in Table 1. The summary shows that there is a significant difference between class levels in intelligence. Table 2 shows the summary of the least significant differences between class levels on the mean intelligence scores. The analysis shows that the six grade (mean intelligence = 100.218), freshmen (mean intelligence = 105.890), and junior and seniors (mean intelligence = 113.006) are all significantly different from one another. Therefore, the analysis of covariance technique was utilized to control for differences in intelligence among the experimental groups.

Table 1. Summary of the analysis of variance for differences in I.Q. among experimental groups

Source of variation	df	Sums of squares	Mean squares	F-ratio	Probability
Direction	1	39.146	39.146	0.269	0.6047
Stimuli	1	376.055	376.055	2.584	0.1097
Class	2	4380.787	2190.394	15.052	0.0000*
Direction by stimuli	1	2.481	2.481	0.017	0.8963
Direction by class	2	102.724	51.362	0.353	0.7032
Stimuli by class	2	56.695	28.347	0.195	0.8232
Direction by stimuli by class	2	148.876	74.438	0.512	0.6005
Residual	172	25028.980	145.517		
Total	183	30121.035			

*Significant beyond the .05 level.

Table 2. Summary of the least significant differences between class levels on the intellectual quotients

Comparison of experimental group means		Absolute difference between means	t	Least significant difference between means	Conclusion
Six grade	= 100.218				
versus		5.672	1.960	4.163	$P < 0.05$
freshmen	= 105.890				
Six grade	= 100.218				
versus		12.788	1.960	4.359	$P < 0.05$
jr. and sr.	= 113.006				
Freshmen	= 105.890				
versus		7.116	1.960	5.339	$P < 0.05$
jr. and sr.	= 113.006				

Another preliminary analysis was conducted to determine which of the scoring techniques would be appropriate to use in the analysis of covariance to determine dependent variable differences among the experimental groups. The subjects were instructed to write at least one reason, and as many reasons as they could for grouping the stimuli together. During the pilot study indications were revealed that older subjects had a tendency to give more reasons for grouping items together. To determine if this occurred during the main study an analysis of covariance was calculated on the total number of responses given by the subjects in the experimental groups. Table 3 is the summary of the analysis of covariance between the adjusted means of the experimental groups on the total number of grouping responses given when classifying. The analysis of covariance reveals that there is a significant difference between the classes in the number of grouping responses given. Table 4, the summary of the least significant differences between the class adjusted means on the total number of grouping responses, shows that the sixth grade (mean responses = 13.112) was significantly lower than the freshmen (mean responses = 14.642) and the juniors and seniors (mean responses = 15.409). There was no significant difference between the freshmen and juniors and seniors.

Because there was a significant difference between the classes in the number of reasons given for classifying, it was decided to report only those analyses which were based on scores uncontaminated by differences in the numbers of responses between the experimental groups. This type of analysis has precedence in the study by Olver (1961) in which only first responses were used. The scoring techniques which are uncontaminated by differences in the numbers of responses are number

Table 3. Summary of the analysis of covariance between the experimental groups on the total number of grouping responses given when categorizing

Source of variation	df	Sums of squares	Mean squares	F-ratio	Probability
Direction	1	4.431	4.431	0.293	0.5888
Stimuli	1	1.932	1.932	0.128	0.7210
Class	2	130.159	65.080	4.309	0.0149*
Direction by stimuli	1	50.681	50.681	3.356	0.0687
Direction by class	2	13.849	6.924	0.458	0.6331
Stimuli by class	2	71.687	35.843	2.373	0.0962
Direction by stimuli by class	2	52.935	26.467	1.752	0.1764
I.Q. (covariant)	1	20.676	20.676	1.369	0.2436
Residual	171	2582.749	15.104		
Total	183	2984.560			

*Significant beyond the .05 level.

Table 4. Summary of the least significant differences between the class adjusted means on the total number of grouping responses

Comparison of experimental group means		Absolute difference between means	t	Least significant difference between means	Conclusion
Six grade versus freshmen	= 13.112 = 14.642	1.530	1.960	1.341	$P < 0.05$
Six grade versus jr. and sr.	= 13.112 = 15.409	2.297	1.960	1.635	$P < 0.05$
Freshmen versus jr. and sr.	= 14.642 = 15.409	0.767	1.960	1.466	N.S.

four on the data sheet, number eight on the data sheet, and number ten on the data sheet. These were the three scoring techniques which were used in the analysis of covariance and which are reported in this study.

Number four on the data sheet lists the total score, by category, of all first reasons given for grouping. It was thought that first responses may be most representative of the initial response of the different subjects to the different experimental conditions. Number eight on the data sheet lists the total of the first reasons for all the groupings by their category cognitive level score as illustrated in Figure 5. For example, a superordinate response is worth three points, a complex response is worth two points, and a thema response is worth one point. Number ten on the data sheet lists the total of all the single highest cognitive level scores given by the subjects. This allows a comparisons of the single highest reasons the subjects could give for their grouping, and permits a determination of any differences among the experimental groups in their highest level of cognitive functioning.

In the following section in which the results of the statistical analyses are presented the data is from scoring technique number eight which appears to be the most sensitive measure of the dependent variables. The results of the three different analyses are almost identical. Therefore the data analyses from number four and ten on the data score sheet are contained in the appendixes. The data analyses from number four on the data score sheet are presented in Appendix K, and the data analyses from number ten on the data sheet are presented in Appendix L.

Results of the Analyses

Contained in the following section are the analysis of covariance tests for significant differences between the experimental groups on grouping structure, attributes, supplemental aspects, level of specificity, unique reasons, memory, and stimuli and task attitudes.

Grouping Structure

The grouping structure refers to how different items are classified together. In the present study the grouping structure was categorized as superordinate, complex, or thema. Hypothesis one states that under conditions designed to test the trends and limits of cognitive efficiency there would be no differences among the experimental groups in the grouping structure used.

Superordinate

In the superordinate grouping structure items are perceived and grouped as equivalent because of one or more common attributes. Table 5 is the summary of the analysis of covariance between the experimental groups on the superordinate cognitive level scores. The analysis reveals that there is a significant difference between the directions of grouping. The mean superordinate score for increasing group size is 14.525 compared with 23.420 for the decreasing groups. Therefore, decreasing group size appears to result in more superordinate responses and thus a higher level of cognitive functioning.

Table 5. Summary of the analysis of covariance between the experimental groups on the total number of superordinate responses scored according to the first category cognitive level score

Source of variation	df	Sums of squares	Mean squares	F-ratio	Probability
Direction	1	3230.397	3230.397	33.635	0.0000*
Stimuli	1	82.493	82.493	0.859	0.3553
Class	2	40.616	20.308	0.211	0.8096
Direction by stimuli	1	5.016	5.016	0.052	0.8195
Direction by class	2	413.552	206.776	2.153	0.1195
Stimuli by class	2	302.379	151.190	1.574	0.2104
Direction by stimuli by class	2	252.389	126.195	1.314	0.2716
I.Q. (covariant)	1	4.082	4.082	0.043	0.8369
Residual	158	15174.656	96.042		
Total	170	20014.102			

*Significant beyond the .05 level.

Complex

In the complex grouping structure items are perceived and grouped as equivalent on the basis of several different or changing attributes. Subgroups are often used.

Table 6 is the summary of the analysis of covariance between the experimental groups on the complex cognitive level scores. The analysis shows that there are no significant differences among the groups.

Thema

In the thema grouping structure items are grouped because of some way they go together in a thema or story created by the student. Table 7 is the summary of the analysis of covariance between the experimental groups on the thema cognitive level scores. The analysis reveals that there are significant differences between the directions, the classes, and a three-way interaction effect between direction by stimuli by class. The mean thema score for increasing groups is 5.689 compared with 4.068 for the decreasing groups. This indicates that the increasing groups use significantly more of the thema responses which are a less efficient way of grouping stimuli when compared to the complex and superordinate structures. Therefore, the decreasing groups used significantly fewer of the less efficient thema responses.

There was a significant difference between the classes. Table 8 is a summary of the least significant differences between the class adjusted means on the thema cognitive level scores.

This analysis shows a significant difference between the six grade and the freshmen groups, with the sixth grade group having a mean score of 6.187 compared to the freshmen score of 3.411. Thus, the six grade

Table 6. Summary of the analysis of covariance between the experimental groups on the total number of complex responses scored according to the first category cognitive level score

Source of variation	df	Sums of squares	Mean squares	F-ratio	Probability
Direction	1	6.044	6.044	0.419	0.5187
Stimuli	1	2.453	2.453	0.170	0.6808
Class	2	62.976	31.488	2.182	0.1169
Direction by stimuli	1	0.082	0.082	0.006	0.9399
Direction by class	2	20.654	10.327	0.716	0.4907
Stimuli by class	2	0.792	0.396	0.027	0.9729
Direction by stimuli by class	2	33.121	16.560	1.148	0.3205
I.Q. (covariant)	1	3.996	3.996	0.277	0.5996
Residual	131	1890.282	14.430		
Total	143	2052.160			

*Significant beyond the .05 level.

Table 7. Summary of the analysis of covariance between the experimental groups on the total number of thema responses scored according to the first category cognitive level score

Source of variation	df	Sums of squares	Mean squares	F-ratio	Probability
Direction	1	73.041	73.041	4.695	0.0323*
Stimuli	1	36.182	36.182	2.326	0.1299
Class	2	151.697	75.848	4.876	0.0092*
Direction by stimuli	1	7.719	7.719	0.496	0.4826
Direction by class	2	16.688	8.344	0.536	0.5863
Stimuli by class	2	35.345	17.672	1.136	0.3245
Direction by stimuli by class	2	122.078	61.039	3.924	0.0224*
I.Q. (covariant)	1	4.998	4.998	0.321	0.5719
Residual	118	1835.582	15.556		
Total	130	2295.969			

*Significant beyond the .05 level.

Table 8. Summary of the least significant differences between the class adjusted means on the total number of first thema responses scored according to the category cognitive level score

Comparison of experimental group means	Absolute difference between means	t	Least significant difference between means	Conclusion
Six grade = 6.187 versus freshmen = 3.411	2.776	2.000	1.798	$P < 0.05$
Six grade = 6.187 versus jr. and sr. = 5.037	1.150	2.000	1.996	N. S.
Freshmen = 3.811 versus jr. and sr. = 5.037	1.226	2.000	1.798	N. S.

group used significantly more of the thema responses than did the freshmen. There was no significant difference between six grade and and juniors and seniors, nor was there a significant difference between freshmen and juniors and seniors. It can be concluded that six grade students use significantly more of the less efficient thema grouping structure than do freshmen.

Table 7 reveals a significant direction by stimuli by class interaction effect. Table 9 is the summary of the least significant differences between the direction by stimuli by class means on the thema cognitive level scores. A significant difference was found indicating a higher thema score (mean score = 8.003) for the decrease by pictures by six grade experimental group when it was compared with the decrease by pictures by freshmen (mean score = 2.096), the decrease by words by freshmen (mean score = 2.160), the decrease by words by six grade (mean score = 2.739), the increase by words by junior and senior (mean score = 3.378), and the increase by pictures by freshmen (mean score = 4,347) experimental groups. These comparisons indicate that the decrease, pictures and six grade factors are three potent factors that interact to produce more thema responses. The significantly lower groups have fewer thema responses because of the influence of the freshmen and junior and senior factors as well as, perhaps, the word factor. An important significant difference shows that six graders grouping decreasingly with pictures produce more thema responses than with words.

A significant difference was found indicating a higher thema score (mean score = 7.706) for the increase by words by six grade

Table 9. Summary of the least significant differences between the direction by stimuli by class adjusted means on the total of the first response thema scores

Direction by stimuli by class ranked by means	No. of Ss.	Ranked means	Mean differences 12	11	10	9	8	7	6	5	4	3	2
(1) Decrease by pictures by six grade	8	8.033	5.937*	5.873*	5.294*	4.655*	3.686*	3.436	3.253	2.991	1.763	0.639	0.327
(2) Increase by words by six grade	11	7.706	5.610*	5.546*	4.967*	4.328*	3.359*	3.109	2.926	2.664	1.436	0.312	
(3) Increase by pictures by jr. and sr.	14	7.394	5.298*	5.234*	4.655*	4.016*	3.047*	2.797	2.614	2.352	1.124		
(4) Increase by pictures by six grade	12	6.270	4.174*	4.110*	3.531	2.892	1.923	1.673	1.490	1.228			
(5) Increase by words by freshmen	19	5.042	2.946	2.882*	2.303	1.664	0.695	0.445	0.262				
(6) Decrease by words by jr. and sr.	5	4.780	2.684	2.620	2.041	1.402	0.433	0.183					
(7) Decrease by pictures by jr. and sr.	9	4.597	2.501	2.437	1.858	1.219	0.250						
(8) Increase by pictures by freshmen	17	4.347	2.251	2.187	1.608	0.969							
(9) Increase by words by jr. and sr.	11	3.378	1.282	1.218	0.639								
(10) Decrease by words by six grade	6	2.739	0.643	0.579									
(11) Decrease by words by freshmen	13	2.160	0.064										
(12) Decrease by pictures by freshmen	6	2.096											

Least significant difference values between means: *for .05 level of significance = 2.00

experimental group when it was compared with the decrease by pictures by freshmen (mean score = 2.096), the decrease by words by freshmen (mean score = 2.160), the decrease by words by six grade (mean score = 2.739), the increase by words by junior and senior (mean score = 3.378), and the increase by pictures by freshmen (mean score = 4.347) experimental groups. These significant differences appear to be a result of the influence of six grade factor producing more thema responses. An important comparison occurs between the increase by words by six grade and the decrease by words by six grade. Apparently the increase factor results in significantly more thema responses.

A significant difference was found indicating a higher thema score (mean score = 7.394) for the increase by pictures by junior and senior experimental group when it was compared with the decrease by pictures by freshmen (mean score = 2.096), the decrease by words by freshmen (mean score = 2.160), the decrease by words by six grade (mean score = 2.739), the increase by words by junior and senior (mean score = 3.378), and the increase by pictures by freshmen (mean score = 4.347) experimental groups. The increase by pictures by junior and senior interaction appears to be a potent combination in producing thema responses. An important interaction is evident when comparing the increase by pictures by junior and senior group with the increase by word by junior and senior group. It appears that in combination with increase and junior and senior the factor of words results in fewer thema responses.

A significant difference was found indicating a higher thema score (mean score = 6.270) for the increase by pictures by six grade experimental group when it was compared with the decrease by pictures by freshmen (mean score = 2.096), and the decrease by words by freshmen (mean score = 2.160) experimental groups. These differences can be accounted for by the observation that the decrease, and freshmen factors interact with pictures or words to produce very low thema scores. On the other hand the observation has been made that the six grade factor in combination with pictures and/or increase factors produce high thema scores.

A significant difference was found indicating a higher thema score (5.042) for the increase by words by freshmen experimental group when it was compared with the decrease by words by freshmen (2.160) experimental group. One may suspect from this comparison that the factor of increasing the size of the groups interacted with the words and freshmen to produce more of the lower cognitive level thema structure responses. The apparent difference here is between the decrease and increase grouping. It appears that increasing, at least in combination with words and freshmen, produce more thema responses.

In summary of the thema results, increasing group size results in more thema responses, and the six grader group produces more thema responses. The three-way interactions appear to be influenced by the single and combined effects of these two potent thema facilitators.

Total of the grouping structure scores

Table 10 is the summary of the analysis of covariance on the total of the grouping structure cognitive level scores. It reveals a significant difference between the directions of grouping the stimuli. The mean grouping cognitive level score for increasing group size is 23.893 compared with 28.578 for decreasing group size. A higher

Table 10. Summary of the analysis of covariance between the experimental groups on the total of the grouping structure responses scored according to the first category cognitive level score

Source of variation	df	Sums of squares	Mean squares	F-ratio	Probability
Direction	1	969.857	969.857	21.427	0.0000*
Stimuli	1	69.014	69.014	1.525	0.2185
Class	2	156.735	78.367	1.731	0.1802
Direction by stimuli	1	35.808	35.808	0.791	0.3750
Direction by class	2	159.218	79.609	1.759	0.1754
Stimuli by class	2	173.229	86.615	1.914	0.1507
Direction by stimuli by class	2	207.233	103.617	2.289	0.1045
I.Q. (covariant)	1	1.052	1.052	0.023	0.8790
Residual	170	7694.613	45.262		
Total	182	9518.688			

*Significant beyond the .05 level.

grouping structure score represents a higher and more efficient cognitive level of functioning when grouping together stimuli. Therefore, in overall efficiency decreasing group size appears to result in a higher cognitive level of functioning.

Summary of the grouping structure analyses

Decreasing group size has resulted in higher superordinate cognitive level scores, lower thema cognitive level scores, and a higher overall grouping structure score. This indicates that decreasing group size is related to higher cognitive level functioning and a more efficient grouping structure. There was no significant directional difference, or any other significant difference, among the complex responses analysis.

In the thema analysis there was a significant directions difference, a significant class difference, and a significant direction by stimuli by class interaction. In the significant directional difference increasing groups produced more thema scores. In the significant class differences it was evident that the six grade group had significantly more thema responses than did the freshmen. Although there were no significant differences in thema responses between the freshmen and juniors and seniors, unexpectedly, there was no significant difference between the six grade and the junior and senior thema scores.

There were many differences among experimental group means when testing the direction by stimuli by class interactions. These interaction effects appear to be influenced by the single and combined effects of the six grade and increase factors to produce more thema responses.

Grouping Attributes

The grouping attributes refers to the criteria or attributes of the stimuli on which the items are grouped. In the present study the grouping attributes were categorized as simple association, concrete, and representational. Each of these three levels of attributes have many subcategories as was discussed in chapter three. Simple association subsumes heaping, itemized naming, fiat, and edge matching. Concrete subsumes perceptual labeling, perceptual attributes, perceptual location, functional association, functional dependence (extrinsic), functional dependence (intrinsic), and functional dependence (situational). Representational subsumes simple representational, compound representational, relational, symbolic, affective representational (simple), and affective representational (abstract).

Hypothesis two states that under conditions designed to test the level of abstractness used in classifying there would be no differences among the experimental groups in the grouping attributes used in classifying.

Simple Association Attributes

Heaping

In the heaping grouping attribute no attribute seems apparent. Items seem to be grouped fortuitously or on the basis of juxtaposition. Table 11 is the summary of the analysis of covariance between the experimental groups on the total heaping cognitive level score. The table shows no significant differences. There were very few responses made in

Table 11. Summary of the analysis of covariance between the experimental groups on the total number of heaping responses scored according to the first category cognitive level score

Source of variation	df	Sums of squares	Mean squares	F-ratio	Probability
Direction	1	0.704	0.704	1.297	0.2726
Stimuli	1	0.005	0.005	0.010	0.9225
Class	2	0.389	0.195	0.359	0.7045
Direction by stimuli	1	0.088	0.088	0.162	0.6927
Direction by class	2	0.626	0.313	0.576	0.5739
Stimuli by class	2	1.466	0.733	1.351	0.2888
Direction by stimuli by class	1	0.110	0.110	0.202	0.6596
I.Q. (covariant)	1	0.060	0.060	0.110	0.7445
Residual	15	8.140	0.543		
Total	26	12.000			

*Significant beyond the .05 level.

this category and there were no responses in one cell (increase by pictures by six grade).

Itemized naming

In the itemized naming grouping attribute, items are grouped without rationale other than that each can be named or labeled. Response may show knowledge of directions and a common attribute may be implicit. There were no responses in this category; therefore, an analysis was not conducted.

Fiat

In the fiat grouping attribute, items are grouped but the rationale fails to adequately explain the basis. There were no responses in this category; therefore, an analysis was not conducted.

Edge matching

In the edge matching grouping attribute, the attribute used for grouping changes from item to item. It occurs frequently in conjunction with thematic structure. Table 12 is the summary of the analysis of covariance between the experimental groups on the total edge matching cognitive level scores. As the table indicates there was a significant direction by stimuli by class interaction effect. Table 13 is the summary of the least significant differences between the direction by stimuli by class means on the edge matching cognitive level scores. A significant difference was found indicating a higher edge matching score (5.930) for the decrease by pictures by six grade experimental group when it was compared with the decrease by words by six grade (1.321) and the decrease by pictures by freshmen (2.061) experimental groups.

Table 12. Summary of the analysis of covariance between the experimental groups on the total number of edge matching responses scored according to the first category cognitive level score

Source of variation	df	Sums of squares	Mean squares	F-ratio	Probability
Direction	1	5.614	5.614	1.106	0.2962
Stimuli	1	1.135	1.135	0.224	0.6377
Class	2	4.440	2.220	0.437	0.6474
Direction by stimuli	1	4.273	4.273	0.842	0.3617
Direction by class	2	2.318	1.159	0.228	0.7964
Stimuli by class	2	15.724	7.862	1.549	0.2189
Direction by stimuli by class	2	42.603	21.301	4.196	0.0186*
I.Q. (covariant)	1	2.502	2.502	0.493	0.4847
Residual	78	395.946	5.076		
Total	90	459.033			

*Significant beyond the .05 level.

Table 13. Summary of the least significant differences between the direction by stimuli by class adjusted means on the total of the first response edge matching scores

Direction by stimuli by class ranked by means	No. of Ss.	Ranked means	Mean differences 12	11	10	9	8	7	6	5	4	3	2
(1) Decrease by pictures by six grade	4	5.930	4.609*	3.869*	2.886	2.791	2.495	2.473	2.710	1.976	1.881	1.533	0.925
(2) Increase by words by six grade	7	5.005	3.684	2.944	1.961	1.866	1.570	1.548	1.487	1.051	0.956	0.608	
(3) Increase by pictures by jr. and sr.	11	4.397	3.076	2.336	1.353	1.258	0.962	0.940	0.879	0.443	0.348		
(4) Increase by words by freshmen	16	4.049	2.737	1.988	1.005	0.910	0.614	0.592	0.531	0.095			
(5) Decrease by words by jr. and sr.	4	3.954	2.633	1.893	0.910	0.815	0.519	0.497	0.436				
(6) Increase by pictures by freshmen	16	3.518	2.197	1.457	0.474	0.379	0.083	0.061					
(7) Decrease by words by freshmen	9	3.457	2.136	1.396	0.413	0.318	0.022						
(8) Increase by pictures by six grade	7	3.435	2.114	1.374	0.391	0.296							
(9) Decrease by pictures by jr. and sr.	5	3.139	1.818	1.078	0.095								
(10) Increase by words by jr. and sr.	7	3.044	1.723	0.983									
(11) Decrease by pictures by freshmen	3	2.061	0.740										
(12) Decrease by words by six grade	2	1.321											

Least significant difference values between means: *for .05 level of significance = 2.00

Apparently pictures in combination with decrease and six grade factors interact to produce more edge matching responses, in comparison to the influences of words or freshmen factors.

Total of the simple association attribute scores

Table 14 is the summary of the analysis of covariance on the total of the simple association attribute cognitive level scores. The table reveals a significant direction effect and a significant direction by stimuli by class interaction effect. The mean simple association score for increasing group size is 3.798 compared with 2.645 for the decreasing groups. This result indicates that increasing group size results in more of the lower level simple association responses compared with decreasing group size.

Table 15 is the summary of the least significant differences between the direction by stimuli by class means on the simple association cognitive level scores. A significant difference was found indicating a higher simple association attribute score (mean score = 4.606) for the increase by words by six grade experimental group when it was compared with the decrease by words by six grade (mean score = 1.204), and the decrease by pictures by freshmen (mean score = 1.504) experimental groups. This result can be explained by the potent effects of the increase factor in combination with the word and six grade factors to produce more simple association associations. As can be noted, the two lowest simple association scores have the decrease factor which has been demonstrated to produce fewer simple association responses. Apparently in combination with pictures with the freshmen, and in combination with words with the six grade the decrease factor interacts to produce very few simple association responses.

Table 14. Summary of the analysis of covariance between the experimental groups on the total of the simple association attributes scored according to the first category cognitive level score

Source of variation	df	Sums of squares	Mean squares	F-ratio	Probability
Direction	1	31.879	31.879	6.706	0.0110*
Stimuli	1	0.119	0.119	0.025	0.8746
Class	2	1.061	0.530	0.112	0.8945
Direction by stimuli	1	1.379	1.379	0.290	0.5914
Direction by class	2	2.289	1.144	0.241	0.7865
Stimuli by class	2	14.660	7.330	1.542	0.2190
Direction by stimuli by class	2	44.360	22.180	4.665	0.0116*
I.Q. (covariant)	1	2.359	2.359	0.496	0.4828
Residual	100	475.408	4.754		
Total	112	560.141			

*Significant beyond the .05 level.

Table 15. Summary of the least significant differences between the direction by stimuli by class adjusted means on the total of the first response simple association attribute scores

Direction by stimuli by class ranked by means	No. of Ss.	Ranked means	Mean differences 12	11	10	9	8	7	6	5	4	3	2
(1) Increase by words by six grade	9	4.606	3.402*	3.102*	1.807	1.705	1.555	1.523	1.426	0.856	0.615	0.509	0.117
(2) Increase by pictures by jr. and sr.	11	4.489	3.285*	2.985*	1.690	1.588	1.438	1.406	1.309	0.739	0.498	0.392	
(3) Decrease by pictures by six grade	7	4.097	2.893*	2.593*	1.298	1.196	1.046	1.014	0.917	0.347	0.106		
(4) Increase by words by freshmen	18	3.991	2.787*	2.487*	1.192	6.892	0.940	0.908	0.811	0.241			
(5) Increase by pictures by freshmen	16	3.750	2.546*	2.246*	0.951	0.849	0.699	0.667	0.570				
(6) Decrease by words by freshmen	12	3.180	1.976	1.676	0.381	0.279	0.129	0.097					
(7) Decrease by words by jr. and sr.	7	3.083	1.879	1.579	0.284	0.182	0.032						
(8) Increase by words by jr. and sr.	7	3.051	1.847	1.547	0.252	0.150							
(9) Increase by pictures by six grade	9	2.901	1.697	1.397	0.102								
(10) Decrease by pictures by jr. and sr.	7	2.799	1.595	1.295									
(11) Decrease by pictures by freshmen	6	1.504	3.000										
(12) Decrease by words by six grade	4	1.204											

Least significant difference values between means: *for .05 level of significance = 2.00

A significant difference was found indicating a higher simple association attribute score (mean score = 4.489) for the increase by pictures by junior and senior experimental group when it was compared with the decrease by words by six grade (mean score = 1.204), and the decrease by pictures by freshmen (mean score = 1.504) experimental groups. In these interactions the increase factor appears to be the potent element which combines with the pictures and junior and senior elements to produce significantly more simple association responses.

A significant difference was found indicating a higher simple association attribute score (mean score = 4.097) for the decrease by pictures by six grade experimental group when it was compared with the decrease by words by six grade (mean score = 1.204), and the decrease by pictures by freshmen (mean score = 1.504) experimental groups. In the comparisons of the decrease by pictures by six grade groups, with the two lowest groups in simple association responses, it becomes apparent that the picture factor interacts with the decrease and six grade factors to produce significantly more simple association responses.

A significant difference was found indicating a higher simple association attribute score (mean score = 3.991) for the increase by words by freshmen experimental group when it was compared with the decrease by words by six grade (mean score = 1.204), and the decrease by pictures by freshmen (mean score = 1.504) experimental groups. In this case it appears that the increase factor is responsible for the significantly higher increase by words by freshmen simple association score.

A significant difference was found indicating a higher simple association attribute score (3.750) for the increase by pictures by freshmen experimental group when it was compared with the decrease by words by six grade (1,204), and the decrease by pictures by freshmen (1,504) experimental groups. In this comparison it is evident that the increase factor is the element responsible for a higher simple association score in the increase by pictures by freshmen experimental group.

Summary of the simple association analyses

There were no significant results in the heaping attributes analysis. The itemized naming analysis and the fiat analysis were not conducted because no responses were scored in these categories. All three of the aforementioned categories appear to be of little use at the age levels in the present study. The edge matching analysis revealed a significant directional effect and a significant direction by stimuli by class interaction. The total analysis indicated that more simple association responses were given in the increasing groups. In the significant three-way interaction the decrease by pictures by freshmen and the decrease by words by six grade experimental groups were significantly lower than the increase by words by six grade, the increase by pictures by junior and senior, the decrease by pictures by six grade, the increase by words by freshmen, and the increase by pictures by freshmen experimental groups. The decrease factor in certain combination with words, six grade, and freshmen factors produces very few simple association responses.

Concrete Attributes

Perceptual labeling

In the perceptual labeling grouping attribute, essentially identical items are grouped on the basis of the same label applying to all of them. There were too few responses and an absence of responses in some cells, thus an analysis of this category is not presented.

Perceptual attributes

In the perceptual attributes category, items are grouped on the basis of some observable attribute or physical property. Table 16 is the summary of the analysis of covariance between the experimental groups on the perceptual attributes cognitive level scores. The analysis reveals a significant difference between the class levels. Table 17 is the summary of the least significant differences between the class means on the perceptual attribute cognitive level scores. A significant difference was found indicating a higher perceptual attributes score (mean score = 6.127) for the six grade experimental group when it was compared with the freshmen (mean score = 2.729), and the junior and senior (mean score = 2.687) experimental groups. There was no significant difference between the freshmen and junior and senior experimental groups. It can be concluded that six graders give more perceptual attribute responses than do freshmen or juniors and seniors.

Perceptual location

In the perceptual location category, items are grouped on the basis of going together in time or space. Table 18 is the summary of the analysis of covariance between the experimental groups on the

Table 16. Summary of the analysis of covariance between the experimental groups on the total number of perceptual attribute responses scored according to the first category cognitive level score

Source of variation	df	Sums of squares	Mean squares	F-ratio	Probability
Direction	1	18.848	18.848	1.149	0.2874
Stimuli	1	51.978	51.978	3.170	0.0795
Class	2	169.191	84.595	5.159	0.0082*
Direction by stimuli	1	2.564	2.564	0.156	0.6938
Direction by class	2	15.159	7.579	0.462	0.6318
Stimuli by class	2	68.636	34.318	2.093	0.1312
Direction by stimuli by class	2	13.231	6.616	0.403	0.6696
I.Q. (covariant)	1	76.012	76.012	4.636	0.0349
Residual	68	1114.988	16.397		
Total	80	1730.765			

*Significant beyond the .05 level.

Table 17. Summary of the least significant differences between the class adjusted means on the total number of first perceptual attribute responses scored according to the category cognitive level score

Comparison of experimental group means	Absolute difference between means	t	Least significant difference between means	Conclusion
Six grade = 6.127 versus freshmen = 2.729	3.398	2.000	2.304	$P < 0.05$
Six grade = 6.127 versus jr. and sr. = 2.687	3.440	2.000	2.586	$P < 0.05$
Freshmen = 2.729 versus jr. and sr. = 2.687	0.042	2.000	2.390	N.S.

Table 18. Summary of the analysis of covariance between the experimental groups on the total number of perceptual location responses scored according to the first category cognitive level score

Source of variation	df	Sums of squares	Mean squares	F-ratio	Probability
Direction	1	2.226	2.226	0.534	0.4688
Stimuli	1	2.896	2.896	0.694	0.4090
Class	2	10.093	5.046	1.210	0.3074
Direction by stimuli	1	1.723	1.723	0.413	0.5236
Direction by class	2	3.426	1.713	0.411	0.6655
Stimuli by class	2	7.404	3.702	0.888	0.4185
Direction by stimuli by class	2	7.344	3.672	0.881	0.4214
I.Q. (covariant)	1	0.862	0.862	0.207	0.6515
Residual	46	191.815	4.170		
Total	58	234.305			

*Significant beyond the .05 level.

perceptual location cognitive level scores. The analysis indicates no significant differences between the experimental groups.

Functional association

In the functional association category, items are grouped on the basis of a bond between them. "This goes with this" is a common phrase. Table 19 is the summary of the analysis of covariance between the experimental groups on the functional association cognitive level scores. The analysis indicates no significant differences between the experimental groups.

Functional dependence (extrinsic)

In the functional dependence (extrinsic) category items are grouped on the basis of the common way they can be used or acted upon by the subject. Usually it involves using the pronoun you or I in the stated reason for grouping. Table 20 is the summary of the analysis of covariance between the experimental groups on the functional dependence (extrinsic) cognitive level scores. The analysis indicates a significant difference between the directions and a significant difference between the class levels. The mean functional dependence (extrinsic) score for increasing group size is 2.353 compared with 4.037 for the decreasing groups. Therefore, the decreasing groups produce more functional dependence (extrinsic) responses. Table 21 is the summary of the least significant differences between the class level means. A significant difference was found indicating a higher functional dependence (extrinsic) score (mean score = 3.774) for the six grade experimental group when compared with the freshmen (mean

Table 19. Summary of the analysis of covariance between the experimental groups on the total number of functional association responses scored according to the first category cognitive level score

Source of variation	df	Sums of squares	Mean squares	F-ratio	Probability
Direction	1	22.431	22.431	2.175	0.1434
Stimuli	1	0.637	0.637	0.062	0.8042
Class	2	6.179	3.089	0.300	0.7418
Direction by stimuli	1	6.789	6.789	0.658	0.4191
Direction by class	2	17.119	8.559	0.830	0.4391
Stimuli by class	2	4.162	2.081	0.202	0.8176
Direction by stimuli by class	2	5.705	2.852	0.277	0.7590
I.Q. (covariant)	1	3.970	3.970	0.385	0.5364
Residual	101	1041.749	10.314		
Total	113	1112.281			

*Significant beyond the .05 level.

Table 20. Summary of the analysis of covariance between the experimental groups on the total number of functional dependence (extrinsic) responses scored according to the first category cognitive level score

Source of variation	df	Sums of squares	Mean squares	F-ratio	Probability
Direction	1	63.456	63.456	11.865	0.0009*
Stimuli	1	0.323	0.323	0.060	0.8066
Class	2	36.085	18.043	3.374	0.0389*
Direction by stimuli	1	0.008	0.008	0.002	0.9683
Direction by class	2	1.404	0.702	0.131	0.8772
Stimuli by class	2	6.157	3.078	0.576	0.5646
Direction by stimuli by class	2	2.792	1.396	0.261	0.7709
I.Q. (covariant)	1	23.633	23.633	4.419	0.0385
Residual	85	454.592	5.348		
Total	97	589.918			

*Significant beyond the .05 level.

Table 21. Summary of the least significant differences between the class adjusted means on the total number of first functional dependence (extrinsic) responses scored according to the single highest category cognitive level score

Comparison of experimental group means		Absolute difference between means	t	Least significant difference between means	Conclusion
Six grade	= 3.774				
versus		1.389	2.000	1.124	P< 0.05
freshmen	= 2.385				
Six grade	= 3.774				
versus		0.347	2.000	1.380	N.S.
jr. and sr.	= 3.427				
Freshmen	= 2.385				
versus		1.042	2.000	1.308	N.S.
jr. and sr.	= 3.427				

score = 2.385) experimental group. The junior and senior score (mean score = 3.427) showed no significant difference when compared with six grade or freshmen scores. In conclusion, six graders produce more functional dependence (extrinsic) responses than do freshmen; however, there are no differences between juniors and seniors and the other two class levels.

Functional dependence (intrinsic)

In the functional dependence (intrinsic) category, items are grouped on the basis of the common way they act. Their action is independent. Table 22 is the summary of the analysis of covariance between the experimental groups on the functional dependence (intrinsic) cognitive level scores. The analysis reveals that there is a significant difference between the class levels, and a significant stimuli by class interaction effect. Table 23 is the summary of the least significant differences between the class means on the functional dependence (intrinsic) scores. A significant difference was found indicating a higher functional dependence (intrinsic) score (mean score = 2.633) for the six grade class level when it was compared with the freshmen class level score (mean score = 0.845). There were no significant differences when the junior and senior score (mean score = 1.643) was compared with both the six grade and freshmen class levels. In conclusion, the six graders produce significantly more functional dependence (intrinsic) responses than do freshmen. However, there are no differences in functional dependence (intrinsic) responses between juniors and seniors and the freshmen and six grade groups.

Table 22. Summary of the analysis of covariance between the experimental groups on the total number of functional dependence (intrinsic) responses scored according to the first category cognitive level score

Source of variation	df	Sums of squares	Mean squares	F-ratio	Probability
Direction	1	0.066	0.066	0.028	0.8686
Stimuli	1	9.221	9.221	3.852	0.0567
Class	2	28.151	14.076	5.880	0.0058*
Direction by stimuli	1	6.577	6.577	2.748	0.1052
Direction by class	2	0.929	0.464	0.194	0.8244
Stimuli by class	2	17.569	8.784	3.670	0.0344*
Direction by stimuli by class	2	4.076	2.038	0.851	0.4344
I.Q. (covariant)	1	4.188	4.188	1.750	0.1934
Residual	40	95.746	2.394		
Total	52	176.453			

*Significant beyond the .05 level.

Table 23. Summary of the least significant differences between the class adjusted means on the total number of first functional dependence (intrinsic) responses scored according to the single highest category cognitive level score

Comparison of experimental group means		Absolute difference between means	t	Least significant difference between means	Conclusion
Six grade	= 2.633				
versus		1.788	2.021	1.487	$P < 0.05$
freshmen	= 0.845				
Six grade	= 2.633				
versus		0.990	2.021	1.219	N.S.
jr. and sr.	= 1.643				
Freshmen	= 0.845				
versus		0.798	2.021	1.182	N.S.
jr. and sr.	= 1.643				

Table 24 is the summary of the least significant differences between the stimuli by class means on the functional dependence (intrinsic) scores. A significant difference was found indicating a higher functional dependence (intrinsic) score (mean score = 2.934) for the pictures by six grade experimental group when it was compared with the pictures by freshmen (mean score = 0.591) experimental group. The six grade factor is undoubtedly the element responsible for the higher picture by six grade score. A significant difference was found indicating a higher score (mean score = 2.934) for the pictures by six grade group when compared with the words by junior and senior (mean score = 0.383) group. It appears that juniors and seniors interact with words to produce fewer functional dependence (intrinsic) responses. Or, perhaps, the six grade factor is a potent interaction agent in combination with pictures. It is difficult to determine which of the two above statements is more accurate.

A significant difference was found indicating a higher score (mean score = 2.903) for the pictures by junior and senior group when it was compared to the pictures by freshmen (mean score = 0.591) group. It is evident that juniors and seniors produce more functional dependence (intrinsic) responses when grouping with pictures than do freshmen.

A significant difference was found indicating a higher score (mean score = 2.903) for the pictures by junior and senior group when it was compared with the words by freshmen (mean score = 1.100) group. Juniors and seniors grouping pictures produce more functional dependence (intrinsic) responses then do freshmen grouping words.

A significant difference was found indicating a higher functional dependence (intrinsic) score (mean score = 2.903) for the pictures by

Table 24. Summary of the least significant differences between the stimuli by class adjusted means on the total number of first functional dependence (intrinsic) responses scored according to the category cognitive level score

Comparison of experimental group means		Absolute difference between means	t	Least significant difference between means	Conclusion
Pictures by six grade versus Pictures by freshmen	= 2.934 = 0.591	2.343	2.021	1.669	$P < 0.05$
Pictures by six grade versus Pictures by jr. and sr.	= 2.934 = 2.903	0.031	2.021	1.526	N.S.
Pictures by six grade versus Words by six grade	= 2.934 = 2.331	0.603	2.021	2.125	N.S.
Pictures by six grade versus Pictures by freshmen	= 2.934 = 1.000	1.934	2.021	2.375	N.S.
Pictures by six grade versus Words by jr. and sr.	= 2.934 = 0.383	2.551	2.021	1.500	$P < 0.05$
Pictures by freshmen versus Pictures by jr. and sr.	= 0.591 = 2.903	2.312	2.021	1.752	$P < 0.05$
Pictures by freshmen versus Words by six grade	= 0.591 = 2.331	1.740	2.021	1.405	N.S.
Pictures by freshmen versus Words by freshmen	= 0.511 = 1.100	0.509	2.021	1.545	N.S.
Pictures by freshmen versus Words by jr. and sr.	= 0.591 = 0.383	0.208	2.021	1.551	N.S.
Pictures by jr. and sr. versus Words by six grade	= 2.903 = 2.331	0.572	2.021	1.807	N.S.
Pictures by jr. and sr. versus Words by freshmen	= 2.903 = 1.100	1.803	2.021	1.752	$P < 0.05$
Pictures by jr. and sr. versus Words by jr. and sr.	= 2.903 = 0.383	2.520	2.021	1.701	$P < 0.05$
Words by six grade versus Words by freshmen	= 2.331 = 1.100	1.231	2.021	1.601	$P < 0.05$
Words by six grade versus Words by jr. and sr.	= 2.331 = 0.383	1.948	2.021	1.601	$P < 0.05$
Words by freshmen versus Words by jr. and sr.	= 1.100 = 0.383	0.717	2.021	1.526	N.S.

junior and seniors produce more functional dependence (intrinsic) responses when grouping with pictures than they do with words.

A significant difference was found indicating a higher score (mean score = 2.331) for the words by six grade group when compared with the words by freshmen (mean score = 1.100) group. Therefore, six graders grouping with words produce more functional dependence (intrinsic) responses than do freshmen. The potent agent in this comparison is the six grade element.

A significant difference was found indicating a higher score (mean score = 2.331) for the words by six grade group when compared to the words by junior and senior (mean score = 0.383) group. Thus, six graders grouping with words produce more functional dependence (intrinsic) responses than do juniors and seniors. There were no significant class differences between these two groups, therefore the significant difference must be due to the interaction effects of the words on the class level.

There appears to be an interaction trend. Whenever pictures interact with six grade or junior and senior experimental groups there is a tendency for significantly more functional dependence (intrinsic) responses to be produced. This is supported by analysis #10, Table 119, of the functional dependence (intrinsic) variable which is contained in Appendix L and which is a very sensitive measure of the single highest cognitive level score. This analysis reveals a significant stimuli difference with pictures (mean score = 2.223) yielding higher functional dependence extrinsic responses than words (mean score = 1.169).

Functional dependence (situational)

In the functional dependence (situational) category, items are grouped on the basis of a bond between them. Two or more items interact independent of the subject. The rationale contains some form of the "they do to they" phrase. Table 25 is the summary of the analysis of covariance between the experimental groups on the functional dependence (situational) cognitive level scores. The analysis reveals a significant difference between the class levels. Table 26 is the summary of the least significant differences between the class means on the functional dependence (situational) scores. The analysis shows a significant difference indicating a higher score (mean score = 6.638) for the six grade group when it was compared with the freshmen (mean score = 4.518) and junior and senior (mean score = 4.747) groups. There was no significant difference between the freshmen and junior and senior groups. The analysis indicates that six graders produce significantly more functional dependence (situational) responses than do the other two class levels.

Total of the concrete attribute scores

Table 27 is the summary of the analysis of covariance on the total of the concrete attribute cognitive level scores. A significant difference is revealed between the class levels. Table 28 is the summary of the least significant differences between the class means on the total of the concrete attribute scores. A significant difference was found indicating a higher concrete attribute score (mean score = 14.304) for the six grade group when it was compared with the freshmen (mean score = 9.594) and the junior and senior (mean score = 10.180)

Table 25. Summary of the analysis of covariance between the experimental groups on the total number of functional dependence (situational) responses scored according to the first category cognitive level score

Source of variation	df	Sums of squares	Mean squares	F-ratio	Probability
Direction	1	13.387	13.387	1.351	0.2478
Stimuli	1	9.661	9.661	0.975	0.3258
Class	2	86.269	43.134	4.352	0.0153*
Direction by stimuli	1	0.003	0.003	0.000	0.9853
Direction by class	2	38.360	19.180	1.935	0.1496
Stimuli by class	2	13.457	6.729	0.679	0.5094
Direction by stimuli by class	2	5.186	2.593	0.262	0.7703
I.Q. (covariant)	1	3.779	3.779	0.381	0.5383
Residual	102	1010.857	9.910		
Total	114	1186.574			

*Significant beyond the .05 level.

Table 26. Summary of the least significant differences between the class adjusted means on the total number of first functional dependence (situational) responses scored according to the category cognitive level score

Comparison of experimental group means	Absolute difference between means	t	Least significant difference between means	Conclusion
Six grade = 6.638 versus freshmen = 4.518	2.120	2.000	1.504	$P < 0.05$
Six grade = 6.638 versus jr. and sr. = 4.747	1.891	2.000	1.724	$P < 0.05$
Freshmen = 4.518 versus jr. and sr. = 4.747	0.229	2.000	1.618	N.S.

Table 27. Summary of the analysis of covariance between the experimental groups on the total of the concrete attribute responses scored according to the first category cognitive level score

Source of variation	df	Sums of squares	Mean squares	F-ratio	Probability
Direction	1	0.395	0.395	0.019	0.8897
Stimuli	1	39.616	39.616	1.939	0.1655
Class	2	719.705	359.852	17.610	0.0000*
Direction by stimuli	1	10.077	10.077	0.493	0.4838
Direction by class	2	22.177	11.088	0.543	0.5824
Stimuli by class	2	1.732	0.866	0.042	0.9585
Direction by stimuli by class	2	33.863	16.932	0.829	0.4386
I.Q. (covariant)	1	78.777	78.777	3.855	0.0512
Residual	169	3453.400	20.434		
Total	181	4603.359			

*Significant beyond the .05 level.

Table 28. Summary of the least significant differences between the class adjusted means on the total of the first concrete attribute responses scored according to the category cognitive level score

Comparison of experimental group means		Absolute difference between means	t	Least significant difference between means	Conclusion
Six grade	= 14.304				
versus		4.710	1.960	1.609	$P < 0.05$
freshmen	= 9.594				
Six grade	= 14.304				
versus		4.124	1.960	0.484	$P < 0.05$
jr. and sr.	= 10.180				
Freshmen	= 9.594				
versus		0.586	1.960	1.609	N.S.
jr. and sr.	= 10.180				

groups. There was no significant difference between the freshmen and junior and senior groups. It can be concluded that six graders produce more concrete level responses than do the other two grade levels.

Summary of the concrete attribute analyses

There were too few perceptual labeling responses for an analysis. The perceptual attribute analysis showed a significant class difference with the six graders producing more responses than the freshmen and juniors and seniors. There were no significant differences between the experimental groups in perceptual location or functional association responses. In the functional dependence (extrinsic) analysis decreasing groups scored significantly higher than the increasing groups and the six graders scored significantly higher than the freshmen. In the functional dependence (intrinsic) analysis six graders scored significantly higher than the freshmen. In addition, there was a significant stimuli by class interaction in the functional dependence (intrinsic) analysis, and it was suggested that a combination of pictures with six grade results in higher concrete scores.

The functional dependence (situational) analysis shows that the six grade group scores significantly higher than both the freshmen and juniors and seniors. The analysis on the total of the concrete attribute scores indicates that the six grade group produces significantly more concrete attribute responses than do the freshmen and juniors and seniors.

Representational Attributes

Simple representational

In the simple representational category the rationale for grouping is the application of an abstract label which is quite perceptually based. Table 29 is the summary of the analysis of covariance between the experimental groups on the simple representational cognitive level scores. The analysis reveals a significant difference between the directions of grouping. The mean simple representational score for increasing group size is 6.855 compared with 9.189 for the decreasing groups. Decreasing group size results in more of the high level simple representational responses than the increasing groups; thus, the decreasing group score represents a higher level of cognitive functioning.

Compound representational

In the compound representational category the rationale for grouping refers to a state, condition or process. Table 30 is the summary of the analysis of covariance between the experimental groups on the compound representational cognitive level scores. The analysis indicates that there is a significant difference between the directions of grouping. The mean compound representational score for the increasing group is 4.462 compared with 7.053 for the decreasing group. This indicates that decreasing group size results in more of the high level attribute responses than does increasing group size.

Table 29. Summary of the analysis of covariance between the experimental groups on the total number of simple representational responses scored according to the first category cognitive level score

Source of variation	df	Sums of squares	Mean squares	F-ratio	Probability
Direction	1	174.262	174.262	9.113	0.0031*
Stimuli	1	35.161	35.161	1.839	0.1774
Class	2	4.702	2.351	0.123	0.8844
Direction by stimuli	1	2.240	2.240	0.117	0.7328
Direction by class	2	4.715	2.358	0.123	0.8841
Stimuli by class	2	28.677	14.339	0.750	0.4746
Direction by stimuli by class	2	5.394	2.697	0.141	0.8686
I.Q. (covariant)	1	13.514	13.514	0.707	0.4022
Residual	129	2466.826	19.123		
Total	141	2778.591			

*Significant beyond the .05 level.

Table 30. Summary of the analysis of covariance between the experimental groups on the total number of compound representational responses scored according to the first category cognitive level score

Source of variation	df	Sums of squares	Mean squares	F-ratio	Probability
Direction	1	122.556	122.556	7.207	0.0088*
Stimuli	1	1.939	1.939	0.114	0.7365
Class	2	33.113	16.557	0.974	0.3820
Direction by stimuli	1	4.159	4.159	0.245	0.6222
Direction by class	2	57.375	28.688	1.687	0.1914
Stimuli by class	2	26.555	13.278	0.781	0.4614
Direction by stimuli by class	2	46.987	23.493	1.382	0.2569
I.Q. (covariant)	1	5.763	5.763	0.339	0.5620
Residual	82	1394.366	17.004		
Total	94	1808.905			

*Significant beyond the .05 level.

Relational

In the relational category the rationale for grouping is identified by a type of "This is to this--as this is to this" connection. Or, a causal relational connection is made. There were too few responses and some experimental cells lacked any responses; therefore, an analysis of the data is not presented.

Symbolic

In the symbolic category items used in the grouping serve as symbols. Table 31 is the summary of the analysis of covariance between the experimental groups on the symbolic cognitive level scores. As the table indicates there are no significant differences between the experimental groups.

Affective representational (simple)

In the affective representational (simple) category items are grouped on the basis of a value judgment. Table 32 is the summary of the analysis of covariance between the experimental groups on the affective representational (simple) cognitive level scores. The table yields no significant differences.

Affective representational (abstract)

In the affective representational (abstract) category items are grouped on the basis of feeling aroused in the subject. Table 33 is the summary of the analysis of covariance between the experimental groups on the affective representational (abstract) cognitive level scores. There are no significant differences between the groups. There are no

Table 31. Summary of the analysis of covariance between the experimental groups on the total number of symbolic responses scored according to the first category cognitive level score

Source of variation	df	Sums of squares	Mean squares	F-ratio	Probability
Direction	1	9.838	9.838	0.674	0.4175
Stimuli	1	48.008	48.008	3.289	0.0788
Class	2	1.861	0.931	0.064	0.9383
Direction by stimuli	1	5.898	5.898	0.404	0.5294
Direction by class	2	18.028	9.014	0.618	0.5454
Stimuli by class	2	5.392	2.696	0.185	0.8322
Direction by stimuli by class	2	41.331	20.665	1.416	0.2571
I.Q. (covariant)	1	0.105	0.105	0.007	0.9331
Residual	33	481.650	14.595		
Total	45	586.956			

*Significant beyond the .05 level.

Table 32. Summary of the analysis of covariance between the experimental groups on the total number of affective representational (simple) responses scored according to the first category cognitive level score

Source of variation	df	Sums of squares	Mean squares	F-ratio	Probability
Direction	1	0.268	0.268	0.026	0.8761
Stimuli	1	3.939	3.939	0.377	0.5542
Class	2	1.041	0.521	0.050	0.9516
Direction by stimuli	1	0.287	0.287	0.028	0.8719
Direction by class	2	9.513	4.756	0.456	0.6478
Stimuli by class	2	5.118	2.559	0.245	0.7876
Direction by stimuli by class	2	2.686	1.343	0.129	0.8808
I.Q. (covariant)	1	0.282	0.282	0.027	0.8732
Residual	9	93.919	10.435		
Total	21	126.000			

*Significant beyond the .05 level.

Table 33. Summary of the analysis of covariance between the experimental groups on the total number of affective representational (abstract) responses scored according to the first category cognitive level score

Source of variation	df	Sums of squares	Mean squares	F-ratio	Probability
Direction	1	0.022	0.022	0.002	0.9615
Stimuli	1	3.423	3.423	0.373	0.5451
Class	2	3.348	1.674	0.183	0.8339
Direction by stimuli	1	1.009	1.009	0.110	0.7421
Direction by class	2	9.913	4.957	0.540	0.5872
Stimuli by class	2	9.108	4.554	0.497	0.6128
Direction by stimuli by class	1	1.777	1.777	0.194	0.6624
I.Q. (covariant)	1	0.765	0.765	0.083	0.7743
Residual	36	330.186	9.172		
Total	47	373.313			

*Significant beyond the .05 level.

responses in the increase by pictures by six grade experimental group which accounts for the missing cell.

Total of the representational attribute scores

Table 34 is the summary of the analysis of covariance on the total of the representational attribute cognitive level scores. It reveals a significant difference between the directions of grouping, between the class levels, and a significant direction by class interaction. The mean cognitive level score for increasing group size is 11.446 compared with 15.444 for decreasing group size. This means that more representational responses were given by the decreasing groups. Therefore, it can be concluded that decreasing group size results in a higher level of cognitive functioning than does increasing group size.

Table 35 is the summary of the least significant differences between the class levels on the total of the representational attribute scores. The analysis shows that a significant difference was found indicating a lower cognitive level score (mean score = 10.468) for the six grade group when it was compared with the freshmen (mean score = 15.170) and the junior and senior (14.696) groups. There was no significant difference between the freshmen and the juniors and seniors. These results indicate that six graders produce fewer of the high level representational responses, and that freshmen and juniors and seniors function at a higher cognitive level than do six grade subjects.

Table 36 is the summary of the least significant differences between the direction by class means on the total of the representational scores. There is a significant difference between the increase by six grade score of 8.817 when compared with the higher, increase by junior

Table 34. Summary of the analysis of covariance between the experimental groups on the total of the representational attribute responses scored according to the first category cognitive level score

Source of variation	df	Sums of squares	Mean squares	F-ratio	Probability
Direction	1	657.423	657.423	11.151	0.0010*
Stimuli	1	56.731	56.731	0.962	0.3281
Class	2	655.930	327.965	5.563	0.0046*
Direction by stimuli	1	11.860	11.860	0.201	0.6544
Direction by class	2	412.133	206.066	3.495	0.0327*
Stimuli by class	2	89.613	44.807	0.760	0.4695
Direction by stimuli by class	2	139.614	69.807	1.184	0.3086
I.Q. (covariant)	1	83.517	83.517	1.417	0.2356
Residual	160	9433.328	58.958		
Total	172	11872.609			

*Significant beyond the .05 level.

Table 35. Summary of the least significant differences between the class adjusted means on the total of the first representational attribute responses scored according to the category cognitive level score

Comparison of experimental group means		Absolute difference between means	t	Least significant difference between means	Conclusion
Six grade versus freshmen	= 10.468 = 15.170	4.702	1.960	2.856	$P < 0.05$
Six grade versus jr. and sr.	= 10.468 = 14.696	4.228	1.960	3.399	$P < 0.05$
Freshmen versus jr. and sr.	= 15.170 = 14.696	0.474	1.960	2.971	N.S.

Table 36. Summary of the least significant differences between the direction by class adjusted means on the total of the first representational attribute responses scored according to the category cognitive level score

Comparison of experimental group means	Absolute difference between means	t	Least significant difference between means	Conclusion
Increase by six grade = 8.817 versus Increase by freshmen = 11.181	2.364	1.960	4.038	N.S.
Increase by six grade = 8.817 versus Increase by jr. and sr. = 14.340	5.523	1.960	4.806	$P < 0.05$
Increase by six grade = 8.817 versus Decrease by six grade = 12.119	3.302	1.960	4.361	N.S.
Increase by six grade = 8.817 versus Decrease by freshmen = 19.160	10.343	1.960	4.038	$P < 0.05$
Increase by six grade = 8.817 versus Decrease by jr. and sr. = 15.053	6.236	1.960	4.361	$P < 0.05$
Increase by freshmen = 11.181 versus Increase by jr. and sr. = 14.340	3.159	1.960	4.204	N.S.
Increase by freshmen = 11.181 versus Decrease by six grade = 12.119	0.938	1.960	3.924	N.S.
Increase by freshmen = 11.181 versus Decrease by freshmen = 19.160	7.979	1.960	3.432	$P < 0.05$
Increase by freshmen = 11.181 versus Decrease by jr. and sr. = 15.053	3.872	1.960	3.983	N.S.
Increase by jr. and sr. = 14.340 versus Decrease by six grade = 12.119	2.221	1.960	4.614	N.S.
Increase by jr. and sr. = 14.340 versus Decrease by freshmen = 19.160	4.820	1.960	4.094	$P < 0.05$
Increase by jr. and sr. = 14.346 versus Decrease by jr. and sr. = 15.053	0.713	1.960	4.465	N.S.
Decrease by six grade = 12.119 versus Decrease by freshmen = 19.160	7.041	1.960	3.924	$P < 0.05$
Decrease by six grade = 12.119 versus Decrease by jr. and sr. = 15.053	2.934	1.960	7.060	N.S.
Decrease by freshmen = 19.164 versus Decrease by jr. and sr. = 15.053	4.111	1.960	4.514	N.S.

and senior group score of 14.340. Because both of these groups increased the size of their groupings the factor responsible for the difference must be the grade level with the seniors scoring higher.

There was a significant difference between the increase by six grade group (mean score = 8.817) compared with the decrease by freshmen group (mean score = 19.160). The reason for this difference appears to be of both the factors of decrease and freshmen which yield higher scores than both increase and six grade.

The increase by six grade group (mean score = 8.817) was found to be significantly lower than the decrease by junior and senior group (mean score 15.053). Both decrease and junior and senior groups score higher than six grade and increase groups, therefore the results are as expected.

There is a significant difference between the increase by freshmen group (mean score = 11.181) and the decrease by freshmen group (mean score = 19.160). The aspect responsible for the higher score for the decrease by freshmen group appears to be the decrease factor.

There is a significant difference between the increase by junior and senior group (mean score = 14.340) and the decrease by freshmen group (mean score = 19.160). There were no significant differences between the freshmen and junior and senior groups; therefore, the higher decrease by freshmen score appears to be due to the decrease factor.

There is a significant difference between the decrease by six grade group (mean score = 12.119) and the decrease by freshmen group (mean score = 19.160). Both of these group comparisons involve a decrease factor, the significantly larger score of the decrease by freshmen group must be due to the freshmen factor.

Summary of the representational attribute analyses

The simple representational analysis yielded a significant directional effect with the decreasing group having a higher cognitive level score. The compound representational analysis also showed a significantly higher cognitive level score for the decrease group. These results lead to the conclusion that decreasing the size of groupings results in more of the high level representational responses and a higher cognitive level of functioning. There were too few responses in the relational category for an analysis. In the symbolic, affective representational (simple), and the affective representational (abstract) analyses there were no significant differences found. The total representational attribute analysis yielded a significant directional effect, a significant class level effect, and a significant direction by class interaction effect. The decrease group had a higher cognitive level score; the six grade group had a lower cognitive level score when compared with the freshmen and the juniors and seniors; the direction by class interaction reflected the class and directional differences.

Total of the attribute scores

The total attributes score was compiled by adding together the totals of the simple association, concrete, and representational attribute scores. Table 37 is the summary of the analysis of covariance between the experimental groups on the total of the attribute cognitive level scores. The analysis yields a significant difference between directions and a significant direction by stimuli by class interaction

Table 37. Summary of the analysis of covariance between the experimental groups on the total of the attribute responses scored according to the first category cognitive level score

Source of variation	df	Sums of squares	Mean squares	F-ratio	Probability
Direction	1	318.468	318.468	15.499	0.0001*
Stimuli	1	2.070	2.070	0.101	0.7513
Class	2	92.518	46.259	2.251	0.1084
Direction by stimuli	1	0.000	0.000	0.000	0.9976
Direction by class	2	76.425	38.212	1.860	0.1589
Stimuli by class	2	85.205	42.603	2.073	0.1289
Direction by stimuli by class	2	128.270	64.135	3.121	0.0466*
I.Q. (covariant)	1	3.174	3.174	0.154	0.6948
Residual	170	3493.213	20.548		
Total	182	4236.949			

*Significant beyond the .05 level.

effect. The mean total attribute score for increasing group size is 24.724 compared with 27.408 for the decreasing groups. Therefore, decreasing group size appears to result in an overall higher level of grouping attribute, cognitive functioning.

Table 38 is the summary of the least significant differences between the direction by stimuli by class means on the total of the attribute scores. A significant difference was found indicating a higher total attributes score for the decrease by pictures by freshmen group (mean score = 30.572) when it was compared with all the other experimental groups except the decrease by words by junior and senior group (mean score = 27.942). It is apparent, then that juniors and seniors handle words as efficiently when decreasing group size as freshmen do when they decrease group size using pictures. In comparing the decrease by picture by freshmen (mean score = 30.572) with decrease by picture by junior and senior (mean score = 27.021) it is revealed that apparently juniors and seniors do not handle pictures when decreasing group size as efficiently as freshmen. This leads to some interesting conclusions regarding the differences between juniors and seniors in their ability to handle different forms of stimuli. The more abstract word stimuli appear to be handled more efficiently by the older juniors and seniors, whereas the younger freshmen handle the more concrete pictures more efficiently. Thus, there may be some quantitative cognitive differences between the juniors and seniors in their ability to handle different levels of abstract stimuli.

In comparing decreasing by pictures by freshmen (mean score = 30.572) with decrease by picture by six grade (mean score = 24.963) a significant difference is observed. This analysis indicates that the

Table 38. Summary of the least significant differences between the direction by stimuli by class adjusted means on the total of all the first response attribute scores

Direction by stimuli by class ranked by means	No. of Ss.	Ranked means	Mean differences 12	11	10	9	8	7	6	5	4	3	2
(1) Decrease by pictures by freshmen	16	30.572	7.804*	6.211*	6.148*	6.044*	5.609*	5.029*	3.853*	3.809*	3.551*	3.382*	2.630
(2) Decrease by words by jr. and sr.	12	27.942	5.174*	3.581*	3.518	3.414	2.979	2.399	1.223	1.179	0.921	0.752	
(3) Decrease by words by freshmen	20	27.190	4.422*	2.829*	2.766	2.662	2.227	1.647	0.471	0.427	0.169		
(4) Decrease by pictures by jr. and sr.	12	27.021	4.253*	2.660	2.600	2.493	2.058	1.478	0.302	0.258			
(5) Decrease by words by six grade	15	26.763	3.995*	2.402	2.339	2.235	1.800	1.220	0.044				
(6) Increase by words by jr. and sr.	12	26.719	3.951*	2.358	2.295	2.191	1.756	1.176					
(7) Increase by pictures by six grade	15	25.543	2.775	1.182	1.119	1.015	0.580						
(8) Decrease by pictures by six grade	14	24.963	2.195	0.602	0.539	0.435							
(9) Increase by pictures by freshmen	18	24.528	1.760	0.167	0.104								
(10) Increase by pictures by jr. and sr.	14	24.424	1.656	0.063									
(11) Increase by words by freshmen	21	24.361	1.593										
(12) Increase by words by six grade	14	22.768											

Least significant difference values between means: *for .05 level of significance = 1.96

six grade group does not handle the stimuli of pictures as efficiently as do the freshmen. However, there is no significant difference between the decreasing groups with pictures between the juniors and seniors and the six graders. Apparently six grade subjects handle pictures in a decreasing manner, equally as well as juniors and seniors.

All other significant differences between experimental group comparisons can be explained by the influence of increase and/or six grade factors which have been previously demonstrated to have a debilitating effect on cognitive level scores.

Supplemental Aspects

The supplemental aspects refers to the quality of the groupings. In the present study the supplemental aspects were categorized as partial use of stimuli, exceptional quality of response, poor quality of response, and regular quality of response. Hypothesis three states that under conditions designed to test the quality used in grouping there would be no differences among the experimental groups in the supplemental aspects used in classifying.

Partial use of stimuli

In the partial use of stimuli classification, grouping is based on the use of a part of the stimuli other than the primary aspect of the stimuli. Table 39 is the summary of the analysis of covariance between the experimental groups on the total of the partial use of stimuli cognitive level scores. The analysis shows a significant difference between the class levels. Table 40 is the summary of the least significant differences between the class means on the partial

Table 39. Summary of the analysis of covariance between the experimental groups on the total number of partial use of stimuli responses scored according to the first category cognitive level score

Source of variation	df	Sums of squares	Mean squares	F-ratio	Probability
Direction	1	0.996	0.996	0.299	0.5865
Stimuli	1	8.332	8.332	2.500	0.1189
Class	2	42.884	21.442	6.433	0.0029*
Direction by stimuli	1	0.000	0.000	0.000	0.9977
Direction by class	2	4.939	2.470	0.741	0.4808
Stimuli by class	2	7.676	3.838	1.151	0.3227
Direction by stimuli by class	2	4.989	2.495	0.748	0.4773
I.Q. (covariant)	1	18.034	18.034	5.410	0.0232
Residual	63	209.991	3.333		
Total	75	342.987			

*Significant beyond the .05 level.

Table 40. Summary of the least significant differences between the class adjusted means on the total of the first partial use of stimuli responses scored according to the category cognitive level score

Comparison of experimental group means	Absolute difference between means	t	Least significant difference between means	Conclusion
Six grade = 2.956 versus freshmen = 1.063	1.893	2.000	1.072	$P < 0.05$
Six grade = 2.956 versus jr. and sr. = 1.495	1.461	2.000	1.242	$P < 0.05$
Freshmen = 1.063 versus jr. and sr. = 1.495	0.432	2.000	1.194	N.S.

use of stimuli. The six grade group (mean score = 2.956) scored significantly higher than did the freshmen (mean score = 1.063) and the junior and senior (mean score = 1.495) groups. There was no significant difference between the freshmen and the junior and senior groups. This analysis indicates that the six grade group gave more of the inferior quality, partial use of stimuli responses than did the other two class levels.

Exceptional quality of response

In the exceptional quality of response classification the grouping has additional clarification provided or has one or several subgroups of a high level. Table 41 is the summary of the analysis of covariance between the experimental groups on the exceptional quality of response, cognitive level scores. The analysis indicates a significant direction by class interaction effect as well as a significant direction by stimuli by class interaction. Table 42 is the summary of the least significant differences between the direction by class means on the exceptional quality of response scores. The analysis shows a significant difference between the increase by freshmen group (mean score = 8.069) compared with the decrease by freshmen group (mean score = 12.148) whose score indicate more high quality responses were given. The decreasing group factor appears responsible for the higher cognitive level score. Another significant comparison is between the increase by junior and senior group (mean score = 10.588) and the decrease by six grade group (mean score = 6.706). The increasing of group size by juniors and seniors apparently results in more high quality responses compared to the decreasing six grade group. It is not clear whether

Table 41. Summary of the analysis of covariance between the experimental groups on the total number of exceptional responses scored according to the first category cognitive level score

Source of variation	df	Sums of squares	Mean squares	F-ratio	Probability
Direction	1	0.269	0.269	0.008	0.9301
Stimuli	1	2.307	2.307	0.066	0.7973
Class	2	104.154	52.077	1.495	0.2278
Direction by stimuli	1	4.468	4.468	0.128	0.7208
Direction by class	2	339.808	169.904	4.877	0.0090*
Stimuli by class	2	121.595	60.797	1.745	0.1784
Direction by stimuli by class	2	231.974	115.987	3.329	0.0387*
I.Q. (covariant)	1	64.410	64.410	1.849	0.1761
Residual	140	4877.328	34.838		
Total	152	5889.656			

*Significant beyond the .05 level.

Table 42. Summary of the least significant differences between the direction by class adjusted means on the total number of first exceptional quality responses scored according to the category cognitive level score

Comparison of experimental group means	Absolute difference between means	t	Least significant difference between means	Conclusion
Increase by six grade = 9.533 versus Increase by freshmen = 8.069	1.464	1.960	3.252	N.S.
Increase by six grade = 9.533 versus Increase by jr. and sr. = 10.588	1.055	1.960	3.695	N.S.
Increase by six grade = 9.533 versus Decrease by six grade = 6.706	2.827	1.960	3.871	N.S.
Increase by six grade = 9.533 versus Decrease by freshmen = 12.148	2.615	1.960	3.312	N.S.
Increase by six grade = 9.533 versus Decrease by jr. and sr. = 9.602	0.069	1.960	3.230	N.S.
Increase by freshmen = 8.069 versus Increase by jr. and sr. = 10.588	2.519	1.960	3.105	N.S.
Increase by freshmen = 8.069 versus Decrease by six grade = 6.706	1.363	1.960	3.622	N.S.
Increase by freshmen = 8.069 versus Decrease by freshmen = 12.148	4.079	1.960	2.638	$P < 0.05$
Increase by freshmen = 8.069 versus Decrease by jr. and sr. = 9.602	1.533	1.960	3.230	N.S.
Increase by jr. and sr. = 10.588 versus Decrease by six grade = 6.706	3.882	1.960	3.767	$P < 0.05$
Increase by jr. and sr. = 10.588 versus Decrease by freshmen = 12.148	1.560	1.960	8.357	N.S.
Increase by jr. and sr. = 10.588 versus Decrease by jr. and sr. = 9.602	0.986	1.960	3.585	N.S.
Decrease by six grade = 9.557 versus Decrease by freshmen = 10.135	0.578	1.960	3.548	N.S.
Decrease by six grade = 6.706 versus Decrease by jr. and sr. = 9.602	2.896	1.960	3.767	N.S.
Decrease by freshmen = 12.148 versus Decrease by jr. and sr. = 9.602	2.878	1.960	3.189	N.S.

the increasing factor, the junior and senior factor, or both in combination are responsible for this result.

Table 43 is the summary of the least significant differences between the direction by stimuli by class means on the exceptional quality of response scores. The analysis indicates that the increase by pictures by junior and senior group (mean score = 13.257) is significantly higher than the increase by pictures by six grade (mean score = 6.330), the decrease by words by six grade (mean score = 6.378), the decrease by pictures by six grade (mean score = 7.034), the increase by words by freshmen (7.386), the increase by words by junior and senior (7.918) and the increase by pictures by freshmen experimental groups. The significantly lower increase by pictures by six grade, decrease by words by six grade and decrease by picture by six grade groups can be explained by the detrimental effect of the six grade factor. In comparing the higher, increase by picture by junior and senior score with the lower increase by words by freshmen score it becomes evident that juniors and seniors handle pictures in an increasing way more efficiently than freshmen handle words. Furthermore, in perhaps the most important discovery, when the increase by <u>pictures</u> by junior and senior group is compared with the increase by <u>words</u> by junior and senior group it becomes apparent that juniors and seniors handle pictures more efficiently than they do words. It also becomes apparent from the comparison of the increase by pictures by junior and senior group with the increase by pictures by freshmen group that juniors and seniors handle pictures in an increasing way more efficiently than do freshmen.

Table 43. Summary of the least significant differences between the direction by stimuli by class adjusted means on the total of the first response exceptional quality of response scores

Direction by stimuli by class ranked by means	No. of Ss.	Ranked means	Mean differences 12	11	10	9	8	7	6	5	4	3	2
(1) Increase by pictures by jr. and sr.	12	13.257	6.927*	6.879*	6.223*	5.871*	5.339*	4.505*	4.184	3.126	1.846	0.525	0.375
(2) Decrease by words by freshmen	19	12.884	6.554*	6.506*	5.850*	5.498*	4.903*	4.132*	3.811	2.753	1.473	0.148	
(3) Increase by words by six grade	8	12.736	6.406*	6.358*	5.702*	5.350*	4.818	3.984	3.663	2.605	1.325		
(4) Decrease by pictures by freshmen	16	11.411	5.081*	5.033	4.377	4.025*	3.493	2.659	2.338	1.280			
(5) Decrease by words by jr. and sr.	10	10.131	3.801	3.753	3.097	2.745	2.213	1.379	1.058				
(6) Decrease by pictures by jr. and sr.	11	9.073	2.743	2.695	2.039	1.687	1.155	0.321					
(7) Increase by pictures by freshmen	16	8.752	2.422	2.374	1.718	1.366	0.834						
(8) Increase by words by jr. and sr.	11	7.918	1.588	1.540	0.884	0.532							
(9) Increase by words by freshmen	22	7.386	1.056	1.008	0.352								
(10) Decrease by pictures by six grade	9	7.034	0.704	0.656									
(11) Decrease by words by six grade	7	6.378	0.048										
(12) Increase by pictures by six grade	12	6.330											

Least significant difference values between means: *for .05 level of significance = 1.96

In summary of the preceding comparisons it can be concluded that the stimuli of pictures is the most important factor in producing exceptional quality responses.

There is a significant difference between the decrease by words by freshmen group (mean score = 12.884) compared with the increase by pictures by six grade (mean score = 6.330), the decrease by words by six grade (mean score = 6.378), the decrease by pictures by six grade (mean score = 7.034), the increase by words by freshmen (mean score = 7.386), the increase by words by junior and senior (mean score = 7.918), and the increase by pictures by freshmen (mean score = 8.752) experimental groups. The significantly lower scores among all of these groups can be explained by the lowering effect of the increase and/or six grade factors.

There is a significant difference between the increase by words by six grade group (mean score = 12.736) compared with the increase by pictures by six grade (mean score = 6.330), the decrease by words by six grade (mean score = 6.378), the decrease by pictures by six grade (mean score = 7.034) and the increase by words by freshmen (mean score = 7.386) experimental groups. As a result of comparing the increase by words by six grade group with the increase by pictures by six grade group it appears that words used by six graders in an increasing manner results in more high quality responses. The other cited six grade comparisons show that the increasing factor among six graders results in higher quality scores. The comparison of the increase by words by six grade group with the increase by words by freshmen group indicates that six graders produce more exceptional quality responses as a result of grouping words in an increasing way than do freshmen. Thus, it can be concluded that not only does the increasing direction have an effect, but it has a stronger effect on six graders who use words as their stimuli.

The decrease by pictures by freshmen group (mean score = 11.411) is significantly higher when compared to the increase by pictures by six grade (mean score = 6.330) experimental group. The decrease and freshmen factors appear to be responsible for this difference.

In summary of the most important direction by stimuli by class interaction effects, the junior and senior experimental group produce more exceptional responses when increasing groups of pictures than increasing groups of words. Juniors and seniors give more exceptional quality responses when increasing picture group sizes than do freshmen. Six graders produce more exceptional quality responses when increasing group size with words than they do with pictures.

<u>Poor quality of response</u>

In the poor quality of response category the rationale applied to the items does not hold for each item. The cognitive level score for a poor quality response is zero, therefore an analysis of covariance using cognitive level scores would yield zeros. The analysis on the first category scores in Appendix K, Table 97, shows a significant difference between directions. The mean number of poor quality responses is 2.747 compared with 1.605 for the decrease group. Thus it can be concluded that increasing group size results in more poor quality responses.

Regular quality of response

The regular quality of response category indicates that the rationale for grouping is regular in the sense that the grouping does not have additional clarification, nor does it have an impoverished quality of content. Table 44 is the summary of the analysis of covariance between the experimental groups on the total quality of response cognitive level scores. The analysis shows no significant differences.

Total of the supplementary aspects scores

Table 45 is the summary of the analysis of covariance on the total of the supplementary aspects scores. It reveals a significant difference between the class levels. Table 46 is the summary of the least significant differences between the class means on the total supplementary aspects scores. The analysis shows that the six grade group (mean score = 22.255) is significantly lower than the freshmen (mean score = 25.204) and the junior and senior (mean score = 24.953) experimental groups. There are no significant differences between the freshmen and the junior and seniors. It can be concluded from this analysis that the six graders produce significantly fewer high quality responses when compared with the other two class levels.

Summary of the supplementary aspects analyses

There was a significant difference between the class levels in the number of partial use of stimuli responses which indicated that the six grade group used more of these low level responses. There was a significant direction by class interaction and a significant direction by stimuli by class interaction when the exceptional responses were examined. In the direction by class interaction effect it appears that

Table 44. Summary of the analysis of covariance between the experimental groups on the total number of regular responses scored according to the first category cognitive level score

Source of variation	df	Sums of squares	Mean squares	F-ratio	Probability
Direction	1	19.488	19.488	0.704	0.4027
Stimuli	1	9.690	9.690	0.350	0.5549
Class	2	7.701	3.851	0.139	0.8703
Direction by stimuli	1	30.964	30.964	1.118	0.2917
Direction by class	2	109.948	54.974	1.985	0.1405
Stimuli by class	2	64.639	32.319	1.167	0.3138
Direction by stimuli by class	2	0.198	0.099	0.004	0.9964
I.Q. (covariant)	1	1.527	1.527	0.055	0.8146
Residual	170	4707.859	27.693		
Total	182	4971.680			

*Significant beyond the .05 level.

Table 45. Summary of the analysis of covariance between the experimental groups on the total of the supplementary aspects responses scored according to the first category cognitive level score

Source of variation	df	Sums of squares	Mean squares	F-ratio	Probability
Direction	1	5.058	5.058	0.220	0.6399
Stimuli	1	15.319	15.319	0.665	0.4159
Class	2	295.169	147.584	6.408	0.0021*
Direction by stimuli	1	1.620	1.620	0.070	0.7912
Direction by class	2	60.966	30.483	1.324	0.2688
Stimuli by class	2	21.808	10.904	0.473	0.6237
Direction by stimuli by class	2	47.706	23.853	1.036	0.3571
I.Q. (covariant)	1	271.574	271.574	11.792	0.007
Residual	171	3938.057	23.030		
Total	183	4922.953			

*Significant beyond the .05 level.

Table 46. Summary of the least significant differences between the class adjusted means on the total of the supplementary aspects responses scored according to the category cognitive level score

Comparison of experimental group means		Absolute difference between means	t	Least significant difference between means	Conclusion
Six grade versus freshmen	= 22.255 = 25.204	2.949	1.960	1.656	$P < 0.05$
Six grade versus jr. and sr.	= 22.255 = 24.953	2.698	1.960	2.017	$P < 0.05$
Freshmen versus jr. and sr.	= 25.204 = 24.953	0.250	1.960	1.809	N.S.

the increase factor in combination with the freshmen factor results in more exceptional quality responses, and the decrease factor in combination with the six grade factor results in fewer exceptional quality responses when compared to the junior and senior group. The major direction by stimuli by class interaction effects are as follows: Juniors and seniors produce more exceptional quality responses when they use pictures to increase group size than do freshmen who use words. Juniors and seniors who use pictures to increase the size of their groups produce more quality responses than when they use words (Thus, they handle pictures more efficiently). Juniors and seniors give more exceptional responses when increasing group size with pictures than do freshmen. Six grade subjects who increase group size using words produce more high quality responses than when using pictures.

The total of the supplementary aspects scores indicated that the six grade group produces fewer high quality responses when compared with the other grade levels.

Level of Specificity

The level of specificity refers to how general or specific the reason for grouping is. Three levels of specificity were defined: specific, middle and general. Hypothesis four states that there would be no differences among the experimental groups in the level of specificity used in classifying.

Specific level of specificity

In the specific category the reason for grouping was a least inclusive response. Table 47 is the summary of the analysis of covariance

Table 47. Summary of the analysis of covariance between the experimental groups on the total number of specific responses scored according to the first category cognitive level score

Source of variation	df	Sums of squares	Mean squares	F-ratio	Probability
Direction	1	190.472	190.472	19.456	0.0000*
Stimuli	1	8.430	8.430	0.861	0.3550
Class	2	9.811	4.905	0.501	0.6069
Direction by stimuli	1	10.016	10.016	1.023	0.3130
Direction by class	2	0.204	0.102	0.010	0.9896
Stimuli by class	2	51.219	25.609	2.616	0.0760
Direction by stimuli by class	2	15.064	7.532	0.769	0.4650
I.Q. (covariant)	1	0.500	0.500	0.051	0.8216
Residual	169	1654.451	9.790		
Total	181	1950.093			

*Significant beyond the .05 level.

between the experimental groups on the total of the specific cognitive level scores. The analysis shows that there is a significant difference between the directions. The mean specificity score for increasing group size is 8.831 compared with 6.745 for the decreasing groups. Therefore, increasing group size appears to result in more specific responses than does decreasing group size.

Middle level of specificity

In the middle level of specificity category the reason for grouping was a middle level of inclusiveness in which the response fell between the specific and general levels. Table 48 is the summary of the analysis of covariance between the experimental groups on the middle level of specificity scores. The analysis reveals a significant difference between directions and a significant direction by stimuli interaction effect. The mean middle level of specificity score for increasing group size is 7.433 compared with 10.297. This indicates that decreasing group size results in more middle level of specificity responses. This appears to indicate that decreasing group size results in more mature, higher cognitive level responses.

Table 49 is the summary of the least significant differences between the direction by stimuli means on the middle level of specificity scores. There is a significant difference between the increase by pictures group (mean score = 6.544) when compared with the decrease by pictures group (mean score = 11.003). It appears that the decrease factor is responsible for the higher decrease by pictures score and results in more middle level of specificity responses by this group.

Table 48. Summary of the analysis of covariance between the experimental groups on the total number middle level of specificity responses scored according to the first category cognitive level score

Source of variation	df	Sums of squares	Mean squares	F-ratio	Probability
Direction	1	288.825	288.825	13.044	0.0004*
Stimuli	1	1.178	1.178	0.053	0.8179
Class	2	74.724	37.362	1.687	0.1888
Direction by stimuli	1	89.426	89.426	4.039	0.0464*
Direction by class	2	11.423	5.711	0.258	0.7730
Stimuli by class	2	73.327	36.663	1.656	0.1947
Direction by stimuli by class	2	19.630	9.815	0.443	0.6429
I.Q. (covariant)	1	11.684	11.684	0.528	0.4689
Residual	137	3033.465	22.142		
Total	149	3630.293			

*Significant beyond the .05 level.

Table 49. Summary of the least significant differences between the direction by stimuli adjusted means on the total number of middle level of specificity responses scored according to the category cognitive level score

Comparison of experimental group means	Absolute difference between means	t	Least significant difference between means	Conclusion
Increase by pictures = 6.544 versus Increase by words = 8.322	1.778	1.960	2.183	N.S.
Increase by pictures = 6.544 versus Decrease by pictures = 11.003	4.459	1.960	2.183	$P < 0.05$
Increase by pictures = 6.544 versus Decrease by words = 9.592	3.048	1.960	2.183	$P < 0.05$
Increase by words = 8.322 versus Decrease by pictures = 11.003	2.681	1.960	2.183	$P < 0.05$
Increase by words = 8.322 versus Decrease by words = 9.592	1.270	1.960	2.183	N.S.
Decrease by pictures = 11.003 versus Decrease by words = 9.592	1.411	1.960	2.183	N.S.

There is a significant difference between the increase by pictures group (mean score = 6.544) and the decrease by words group (mean score = 9.592). It can be concluded in this case that both the decrease factor as well as the word factor contributed to the higher decrease by words score.

There is a significant difference between the increase by words group (mean score = 8.322) and the decrease by pictures group (mean score = 11.003). It can be concluded that both the decrease factor and the picture factor were responsible for the higher decrease by pictures score.

In summary of the direction by stimuli interaction analysis, it appears that the decreasing factor has a strong effect in producing more middle level of specificity responses, and it has even a stronger effect when it interacts with the word or picture factors.

General level of specificity

In the general level of specificity category the reason for grouping was a most inclusive response. Table 50 is the summary of the analysis of covariance between the experimental groups on the general level of specificity scores. The analysis reveals no significant results. There are no responses in one cell, the increase by pictures by six grade experimental group.

Total of the level of specificity scores

Table 51 is the summary of the analysis of covariance on the total number of level of specificity responses. It reveals a significant difference between the directions of grouping. The mean level of specificity score for increasing groups is 15.648 compared with 16.884

Table 50. Summary of the analysis of covariance between the experimental groups on the total number of general responses scored according to the first category cognitive level score

Source of variation	df	Sums of squares	Mean squares	F-ratio	Probability
Direction	1	10.551	10.551	0.683	0.4174
Stimuli	1	8.458	8.458	0.548	0.4671
Class	2	40.845	20.422	1.322	0.2869
Direction by stimuli	1	60.483	60.483	3.916	0.0605
Direction by class	2	56.187	28.093	1.819	0.1858
Stimuli by class	2	41.244	20.622	1.335	0.2836
Direction by stimuli by class	1	38.282	38.282	2.479	0.1297
I.Q. (covariant)	1	114.419	114.419	7.408	0.0125
Residual	22	339.782	15.445		
Total	33	697.765			

*Significant beyond the .05 level.

Table 51. Summary of the analysis of covariance between the experimental groups on the total of the level of specificity responses scored according to the first category cognitive level score

Source of variation	df	Sums of squares	Mean squares	F-ratio	Probability
Direction	1	66.877	66.877	4.500	0.0353*
Stimuli	1	2.645	2.645	0.178	0.6738
Class	2	25.974	12.987	0.874	0.4194
Direction by stimuli	1	24.973	24.973	1.681	0.1965
Direction by class	2	20.899	10.449	0.703	0.4966
Stimuli by class	2	61.965	30.983	2.085	0.1274
Direction by stimuli by class	2	6.765	3.382	0.228	0.7967
I.Q. (covariant)	1	0.869	0.869	0.058	0.8093
Residual	169	2511.370	14.860		
Total	181	2740.379			

*Significant beyond the .05 level.

for decreasing group size. This result indicates that decreasing group size results in more general responses as opposed to specific responses.

Summary of the level of specificity analyses

The specific level of specificity analysis indicates that increasing group size results in more specific responses as compared to decreasing group size. The middle level of specificity analysis yields a significant directional difference as well as a significant direction by stimuli interaction. Decreasing group size results in more middle level of specificity responses. The interaction analysis indicates that the decrease factor is a potent influence, and in combination with the pictures or words factors, interacts to produce more middle level of specificity responses.

Analyses of Unique Reasons, Memory and Attitudes

Unique reasons

The unique reasons score was derived by counting the total number of different reasons a subject gave for all his groupings. Hypothesis five states that there would be no differences among the experimental group in the number of unique reasons used in classifying. Table 52 is the summary of the analysis of covariance between the experimental groups on the number of unique reasons given when classifying. The analysis shows a significant difference between directions, between class levels, and a significant stimuli by class interaction. The mean number of unique reason for increasing group size is 13.058 compared with 11.690 for the decreasing groups. Therefore, it can be concluded that

Table 52. Summary of the analysis of covariance between the experimental groups on the number of unique reasons given when classifying

Source of variation	df	Sums of squares	Mean squares	F-ratio	Probability
Direction	1	82.968	82.968	6.066	0.0148*
Stimuli	1	0.367	0.367	0.027	0.8701
Class	2	98.862	49.431	3.614	0.0290*
Direction by stimuli	1	25.111	25.111	1.836	0.1772
Direction by class	2	45.577	22.788	1.666	0.1920
Stimuli by class	2	85.384	42.692	3.121	0.0466*
Direction by stimuli by class	2	24.471	12.236	0.895	0.4108
I.Q. (covariant)	1	35.925	35.925	2.626	0.1069
Residual	171	2338.920	13.678		
Total	183	2785.740			

*Significant beyond the .05 level.

increasing the size of groupings results in a greater number of different reasons for the groupings.

Table 53 is the summary of the least significant differences between the class means on the total number of unique reasons given for grouping. The six grade level (mean score = 11.252) was significantly lower than the freshmen (mean score = 12.862) and the junior and senior (mean score = 13.009) groups. There was no significant difference between the freshmen and junior and senior groups. This result indicates that six graders give significantly fewer different reasons when grouping. This result is based on the total of all reasons and may be biased as a result of the freshmen and junior and senior groups giving more responses.

Table 54 is the summary of the least significant differences between the stimuli by class means on the total number of unique reasons given. Most of the significant interactions can be explained because they contain differences in class levels between the six grade level and either freshmen or junior and senior levels. One important significant difference is between pictures by freshmen (mean score = 13.819) and words by freshmen (mean score = 11.904). This indicates that freshmen grouping pictures produce more unique reasons than do freshmen grouping words. The picture factor appears to be the facilitating element.

Memory

The memory score was derived by counting the total number of correct responses when the subjects were asked to recall as many of the stimuli as they could that were used in the groupings. Hypothesis six states

Table 53. Summary of the least significant differences between the class adjusted means on the total number of unique reasons given when classifying

Comparison of experimental group means		Absolute difference between means	t	Least significant difference between means	Conclusion
Six grade versus freshmen	= 11.252 = 12.862	1.610	1.960	1.276	$P < 0.05$
Six grade versus jr. and sr.	= 11.252 = 13.009	1.757	1.960	1.554	$P < 0.05$
Freshmen versus jr. and sr.	= 12.862 = 13.009	0.147	1.960	1.394	N.S.

Table 54. Summary of the least significant differences between the stimuli by class adjusted means on the total number of unique reasons given when classifying

Comparison of experimental group means		Absolute difference between means	t	Least significant difference between means	Conclusion
Pictures by six grade versus Pictures by freshmen	= 11.049 = 13.819	2.770	1.960	2.125	$P < 0.05$
Pictures by six grade versus Pictures by jr. and sr.	= 11.049 = 12.392	1.343	1.960	2.076	N.S.
Pictures by six grade versus Words by six grade	= 11.049 = 9.971	1.078	1.960	1.889	N.S.
Pictures by six grade versus Words by freshmen	= 11.049 = 11.904	0.855	1.960	1.276	N.S.
Pictures by six grade versus Words by jr. and sr.	= 11.049 = 13.627	2.578	1.960	2.076	$P < 0.05$
Pictures by freshmen versus Pictures by jr. and sr.	= 13.819 = 12.392	1.427	1.960	1.999	N.S.
Pictures by freshmen versus Words by six grade	= 13.819 = 11.454	2.365	1.960	1.833	$P < 0.05$
Pictures by freshmen versus Words by freshmen	= 13.819 = 11.904	1.915	1.960	1.715	$p < 0.05$
Pictures by freshmen versus Words by jr. and sr.	= 13.819 = 13.627	0.192	1.960	1.944	N.S.
Pictures by jr. and sr. versus Words by six grade	= 12.392 = 11.454	0.938	1.960	2.125	N.S.
Pictures by jr. and sr. versus Words by freshmen	= 12.392 = 11.904	0.488	1.960	1.944	N.S.
Pictures by jr. and sr. versus Words by jr. and sr.	= 12.392 = 13.627	1.235	1.960	1.999	N.S.
Words by six grade versus Words by freshmen	= 11.454 = 11.904	0.450	1.960	1.746	N.S.
Words by six grade versus Words by jr. and sr.	= 11.454 = 13.627	2.173	1.960	2.025	$P < 0.05$
Words by freshmen versus Words by jr. and sr.	= 11.904 = 13.627	1.723	1.960	1.776	N.S.

that there would be no differences among the experimental groups in the number of stimuli recalled after classifying. Table 55 is the summary of the analysis of covariance between the experimental groups on the number of stimuli recalled after grouping. The analysis reveals significant differences between direction, stimuli class, direction by stimuli, and direction by stimuli by class groups.

The mean recall score for the increase group is 19.422 compared with 18.025 for the decreasing groups. Therefore, increasing group size appears to have a facilitating effect on memory. The mean recall score for pictures is 19.640 compared with 17.808 for words. Therefore, pictures have a more facilitating effect on memory than do words.

Table 56 is the summary of the least significant differences between the class means on the number of stimuli recalled. There is a significant difference between the six grade (mean score = 16.485) and the freshmen (20.154) and junior and senior (19.534) experimental groups. Therefore six graders remember fewer stimuli than the other class levels. There is no significant difference between the freshmen and the junior and senior groups.

Table 57 is the summary of the least significant differences between the direction by stimuli means on the number of stimuli recalled. The significant difference between the increase by pictures (mean score = 19.685) compared with the decrease by words (mean score = 16.456) group is a result of the combined facilitating effect of both the picture and the decrease factors. There is a significant interaction effect in the increase by words (mean score = 19.159) group compared with the decrease by words group. The increase factor is probably the facilitating agent in this interaction. There is a significant

Table 55. Summary of the analysis of covariance between the experimental groups on the number of stimuli recalled after grouping

Source of variation	df	Sums of squares	Mean squares	F-ratio	Probability
Direction	1	80.995	80.995	7.554	0.0067*
Stimuli	1	137.274	137.274	12.803	0.0005*
Class	2	411.802	205.901	19.204	0.0000*
Direction by stimuli	1	70.962	70.962	6.619	0.0110*
Direction by class	2	6.095	3.048	0.284	0.7529
Stimuli by class	2	12.969	6.484	0.605	0.5474
Direction by stimuli by class	2	88.546	44.273	4.129	0.0179*
I.Q. (covariant)	1	256.309	256.309	23.906	0.0000
Residual	158	1694.019	10.722		
Total	170	2982.643			

*Significant beyond the .05 level.

Table 56. Summary of the least significant differences between the class adjusted means on the total number of stimuli recalled

Comparison of experimental group means		Absolute difference between means	t	Least significant difference between means	Conclusion
Six grade versus freshmen	= 16.485 = 20.154	3.669	1.960	1.184	$P < 0.05$
Six grade versus jr. and sr.	= 16.485 = 19.534	3.049	1.960	1.331	$P < 0.05$
Freshmen versus jr. and sr.	= 20.154 = 19.534	0.620	1.960	1.235	N.S.

Table 57. Summary of the least significant differences between the direction by stimuli adjusted means on the total number of stimuli recalled after classifying

Comparison of experimental group means	Absolute difference between means	t	Least significant difference between means	Conclusion
Increase by pictures = 19.685 versus Increase by words = 19.159	0.526	1.960	1.407	N.S.
Increase by pictures = 19.685 versus Decrease by pictures = 19.596	0.089	1.960	1.407	N.S.
Increase by pictures = 19.685 versus Decrease by words = 16.456	3.229	1.960	1.407	$P < 0.05$
Increase by words = 19.159 versus Decrease by pictures = 19.596	0.437	1.960	1.407	N.S.
Increase by words = 19.159 versus Decrease by words = 16.456	2.703	1.960	1.407	$P < 0.05$
Decrease by pictures = 19.596 versus Decrease by words = 16.456	3.160	1.960	1.407	$P < 0.05$

difference between the decrease by picture (mean score = 19.596) and the decrease by words (mean score = 16.456) experimental groups. It may be concluded that in this difference the picture factor had a more facilitating memory effect with the decrease groups than did the words.

Table 58 is the summary of the least significant differences between the direction by stimuli by class means on the number of stimuli recalled. A significant difference was found indicating a higher memory score (mean score = 22.214) for the increase by pictures by freshmen experimental group when it was compared with the decrease by words by six grade (mean score = 13.848), the decrease by words by junior and senior (mean score = 16.750), the increase by pictures by six grade (mean score = 17.081), the increase by words by six grade (mean score = 17.178), the decrease by pictures by six grade (mean score = 17.831), the decrease by words by freshmen (mean score = 18.770) and the increase by words by freshmen (mean score = 19.071) experimental groups. In interpreting why these groups are significantly lower it can be noted that they all contain the previously proven debilitating memory effects of decrease, six grade or word factors. These factors appear to have a cumulative debilitating effect, with the six grade level being the strongest of the debilitating agents. A single most interesting result in this comparison is that freshmen remember significantly more stimuli when increasing groups with pictures than they do with words. This is not the case with juniors and seniors because they handle both stimuli equally well in an increasing manner. This illustrates an interesting quantitative difference between freshmen and juniors and seniors.

Table 58. Summary of the least significant differences between the direction by stimuli by class adjusted means on the number of stimuli recalled

Direction by stimuli by class ranked by means	No. of Ss.	Ranked means	Mean differences 12	11	10	9	8	7	6	5	4	3	2
(1) Increase by pictures by freshmen	13	22.214	8.366*	5.464*	5.133*	5.036*	4.383*	3.444*	3.143*	2.454	1.817	1.655	0.986
(2) Increase by words by jr. and sr.	11	21.228	7.380*	4.478*	4.147*	4.050*	3.397*	2.458	2.157	1.468	0.831	0.669	
(3) Decrease by pictures by freshmen	16	20.559	6.711*	3.809*	3.478*	3.381*	2.728*	1.789	1.488	0.799	0.162		
(4) Decrease by pictures by jr. and sr.	11	20.397	6.549*	3.647*	3.316*	3.219*	2.566	1.627	1.326	0.637			
(5) Increase by pictures by jr. and sr.	14	19.760	5.912*	3.090*	2.679*	2.582*	1.929	0.990	0.689				
(6) Increase by pictures by freshmen	20	19.071	5.223*	2.321	1.990	1.893	1.240	0.301					
(7) Decrease by words by freshmen	17	18.770	4.922*	2.020	1.689	1.592	0.939						
(8) Decrease by pictures by six grade	13	17.831	3.983*	1.081	0.750	0.653							
(9) Increase by words by six grade	14	17.178	3.330*	0.428	0.097								
(10) Increase by pictures by six grade	15	17.081	3.233*	0.331									
(11) Decrease by words by jr. and sr.	12	16.750	2.902*										
(12) Decrease by words by six grade	15	13.848											

Least significant difference values between means: *for .05 level of significance = 1.96

A significant difference was found indicating a higher memory score (mean score = 21.228) for the increase by words by junior and senior group when it was compared with the decrease by words by six grade (mean score = 13.848), the decrease by words by junior and senior (mean score = 16.750), the increase by pictures by six grade (mean score = 17.081), the increase by words by six grade (mean score = 17.178) and the decrease by pictures by six grade (mean score = 17.831) experimental groups. These are all expected differences due to the single and combined effects of the decrease, words, and six grade factors.

A significant difference was found indicating a higher memory score (mean score = 20.559) for the decrease by pictures by freshmen group when it was compared with the decrease by words by six grade (mean score = 13.848), the decrease by words by junior and senior (mean score = 16.750), the increase by pictures by six grade (mean score = 17.081), the increase by words by six grade (mean score = 17.178), and the decrease by pictures by six grade (mean score = 17.831) experimental groups. These significantly lower scores are explained by the strong debilitating effects on memory of the six grade and word factors.

All the significant interactions in table 58 can be explained by the debilitating effects of the six grade, word, or decreasing factors interacting singly or in unison to produce lower memory scores. It is notable that the significantly lowest memory score (mean score = 13.848) was in the decrease by words by six grade group which contained all three debilitating factors.

Stimuli attitude

The attitude toward stimuli was measured using the bipolar adjective scales presented in Appendix E. Hypothesis seven states that there would be no differences among the experimental groups in their attitudes toward the stimuli after classifying. Table 59 is the summary of the analysis of covariance between the experimental groups on attitudes toward stimuli after grouping. There are no significant differences revealed.

Task attitude

Like the attitude toward stimuli, the task attitude was measured using bipolar adjective rating scales presented in Appendix E. Hypothesis eight stated that there would be no differences among the experimental groups in their attitudes toward the tasks after classifying. Table 60 is the summary of the analysis of covariance between the experimental groups on attitudes toward tasks after grouping. There are no significant differences shown.

Summary of the unique reasons, memory, and attitudes analyses

Significant differences were found in the number of unique reasons produced between the direction, the class and the stimuli by class groups. Increasing group size results in more unique reasons. The six grade group produces fewer unique reasons than do the freshmen and the junior and senior groups. These results are based on the total of all responses and may be biased due to six graders producing fewer responses. In the stimuli by class interaction effect most of the results can be attributed to the influence of class level. One important interaction,

Table 59. Summary of the analysis of covariance between the experimental groups on attitudes toward stimuli after grouping

Source of variation	df	Sums of squares	Mean squares	F-ratio	Probability
Direction	1	116.480	116.480	1.621	0.2848
Stimuli	1	23.763	23.763	0.331	0.5662
Class	2	70.670	35.335	0.492	0.6126
Direction by stimuli	1	21.018	21.018	0.292	0.5895
Direction by class	2	161.978	80.989	1.127	0.3266
Stimuli by class	2	185.697	92.848	1.292	0.2775
Direction by stimuli by class	2	90.826	45.413	0.632	0.5330
I.Q. (covariant)	1	24.542	24.542	0.341	0.5599
Residual	129	11427.855	71.873		
Total	171	12120.695			

*Significant beyond the .05 level.

Table 60. Summary of the analysis of covariance between the experimental groups on attitudes toward tasks after grouping

Source of variation	df	Sums of squares	Mean squares	F-ratio	Probability
Direction	1	1.583	1.583	0.014	0.9062
Stimuli	1	19.448	19.448	0.171	0.6795
Class	2	113.614	56.807	0.500	0.6072
Direction by stimuli	1	0.391	0.391	0.003	0.9533
Direction by class	2	382.974	191.487	1.687	0.1884
Stimuli by class	2	532.793	266.396	2.347	0.0990
Direction by stimuli by class	2	260.553	130.277	1.148	0.3199
I.Q. (covariant)	1	13.409	13.409	0.118	0.7315
Residual	156	11706.652	113.504		
Total	168	19049.465			

*Significant beyond the .05 level.

however, indicates that freshmen grouping pictures, produce more unique reasons than with words.

The memory analysis shows significant direction, stimuli, class, direction by stimuli, and direction by stimuli by class effects. The effect of increasing group size and the effect of pictures result in better recall. The six grade group recalls fewer items than the freshmen and juniors and seniors. The significant direction by stimuli interactions can be explained by the debilitating effects of the decrease and word factors interacting cumulatively to produce significantly lower recall scores. The direction by stimuli by class interactions can be explained by the single and cumulative effects of the decrease, words, and six grade factors interacting to produce significantly lower memory scores.

There were no significant differences among the experimental groups in either stimuli or task attitudes.

Other analyses

Appendix K contains Tables 61 to 102 of number four scores on the data sheet which lists the total scores by category of all first reasons given for grouping. Appendix L contains Tables 103 to 145 of the number ten scores on the data sheet which lists the total of all the single highest cognitive level scores given by the subject.

Summary

It was found that there were significant differences between the class levels in intelligence; therefore, the analysis of covariance technique was used in the analysis of the data. It was also found that six grade subjects produced fewer reasons for their groupings than did freshmen and juniors and seniors. For this reason the analyses that were reported were based on scores uncontaminated by differences in the numbers of responses between the experimental groups. These analyses were numbers four, eight and ten on the data sheet. Number four lists the total score, by category, of all first reasons given for grouping. Number eight lists the total of the first reasons for all the groupings by their category cognitive level score as illustrated in Figure 5. Number ten lists the total of all the single highest cognitive level scores. The results of the three analyses were almost identical; therefore, the data from the number eight scoring technique was presented in chapter four, and the other analyses were presented in the appendices.

In the grouping structure analyses it was found that decreasing group size resulted in higher superordinate cognitive level scores, lower thema scores, and a higher overall grouping structure score. This indicated that decreasing group size is related to higher cognitive level functioning and a more efficient grouping structure. There were no significant differences found in the complex grouping analysis. In the thema analysis it was found that the increasing group compared with the decreasing group produced more thema scores, and that the six grade group produced more thema responses than did freshmen. However, there was no significant difference between the juniors and seniors and six graders in thema scores. There was a significant stimuli by class interaction effect in the thema analysis which appeared to be the result of the single and combined effects of the six grade and increase factors to produce more thema responses.

In the simple association analyses it was found that the heaping attribute, itemized naming, and fiat categories yielded no significant differences and were of little use as scoring categories for the age levels in the present study. The decrease by pictures by six grade group yielded the highest number of edge matching responses. The total analysis indicated that more simple association responses were given in the increasing groups. The lowest simple association score was in the decrease by pictures by freshmen group. It was concluded that the decrease factor in certain combinations with words, six grade, and freshmen factors produces very few simple association responses.

In the concrete attribute analyses there were too few perceptual labeling responses for an analysis. There were no significant differences between the experimental groups in perceptual location or functional association responses. In the functional dependence (extrinsic) analysis, the decreasing groups scored significantly higher than the increasing groups, and the six graders scored significantly higher than the freshmen. In the functional dependence (intrinsic) analysis, six graders scored significantly higher than the freshmen. There was a significant stimuli by class interaction in the functional dependence (intrinsic) analysis, and it was suggested that a combination of pictures with six grade results in higher concrete scores. The functional dependence (situational) analysis shows that the six grade group scores significantly higher than the freshmen and juniors and seniors. The analysis on the total of the concrete attribute scores indicates that the six grade group produces significantly more concrete attribute responses than do the freshmen and juniors and seniors.

In the representational analyses the simple representational analysis yielded a significant directional effect with the decreasing group having a higher cognitive level score. The compound representational analysis also yielded a significantly higher cognitive level score for the decrease group. These results lead to the conclusion that decreasing the size of groupings results in more of the high level representational responses and a higher cognitive level of functioning. There were too few responses in the relational category for an analysis. In the symbolic, affective representational (simple) and the affective representational (abstract) analyses there were no significant differences found. The total representational attribute analysis yielded a significant directional effect, a significant class level effect, and a significant direction by class interaction effect. The decrease group had a higher cognitive level score; the six grade group had a lower cognitive level score when compared with the freshmen and the juniors and seniors; the direction by class interaction reflected the class and directional differences.

In the total attribute cognitive score analysis, decreasing group size resulted in an overall higher level of grouping attribute, cognitive functioning. In addition to the significant directional effect there was a significant direction by stimuli by class interaction: It was apparent that juniors and seniors handle words as efficiently when decreasing group size as freshmen do when they decrease group size using pictures; however, juniors and seniors do not handle pictures when decreasing group size as efficiently as freshmen. This leads to some interesting conclusions regarding the differences between juniors and seniors in their ability to handle different forms of stimuli. The more abstract word stimuli appear to be handled more efficiently by the older juniors and seniors, whereas the younger freshmen handle the more concrete pictures more efficiently. Thus, there may be some quantitative cognitive differences between the juniors and seniors in their ability to handle different levels of abstract stimuli. Other analyses indicated that the six grade group does not handle the picture stimuli as efficiently as do the freshmen; however, six grade subjects apparently handle pictures, in a decreasing manner, as well as juniors and seniors. Other significant differences in the three-way interaction were explained by the influence of increase and/or six grade factors which appear to have a debilitating effect on cognitive level scores.

In the supplementary aspects analyses when testing the partial use of stimuli variable it was found that the six grade group used significantly more of these low level responses than did freshmen and juniors and seniors. In examining the exceptional quality of responses there was found a significant direction by class interaction and a significant direction by stimuli by class interaction. In the direction by class interaction effect it was concluded that the increase factor in combination with the freshmen factor results in a high number of exceptional quality responses; the decrease factor in combination with the six grade factor resulted in few exceptional quality responses when compared to the junior and senior group. The major direction by stimuli by class interaction effects were as follows; Juniors and seniors produced more exceptional quality responses when they used pictures to increase group size than did freshmen who used words. Juniors and seniors who used pictures to increase the size of their groups produced more quality responses than when they used words. (Thus, they handle pictures more efficiently). Juniors and seniors gave more exceptional responses when increasing group size with pictures than did freshmen. Six grade subjects who increased group size using words produced more high quality responses than when using pictures. The total of the supplementary aspects scores indicated that the six grade group produced fewer high quality responses when compared with the other grade levels.

The specific level of specificity analysis indicated that increasing group size resulted in more specific responses as compared to decreasing group size. The middle level of specificity analysis indicated a significant directional difference as well as a significant direction by stimuli interaction. Decreasing group size resulted in more middle level of specificity responses (Thus, this may indicate a higher level of functioning). The interaction analysis indicated that the decrease factor is a potent influence, and in combination with the pictures or words factors, interact to produce more middle level of specificity responses.

Significant differences were found in the number of unique reasons produced between the direction, the class, and the stimuli by class groups. Increasing group size resulted in more unique reasons. The six grade group produced fewer unique reasons than did the older groups. These results are based on the total of all responses and may be biased due to six graders producing fewer responses. In the stimuli by class interaction effect, most of the results could be attributed to the influence of class level. One important interaction, however, indicated that freshmen grouping pictures, produce more unique reasons than with words.

The memory analysis showed significant direction, stimuli, class, direction by stimuli, and direction by stimuli by class effects: The effects of increasing group size and the effect of pictures resulted in more stimuli being recalled. The six grade group recalled fewer items than the freshmen and juniors and seniors. The significant direction by stimuli interaction was explained by the debilitating effects of the decrease and word factors interacting cumulatively to produce significantly lower recall scores. The direction by stimuli by class interactions were explained by the single and cumulative effects of the decrease, words and six grade factors interacting to produce significantly lower memory scores.

There were no significant differences among the experimental groups in either stimuli or task attitudes.

CHAPTER V

DISCUSSION

Introduction

The results of this study are a significant contribution to the existing body of knowledge relevant to how the human organism perceives, classifies, and organizes as he grows older. These results confirm, clarify and extend to new areas much of the previously acquired knowledge in the area of cognitive growth. For discussion of the results, the organization of the chapter is as follows: First a discussion of the main effects of the independent variables of direction, stimuli, and class on the dependent variables is presented. Next a discussion of the interaction effects is pursued. Then, suggestions for future research are made.

Increasing versus decreasing in grouping

One particular point of interest in this study is whether or not increasing or decreasing the size of the groups results in different types of equivalence classifying.

When Sigel (1953) tested the limits and stability of concept formation in children by having them increase the size of groupings he found that older children suffered an impairment in their ability to form high level groupings and used more perceptual groupings. Carson (1965) also had children increase the size of groupings and found that there was a general trend for higher grades (between kindergarten and grade three) to maintain more of the high attribute levels in their reasons for grouping. His ninth graders appeared to have greater ability to broaden grouping structure and attributes to accommodate new items. Low (1970), in addition, found that ten-year-old subjects produced more groupings based on perceptual attributes than older children when going from their own groupings to groups having three pictures or fewer.

In the aforementioned studies there is ample evidence that changing the size of groupings may result in a change in the level of grouping structure, attribute, supplemental aspects, and specificity. One purpose of the present study was to determine the effects of progressively increasing group sizes from two, to four, to six elements and progressively decreasing group sizes from six to four, to two elements per group. In general, the results of the present study, as indicated in Table 146, shows that decreasing group size results in more high level responses, and conversely, increasing the size of groupings results in more low level responses. In viewing the grouping structure more of the high level superordinate responses were found in the decreasing groups. More of the low level responses were found in the low level thema grouping structure. There was no significant difference in the complex category. In addition, when testing the total grouping structure score which is a measure of cognitive level, grouping structure functioning, it is found that the decreasing group is higher in cognitive grouping structure functioning.

The simple association grouping attributes category is the lowest category in the attribute scale. The only significant measure among the different simple association subcategories was in the total of the

Table 146. Summary of the significant directional effects

	Significantly Higher	Significantly Lower
GROUPING STRUCTURE		
Superordinate	D	I
Complex	N.S.	
Thema	I	D
Total	D	I
ATTRIBUTES		
Simple Assoc. Heaping	N.S.	
Itemized Naming	N.S.	
Fiat	N.S.	
Edge Matching	N.S.	
Total	I	D
Concrete		
Perceptual Labeling	N.S.	
Perceptual Attributes	N.S.	
Perceptual Location	N.S.	
Functional Association	N.S.	
Functional Dependence (Extrinsic)	D	I
Functional Dependence (Intrinsic)	N.S.	
Functional Dependence (Situational)	N.S.	
Total	N.S.	
Representational		
Simple Representational	D	I
Compound Representational	D	I
Relational	N.S.	
Symbolic	N.S.	
Affective Representational (Simple)	N.S.	
Affective Representational (Abstract)	N.S.	
Total	D	I
Total Attributes	D	I
Supplementary Aspects		
Partial Use of Stimuli	N.S.	
Exceptional Quality of Response	N.S.	
Poor Quality of Response	I	D
Regular or No Extra Supplemental Aspects	N.S.	
Total	D	I
Level of Specificity		
Specific	I	D
Middle	D	I
General	N.S.	
Total	D	I
Unique Reasons	I	D
Memory	I	D
Stimuli Attitude	N.S.	
Task Attitude	N.S.	

I = Increase
D = Decrease
N.S. = Not Significant

simple association responses. This total represents grouping attribute responses at the lowest level. The increase group had significantly more of the total simple association responses. This is additional evidence that increasing group size results in lower cognitive level functioning.

The middle level of grouping attributes is the concrete level. The only significant difference evident in this level is in the functional dependence (extrinsic) category which shows the decrease group yielding more of these higher level responses. Additional evidence in favor of the contention that decreasing group size results in higher cognitive functioning comes from the highest attributes category, the representational level. Only the decrease group is significantly higher at this level. Significantly more responses in the simple representational, compound representational and total representational categories are found in the decrease groups. Furthermore, the decrease group has a higher total attributes score which is a measure of the total level of attribute categorizing.

The only significant supplementary aspects category was the poor quality of response category. The increase group had significantly more of these poor quality responses.

The level of specificity categories appear to be a measure of maturity. Olver's (1961) results relative to these categories suggested that more general reasons are given by older subjects; it is apparent from the present results that the more general the response the more mature is the cognitive level. The increase group had more of the specific level of specificity responses. The decrease group had more middle level of specificity responses as well as a higher total level of specificity score which is a general measure of the level of specificity.

In summary, there is ample evidence to indicate that decreasing group size results in a high level of cognitive functioning; increasing group size results in a low level of cognitive functioning. One explanation for these results is that in decreasing group size one must first produce a reason for grouping all six elements together. When reducing the group size, the original reason still applies to the smaller group. The subject is then free to explore for other reasons for the smaller groupings, reasons that are more exact and of a high quality. Decreasing group size appears to provide more flexibility and opportunity for divergent thinking.

On the other hand, increasing group size results in convergent thinking. The subject has a preestablished reason for grouping which no longer applies when he adds more items. He has a mental set which must be broken up. Therefore, he must first disregard his old reason and actively search for one new reason which would apply to his grouping. His previous reason for grouping may be an inhibiting factor because it no longer applies to the new grouping. In addition, the individual may attempt to continue use of the previous reason and force the new additions into the concept he has already utilized; in doing so he limits the possibilities of interaction among the items chosen and versatility of reason selection decreases.

Unique. Low (1970) indicated that younger students consistently produced more unique reasons for their groupings than did older subjects. His measure of unique was similar to that of the present study. Both were based on the number of different responses given. There are more unique reasons given in the increase groups. An explanation of this result might be that when increasing group size one is forced to produce new reasons for adding more stimuli. However, when one decreases group size the original reason for the grouping may still apply. Thus, one need not actively search for a new reason for the reduced grouping.

Memory. The increase group recalls more of the stimuli than does the decrease group. An explanation of this result might be that to increase the size of groups one must change the reasons for the grouping and repeatedly and actively manipulate all the stimuli as one builds an entire, intact unit of six stimuli. Whereas, the decrease group removes part of the stimuli with each grouping and disregards that aspect of the stimuli. The end products in the decrease group are many small groups. The end products in the increase group are several large intact groups.

Stimuli and task attitudes. There were no significant differences in the stimuli and task attitudes. Osgood, Suci, and Tannenbaum's (1957) evaluative dimension of the semantic differential yielded no significant results in any of the analyses. Either there were no significant differences in attitudes between the experimental groups, or the semantic differential was not sensitive enough to detect the differences.

Words versus pictures

Another objective of this study was to compare in the same investigation the classifying of groups of pictures as opposed to words. Olver (1961) had children sort words into groups in terms of how they were alike, and Rigney (1962) had children sort pictures into equivalence groups in terms of how they were alike. They concluded, as a result of comparing their separate studies, that there were no differences in grouping as a result of the use of words as opposed to pictures. Futterman (1971) in a study using word and picture stimuli found that young children (aged 5, 7, and 9) performed higher conceptually with concrete (visual) as opposed to abstract (words) material. It was concluded that children perform more efficiently with pictures because they are more familiar with that form of stimuli as opposed to words. Stephens and Nopar (1971), in a study comparing mentally retarded and non retarded children, used pictorial and printed word stimulus items and concluded that pictures evoke more perceptual groupings than do words.

The aforementioned studies do not demonstrate conclusively whether there are differences in grouping as a result of using picture or word stimuli. In the present study there were no significant differences found between words and pictures in any of the grouping dependent variables as shown in Table 147. Therefore, it can be concluded that there are no grouping differences, as far as main effects are concerned, between words or pictures.

Memory. In testing memory, the total number of stimuli that could be recalled after grouping, it was found that more pictures are recalled. An explanation of this might be that more sensory involvement occurs with the concrete picture stimuli than with the more abstract words. One's awareness and attention to the details and concrete aspects of the pictures makes for more involvement with this type of

Table 147. Summary of the significant stimuli effects

	Significantly Higher	Significantly Lower
GROUPING STRUCTURE		
Superordinate	N.S.	
Complex	N.S.	
Thema	N.S.	
Total	N.S.	
ATTRIBUTES		
Simple Assoc. Heaping	N.S.	
Itemized Naming	N.S.	
Fiat	N.S.	
Edge Matching	N.S.	
Total	N.S.	
Concrete		
Perceptual Labeling	N.S.	
Perceptual Attributes	N.S.	
Perceptual Location	N.S.	
Functional Association	N.S.	
Functional Dependence (Extrinsic)	N.S.	
Functional Dependence (Intrinsic)	N.S.	
Functional Dependence (Situational)	N.S.	
Total	N.S.	
Representational		
Simple Representational	N.S.	
Compound Representational	N.S.	
Relational	N.S.	
Symbolic	N.S.	
Affective Representational (Simple)	N.S.	
Affective Representational (Abstract)	N.S.	
Total	N.S.	
Total Attributes	N.S.	
Supplementary Aspects		
Partial Use of Stimuli	N.S.	
Exceptional Quality of Response	N.S.	
Poor Quality of Response	N.S.	
Regular or No Extra Supplemental Aspects	N.S.	
Total	N.S.	
Level of Specificity		
Specific	N.S.	
Middle	N.S.	
General	N.S.	
Total	N.S.	
Unique Reasons	N.S.	
Memory	Pictures	Words
Stimuli Attitude	N.S.	
Task Attitude	N.S.	

N.S. = Not Significant

stimuli. The increased involvement, attention, and effort results in better recall.

Six grade versus freshmen versus junior and senior

A major objective of the present study is to further study the age and grade level differences in how people perceive, classify, and organize. Recently a number of studies (Olver, 1961; Rigney, 1962; Carson, 1965; Low, 1970) have found that children perceive, classify, and organize differently as they grow older. As Sigel (1953) and Vinacke (1954) indicated the human organism becomes increasingly more sophisticated in his ability to form concepts and classify things in his environment as he progresses through childhood. The results of this study support Sigel and Vinacke. The results of this study also support Piaget's (Berlyne, 1957) views in that the younger subjects gave more concrete responses and the older subjects gave more representational responses.

In testing grouping structure Olver (1961), Rigney (1962) and Carson (1965) found that older children use more of the higher grouping structure responses (superordinate). Table 148 reflects that there were no significant differences found between the classes in superordinate and complex responses. However, it was found that the six grade group gave significantly more of the thema responses than did the freshmen. This gives support to the argument that the younger children are operating at a lower cognitive level. The fact that there were no significant differences between the juniors and seniors and the freshmen and the juniors and seniors and the six grade may indicate that there is a tapering off in cognitive development among older subjects.

Table 148. Summary of the significant class effects

	Significantly Higher	Significantly Lower
GROUPING STRUCTURE		
Superordinate	N.S.	
Complex	N.S.	
Thema	SG	Fr
Total	N.S.	
ATTRIBUTES		
Simple Assoc. Heaping	N.S.	
Itemized Naming	N.S.	
Fiat	N.S.	
Edge Matching	N.S.	
Total	N.S.	
Concrete		
Perceptual Labeling	N.S.	
Perceptual Attributes	SG	Fr; Jr & Sr
Perceptual Location	N.S.	N.S.
Functional Association	N.S.	N.S.
Functional Dependence (Extrinsic)	SG	Fr
Functional Dependence (Intrinsic)	SG	Fr
Functional Dependence (Situational)	SG	Fr; Jr & Sr
Total	SG	Fr; Jr & Sr
Representational		
Simple Representational	N.S.	N.S.
Compound Representational	N.S.	N.S.
Relational	N.S.	N.S.
Symbolic	N.S.	N.S.
Affective Representational (Simple)	N.S.	
Affective Representational (Abstract)	N.S.	
Total	Fr; Jr & Sr	SG
Total Attributes	N.S.	
Supplementary Aspects		
Partial Use of Stimuli	SG	Fr: Jr & Sr
Exceptional Quality of Response	N.S.	N.S.
Poor Quality of Response	N.S.	N.S.
Regular or No Extra Supplemental Aspects	N.S.	N.S.
Total	Fr; Jr & Sr	SG
Level of Specificity		
Specific	N.S.	
Middle	N.S.	
General	N.S.	
Total	N.S.	
Unique Reasons	Fr; Jr & Sr	SG
Memory	Fr; Jr & Sr	SG
Stimuli Attitude	N.S.	
Task Attitude	N.S.	

N.S. = Not Significant
Fr = Freshmen
Jr & Sr = Juniors and Seniors
SG = Six Grade

In any case it has been demonstrated that younger subjects group in a less efficient manner. There were no differences among the groups in simple association attributes. Indeed, there were very few responses at this low level and it probably is not of use at these higher age levels.

The middle level of functioning, the concrete level, shows some very important results. Piaget's (Berlyne, 1957) theory indicates that the six grade group should be in the concrete stage. Our results support his contention.

In the perceptual labeling, perceptual location and functional association categories there were no significant differences. However, in the perceptual attribute, functional dependence (extrinsic), functional dependence (intrinsic), functional dependence (situational), and total concrete categories the six grade group had significantly more responses. These results are congruent with those of Piaget (Berlyne, 1957), Olver (1961), Rigney (1962) Carson (1965), and Low (1970). An interesting observation is that in the functional dependence (extrinsic) and the functional dependence (intrinsic) categories there were no differences between the junior and seniors and the other two groups. This tendency of the juniors and seniors in the thema category and in the concrete levels should be explored further.

Piaget's (Berlyne, 1957) theory, as well as the previously mentioned studies, indicate that the older subjects should give more representational responses. There were no significant differences found in any of the six representational subcategories or the total attribute category. However, when the total of the representational responses were tested it was found that the freshmen and junior and senior groups made significantly more representational responses than did the six grade group. This result gives us further evidence for a cognitive developmental progression.

The supplemental aspects contain categories which represent the quality of the response. That is, a poor quality response would be one that does not represent or have any real relationship to the items in the grouping. The partial use of stimuli is another relatively poor quality response. The six grade group had significantly more partial use of stimuli responses. The total supplementary aspects category represents the quality level of responses. A high score would represent high quality of responses. The freshmen and junior and senior groups had significantly higher total supplementary aspects scores.

In the level of specificity scores there were no differences found between the class levels. Olver's (1961) results indicated that more general reasons are given by older subjects. Some support for this contention was given in the directions analysis. In the analysis in Appendix 4, Tables 143 and 144 show significant differences between the class levels on the middle level of specificity responses. Freshmen and juniors and seniors have significantly more middle level of specificity responses. Therefore, it can be concluded that middle level of specificity responses are representative of a more mature cognitive level of functioning.

Unique. Low (1970) found that younger children produced more different reasons for their groupings. The results of the present study show that freshmen and juniors and seniors produce more different reasons for their groups. This analysis was based on the total number of responses and may be biased due to the tendency of older subjects to produce more responses. However, it does seem logical that subjects who produce more responses are capable of producing a greater number of diversified responses.

Memory. The results of Rigney's (1962) study indicated that from grade to grade subjects progressively remembered more items. It was expected that older subjects with more efficient clusters would be able to regenerate more items. The results of the present study are congruent with Rigney's findings. Significantly more items were recalled by the freshmen and juniors and seniors. The fact that these two older groups have higher cognitive level scores than the six grade group, and their ability to deal more efficiently with the grouping tasks, allowed them to retrieve more items.

Interaction effects

Table 149 shows the significantly higher and lower interactions among the experimental groups. It appears that certain factors in the interactions have more influence in increasing or decreasing responses in certain categories. Table 150 shows a comparison of the significant three-way thema interactions. Some important comparisons have an asterisk. It is evident from examining the total pattern of results that the six grade factor is perhaps the strongest factor in the interactions which produces more thema scores. Next, the increase factor appears to have considerable influence perhaps equal to the six grade in facilitating thema scores. Also it is evident that pictures do exert an influence in the interaction to create higher thema scores. This is seen in the comparison of the decrease by picture by six grade

Table 149. Summary of the categories which have significant interaction effects

	Significant Interactions
GROUPING STRUCTURE	
Superordinate	N.S.
Complex	N.S.
Thema	D x S x C
Total	N.S.
ATTRIBUTES	
Simple Assoc. Heaping	N.S.
Itemized Naming	N.S.
Fiat	N.S.
Edge Matching	D x S x C
Total	D x S x C
Concrete	
Perceptual Labeling	N.S.
Perceptual Attributes	N.S.
Perceptual Location	N.S.
Functional Association	N.S.
Functional Dependence (Extrinsic)	N.S.
Functional Dependence (Intrinsic)	S x C
Functional Dependence (Situational)	N.S.
Total	N.S.
Representational	
Simple Representational	N.S.
Compound Representational	N.S.
Relational	N.S.
Symbolic	N.S.
Affective Representational (Simple)	N.S.
Affective Representational (Abstract)	N.S.
Total	D x C
Total Attributes	D x S x C
Supplementary Aspects	
Partial Use of Stimuli	N.S.
Exceptional Quality of Response	D x C & D x S x C
Poor Quality of Response	N.S.
Regular or No Extra Supplemental Aspects	N.S.
Total	N.S.
Level of Specificity	
Specific	N.S.
Middle	D x S
General	N.S.
Total	N.S.
Unique Reasons	S x C
Memory	D x S & D x S x C
Stimuli Attitude	N.S.
Task Attitude	N.S.

N.S. = Not Significant
D = Direction
S = Stimuli
C = Class

Table 150. Summary of the significant three-way thema interactions

Significantly Higher	Significantly Lower
D x P x SG	D x P x Fr
D x P x SG	D x W x Fr
D x P x SG	D x W x SG*
D x P x SG	I x W x Jr & Sr
D x P x SG	I x P x Fr
I x W x SG	D x P x Fr
I x W x SG	D x W x Fr
I x W x SG	D x W x SG*
I x W x SG	I x W x Jr & Sr
I x W x SG	I x P x Fr
I x P x Jr & Sr	D x P x Fr
I x P x Jr & Sr	D x W x Fr
I x P x Jr & Sr	D x W x SG
I x P x Jr & Sr	I x W x Jr & Sr*
I x P x Jr & Sr	I x P x Fr
I x P x SG	D x P x Fr
I x P x SG	D x W x Fr
I x W x Fr	D x W x Fr

I = Increase
D = Decrease
SG = Six Grade

P = Picture
W = Word
Fr = Freshmen
Jr & Sr = Juniors and Seniors

with the decrease by word by six grade group. Also it is seen in the comparison of the increase by picture by junior and senior with the increase by words by junior and senior group. The factors of increase, pictures, and six grade, may have a cumulative effect in combination to debilitate cognitive functioning.

In conclusion, if the direction and class factors are held constant, the picture stimuli takes precedence in creating higher thema scores. If the direction and stimuli factors are held constant, the six grade factor takes precedence in facilitating thema scores. If the stimuli and class factors are held constant the increase factor takes precedence in facilitating thema scores. These relationships may also be predictive of, and result in, lower cognitive level functioning.

There was a significant three-way interaction in the edge matching analysis. The decrease by pictures by six grade group was significantly higher than the decrease by word by six grade, and the decrease by picture by freshmen groups. This result is congruent with our previously described explanation of lower cognitive level functioning. For example, the decrease (direction) and six grade (class) groups are held constant; therefore, the picture stimuli takes precedence in facilitating more of the low level edge matching responses. The decrease (direction) and picture (stimuli) are held constant, and the six grade class takes precedence in facilitating more of the lower level edge matching responses.

There was a significant three-way interaction when the total of the simple association attributes was tested. Table 151 shows a comparison of the significant interactions. These results are congruent with the previously mentioned analysis. For example, in the first comparison

Table 151. Summary of the significant three-way simple association interactions

Significantly Higher	Significantly Lower
I x W x SG	D x W x SG
I x W x SG	D x P x Fr
I x P x Jr & Sr	D x W x SG
I x P x Jr & Sr	D x P x Fr
D x P x SG	D x W x SG
D x P x SG	D x P x Fr
I x W x Fr	D x W x SG
I x W x Fr	D x P x Fr
I x P x Fr	D x W x SG
I x P x Fr	D x P x Fr

I = Increase
D = Decrease
SG = Six Grade

P = Picture
W = Word
Fr = Freshmen
Jr & Sr = Juniors and Seniors

in Table 151 words and six grade are held constant; therefore the increase group took precedence in facilitating a higher simple association score, which represents more low level responses. In the second example in Table 151 the combined cumulative effect of two factors, the increase and six grade in combination results in more of the low level responses when compared with the single factor of pictures in combination with the decrease and freshmen groups. In like manner, these trends continue throughout the other comparisons.

One must be aware when using the present analysis that in comparing the highest and lowest groups other factors than the independent variables are minimized as agents influencing the group differences. Therefore, the present analysis is expected to hold "more true" for comparisons of groups with larger mean differences.

Table 152 is the significant stimuli by class interaction in the functional dependence (intrinsic) analysis. This category is in the concrete level of cognitive functioning and represents a lower level of cognitive functioning when compared to the representational level. The suppositions concerning the analysis of interaction effects also are shown relevant to these results. However, there are some interesting observations in this analysis. When comparing the picture by junior and senior interaction with the picture by freshmen interaction the juniors and seniors apparently produce more of the lower concrete responses than do the freshmen when they use pictures. In addition, pictures facilitate more of these concrete responses among juniors and seniors than do words. Perhaps pictures have a debilitating effect on the cognitive functioning of the older subjects.

Table 152. Summary of the two-way functional dependence (intrinsic) interactions

Significantly Higher	Significantly Lower
P x SG	P x Fr
P x SG	W x Jr & Sr
P x Jr & Sr	P x Fr
P x Jr & Sr	W x Fr
P x Jr & Sr	W x Jr & Sr
W x SG	W x Fr
W x SG	W x Jr & Sr

SG = Six Grade
Fr = Freshmen

P = Picture
W = Word
Jr & Sr = Juniors and Seniors

Table 153 shows the direction by class interactions in the total representational analysis. The total representational scores represent a high level of cognitive functioning. In extending the conclusions concerning interpretation of interactions one would expect that decreasing groups would have a facilitating effect on higher cognitive functioning, that words may have a facilitating effect on higher cognitive functioning, and that the two college level groups would have a higher facilitating effect on cognitive functioning. These factors working singly or in combination would have a cumulative effect in facilitating higher cognitive scores. If direction and class are held constant it is not clear whether words or pictures should result in higher scores. If stimuli and class are held constant, decrease should result in higher scores. If direction and stimuli are held constant the college levels should result in higher scores.

In viewing the significant direction by class interactions in Table 153 the results are congruent with the aforementioned analysis.

Table 154 is the summary of the three-way interaction of the total attributes analysis. The total attributes analysis represents the total level of cognitive functioning relative to grouping attributes. The results in Table 154 are congruent with the aforementioned analysis. It should be noted, however, that freshmen have higher attributes scores compared with juniors and seniors when using pictures in a decreasing manner. Also, apparently freshmen don't handle words as well as they do pictures. Note, however, that junior and seniors handle words as well as freshmen handle pictures. Perhaps, then, it can be concluded that there is a real difference in the way that different stimuli are handled by college level subjects. That is, juniors and

Table 153. Summary of the two-way total representational interactions

Significantly Higher	Significantly Lower
I x Jr & Sr	I x SG
D x Fr	I x SG
D x Jr & Sr	I x SG
D x Fr	I x Fr
D x Fr	I x Jr & Sr
D x Fr	D x SG

I = Increase
D = Decrease
SG = Six Grade

P = Picture
W = Word
Fr = Freshmen
Jr & Sr = Juniors and Seniors

Table 154. Summary of the three-way interaction of the total attributes analysis

Significantly Higher	Significantly Lower
D x P x Fr	I x W x SG
D x P x Fr	I x W x Fr
D x P x Fr	I x W x Jr & Sr
D x P x Fr	I x P x Fr
D x P x Fr	D x P x SG
D x P x Fr	I x P x SG
D x P x Fr	I x W x Jr & Sr
D x P x Fr	D x W x SG
D x P x Fr	D x P x Jr & Sr
D x P x Fr	D x W x Fr
D x W x Jr & Sr	I x W x SG
D x W x Jr & Sr	I x W x Fr
D x W x Fr	I x W x SG
D x W x Fr	I x W x Fr
D x P x Jr & Sr	I x W x SG
D x W x SG	I x W x SG
I x W x Jr & Sr	I x W x SG

I = Increase
D = Decrease
SG = Six Grade

P = Picture
W = Word
Fr = Freshmen
Jr & Sr = Juniors and Seniors

seniors handle words as well as freshmen handle pictures. But, freshmen handle pictures more efficiently than they do words.

In the exceptional quality of response analysis, in the direction by class interaction it was found that the decrease by freshmen group was significantly higher than the increase by freshmen group. The increase by junior and senior scores were higher than the decrease by six grade scores. These results are congruent with the stated interpretation for interactions.

Table 155 is the summary of three-way interaction of the exceptional quality analysis. For the most part, the results of this analysis fit with the stated thesis concerning interpretation of interactions. However, in this case we have some evidence that the picture stimuli apparently results in a higher level of functioning than words. For example, juniors and seniors produce more high quality responses using words in an increasing manner than freshmen using words. Juniors and seniors give more exceptional quality responses to pictures used in an increasing manner than do freshmen. Clarification of these results are needed in future research.

Table 156 shows the direction by stimuli interactions from the middle level of specificity analysis. It appears that the decrease factor takes precedence in facilitating more middle level of specificity responses. As indicated previously more general level of specificity is related to more mature functioning; therefore the above results are expected and congruent with our earlier explanations.

Unique. In the summary of the stimuli by class results in Table 157 it is clear that the interaction interpretation also holds true for the number of unique reasons produced. One interesting result is that

Table 155. Summary of the three-way interaction of the exceptional quality analysis

Significantly Higher	Significantly Lower
I x P x Jr & Sr	I x P x SG
I x P x Jr & Sr	D x W x SG
I x P x Jr & Sr	D x P x SG
I x P x Jr & Sr	I x W x Fr
I x P x Jr & Sr	I x W x Jr & Sr
I x P x Jr & Sr	I x P x Fr
D x W x Fr	I x P x SG
D x W x Fr	D x W x SG
D x W x Fr	D x P x SG
D x W x Fr	I x W x Fr
D x W x Fr	I x W x Jr & Sr
D x W x Fr	I x P x Fr
I x W x SG	I x P x SG
I x W x SG	D x W x SG
I x W x SG	D x P x SG
I x W x SG	I x W x Fr
D x P x Fr	I x P x SG

I = Increase
D = Decrease
SG = Six Grade

P = Picture
W = Word
Fr = Freshmen
Jr & Sr = Juniors and Seniors

Table 156. Summary of the two-way interaction of the middle level of specificity analysis

Significantly Higher	Significantly Lower
D x P	I x W
D x P	I x P
D x W	I x P

I = Increase
D = Decrease

P = Picture
W = Word

Table 157. Summary of the two-way interaction of the number of unique reasons analysis

Significantly Higher	Significantly Lower
P x Fr	P x SG
P x Fr	W x SG
P x Fr	W x Fr
W x Jr & Sr	P x SG
W x Jr & Sr	W x SG

P = Picture
W = Word

SG = Six Grade
Fr = Freshmen
Jr & Sr = Juniors and Seniors

freshmen produce more unique reasons using pictures than they do words. This is congruent with the previous results in which freshmen were more facile with pictures.

Memory. In the significant memory interactions the increase factor appears to take precedence over the decrease factor to result in better recall. The picture factor takes precedence over the word factor and the college levels take precedence over six grade. In the significant direction by stimuli interaction as well as the three-way interaction this analysis appears to be predictive.

Suggestions for future research

It would be of value to use more class levels. For example, third or fourth grade students would probably give a more complete comparison among experimental groups at the simple association and concrete levels. A Master's degree candidate group may yield more complete comparisons in the representational categories. With the addition of these two groups perhaps more definite differences between the forms of stimuli would emerge.

In future studies it may be appropriate to instruct the subjects to give one, and only one, good reason for their grouping. This would avoid difficulty in interpretation due to a difference among groups in the numbers of responses given.

It would be interesting to add another type of stimulus to the words and pictures to compare the effects of a complex word set, which fully describes the pictures, to more fully determine the effects of different types of stimuli on grouping. The elaborate word descriptions in Appendix F would be suitable.

Personality factors appear to have an effect on the kinds of reasons subjects give for grouping and on the kinds of groupings which are made. This should be thoroughly explored in future studies.

Summary

The results of this study are a significant contribution to the existing body of knowledge relevant to how the human organism perceives, classifies, and organizes as he grows older. In the increase versus decrease analysis, it was found that decreasing group size results in more high level grouping structure responses, and increasing group size results in more low level grouping structure responses. This was evident when the total grouping structure score was examined. It was also found that the increasing factor also resulted in more of the lower level simple association responses. In the functional dependence (extrinsic) category the decreasing group scored significantly higher which was interpreted to mean that this was a somewhat higher category than the simple association subgroups. The representational category (simple representational, compound representational and total representational) had more responses in the decrease groupings which led to the conclusion that decreasing group size resulted in a higher level of cognitive functioning. The decreasing groups also had higher total attribute scores which added further evidence that decreasing group size results in more efficient grouping.

The supplemental aspects category of poor quality of responses was used more often in the increase groups which gave further evidence of its debilitating effect. In the level of specificity category, the decreasing groups used more middle level of specificity responses and had a higher total score representative of a high level of functioning than did the decreasing groups. In addition the increasing groups had more specific level of specificity responses which is representative of low level functioning.

In both the unique reasons and memory analyses the increase groups scored higher. These results are explainable in that the decreasing groups can use their original grouping reason repeatedly. The increased recall effect in the increase groups may be a result of the end product of grouping. Increasing group size results in larger intact groups.

There were no attitudinal effects in any of the experimental groups.

In the words versus pictures discussion, previous research indicated very few differences in grouping structure as a result of using pictures versus words. The conclusions relative to this study were also that, so far as main effects are concerned, there were no significant differences produced in grouping as a result of different forms of stimuli.

The class level analysis supports most of the previous research by Olver (1961) Rigney (1962) Carson (1965) Low (1970) in that children do perceive and classify differently as they grow older. It was found that six grade subjects had significantly more of the thema responses. In addition, six graders made significantly more responses at the concrete level. Freshmen and juniors and seniors had more responses at the representational level. This confirms the thesis that there is a cognitive progression with older subjects being more abstract in their thought processes. The six graders used more partial use of stimuli responses, and the juniors and seniors had a higher supplementary aspects score. This result is in favor of the older subjects having higher quality responses in their groupings.

Contrary to Low's (1970) finding freshmen and juniors and seniors produced more unique reasons for their groupings; this reflects their superior flexibility and greater reservoir of responses. As in the Rigney (1962) study older subjects remembered more stimuli; the juniors and seniors recalled more items than did the six grade group.

The interaction effects were many; however, they were quite explainable. Decrease factors have a facilitating effect resulting in higher cognitive functioning. Juniors and seniors and freshmen groups are factors facilitating higher cognitive functioning. For the most part pictures are associated with higher cognitive functioning. These factors have singular and combinational effects in interactions. These factors when put together in combinations have a cumulative effect resulting in higher cognitive functioning. Conversely, the increase factor, the six grade factor, and perhaps the word factor appear to have a debilitating effect. It is not altogether clear concerning the effects of the word and picture stimuli. More study is needed to clarify their effects.

Another suggestion for future research is to have the subjects return the stimuli to the start sheet before they regroup. This would allow the subjects more flexibility in their groupings. In the present study subjects are forced to maintain their original stimuli.

CHAPTER VI

SUMMARY AND CONCLUSIONS

Introduction

The cognitive domain is an extremely important realm of activity in human beings, and a scientific analysis of the thought process is a worthwhile endeavor. The growth of the mind (Bruner, 1965) and developmental trends in perception and thought processes (Berlyne, 1957) are cognitive areas which have received a great deal of scientific analysis under the stimulation of Jean Piaget's (Phillips, 1969) theories. In recent years a number of theses and dissertations (Olver, 1961; Rigney, 1962; Carson, 1965; Low, 1970) have found that children perceive, classify, and organize differently as they grow older. The present study, using a complex experimental design, is an attempt to elaborate on and extend some of the findings to unexplored areas.

The major purpose of this investigation is to study the structure, attributes and supplemental aspects of equivalence classifying of words and pictures made by sixth graders, freshmen college students, and junior and senior college students. A particular point of interest is whether or not increasing or decreasing the size of the groups results in different types of equivalence classifying.

There is a need for a study of this kind. It has often been stated (Sigel, 1953; Vinacke, 1954; Anglin, 1970) that as the human organism progresses through childhood he becomes increasingly sophisticated in his ability to form concepts and classify things in his environment. It is often noted that these trends toward sophistication in the cognitive realm "continue into high school and beyond" (Vinacke, 1954, p. 533). If this contention is true, there is a need to compare the stability and types of equivalence classifications made by mature young adults as opposed to children of elementary school age.

Another important objective of this study stems from the work of Olver (1961) Carson (1965), and Low (1970) who had children sort pictures into equivalence groups in terms of how they were alike, and Rigney (1962) who did somewhat the same experiment with words. In the present investigation one objective was to compare in the same investigation the classifying of groups of pictures as opposed to words.

Stability of groups (Sigel, 1953) made by the individual is also related to age level. While Sigel (1953) tested the limits and stability of concept formation in children by having them reduce the size of groupings, Carson had his subjects increase the size of their groupings. Low (1970) had his subjects increase as well as decrease group sizes. A purpose of the present study is to determine the effects of progressively increasing group sizes from two, to four, to six elements, and progressively decreasing group sizes from six to four, to two elements per group.

Other supplemental objectives were to determine the number of unique responses produced under the various conditions, to determine the number of stimuli that can be recalled after completing the groupings, and to determine the differences in evaluation of stimuli and tasks by the various groups.

Statement of Hypotheses

Based on the literature reviewed and the experimental findings of Olver, Rigney, Carson and Low the following hypotheses were developed:

Grouping structure

1. It was hypothesized that under conditions designed to test the trends and limits of cognitive efficiency there would be no differences among the experimental groups in the grouping structure used in classifying.

Grouping attributes

2. It was hypothesized that under conditions designed to test the level of abstractness used in classifying there would be no differences among the experimental groups in the grouping attributes used in classifying.

Supplemental aspects

3. It was hypothesized that under conditions designed to test the quality used in grouping there would be no differences among the experimental groups in the supplemental aspects used in classifying.

Level of specificity

4. It was hypothesized that there would be no differences among the experimental groups in the level of specificity used in classifying.

Unique reasons

5. It was hypothesized that there would be no differences among the experimental groups in the number of unique reasons used in classifying.

Memory

6. It was hypothesized that there would be no differences among the experimental groups in the number of stimuli (words or pictures) they could recall after classifying.

Stimuli attitude

7. It was hypothesized that there would be no differences among the experimental groups in their attitudes toward the stimuli after classifying.

Task attitude

8. It was hypothesized that there would be no differences among the experimental groups in their attitudes toward the tasks after classifying.

Research Design

The design of this study is three dimensional (Lindquist, 1956). Basically there are two categories in A and B and three categories in C (2 x 2 x 3). Factor A exposes each of its subjects to three conditions in each of its two categories. Factor A refers to the direction of forming groups by the subjects. In category A_1 the subjects form groups by progressively increasing the sizes of their groupings from 2 to 4 to 6. In category A_2 the subjects progressively decrease the size of their groupings from 6 to 4 to 2. Factor B is the form of the stimuli used in the groupings made by the subjects. Category B_1 is pictures; B_2 is words. Factor C is the grade level of the subjects. Category C_1 is sixth grade students; C_2 is freshmen college students; C_3 is college juniors and seniors.

Sources of Data

Data for this study was collected by the experimenter using college subjects from psychology classes at Kansas State Teachers College and elementary students from sixth grade classes in the Emporia, Kansas area. The Lorge-Thorndike Verbal Test of Intelligence was administered by the experimenter to conveniently sized groups of the subjects prior to exposure to the experimental instrument. The experimental instruments were also administered to the subjects in conveniently sized groups.

Measuring Instruments

The experimental instruments were pictures, words, a response sheet, the Lorge-Thorndike Verbal Test of Intelligence, and the semantic differential. The first experimental instrument mentioned above consists of an array of 24 drawn pictures. The words were an array of 24 words printed on similar sized squares as the pictures and accurately describe the pictures. The Lorge-Thorndike Verbal Test of Intelligence was used because it provides for testing at the sixth grade as well as the college level. The semantic differential (Osgood, et. al., 1957, pp. 50 to 62) was constructed from bipolar adjectives found to be indicative of an evaluative factor when they were used to rate concepts.

An "elaborate word description" of the pictures was developed during the pilot study and was used with college students. This word array is contained in Appendix F. The results of this "elaborate word groupings" were intended to be an exploratory analysis, supplementary to the main project.

Methods and Procedures

The groups of subjects used in this study were first administered the Lorge-Thorndike Verbal Test of Intelligence and assigned randomly to experimental conditions. Approximately a week later they were asked to group words or pictures and write their reasons for their groupings. About two days following the groupings the subjects were asked to recall as many of the words or pictures as they could, and then they were asked to respond to a semantic differential which tested their attitudes.

The experimental instrument and procedures were administered to the subjects in convenient small groups. To aid the experimenter in giving instructions a display board was constructed with the material to be used by the subjects prominently arranged. Nearly identical instructions were given to the subjects except which sized groups were to be made (increasing or decreasing), and which stimuli were to be used (words or pictures).

Results and Conclusions

It was found that there were significant differences between the class levels in intelligence; therefore, the analysis of covariance technique was used in the analysis of the data. It was also found that six grade subjects produced fewer reasons for their groupings than did freshmen and juniors and seniors. For this reason the analyses that were reported were based on scores uncontaminated by differences in the numbers of responses between the experimental groups. These analyses were numbers four, eight and ten on the data sheet. Number four lists the total score, by category, of all first reasons given for grouping.

Number eight lists the total of the first reasons for all the groupings by their category cognitive level score as illustrated in Figure 5. Number ten lists the total of all the single highest cognitive level scores. The results of the three analyses were almost identical; therefore, the data from the number eight scoring technique was presented in chapter four, and the other analyses were presented in the appendices.

The overall results support much of the previously cited research. For example, the results of the class analysis indicated that freshmen and juniors and seniors have higher representational scores and higher supplementary aspects scores, both of which are representative of a high level of cognitive functioning. Six grade students have lower grouping structure scores (in the form of having many thema responses) and higher concrete level scores; these results are indicative of a lower level of cognitive functioning. Older subjects also had more unique responses and better recall. This may be due to their greater capacity to produce more responses, and their more efficient cognitive level. There were no differences found in any of the attitudinal analyses.

The results of the directional analysis were overwhelmingly in support of the thesis that decreasing the size of groups facilitates a higher level of cognitive functioning. Increasing group size results in more thema, more simple association, more concrete level and more poor quality responses, all of which are characteristic of a low level of cognitive functioning. Decreasing group size results in more representational responses and more responses of a less specific nature, both of which are characteristic of a higher level of functioning.

The unique reasons and memory scores were significantly higher in the increase groups. A reason for the unique score being higher in the increase groups is that subjects are forced to change their reasons when increasing; when decreasing they can use the same reasons. An explanation of the higher memory score may be that larger intact groups are the end products in the increase groups, but not in the decrease groups.

There were no differences between words and pictures in the way that they were classified. This result gives support to Olver and Rigney's (1970) conclusion that pictures and words used in grouping yield similar results. There was a difference in the memory scores between the stimuli and the use of pictures resulted in higher recall scores. This is explainable in terms of the concrete nature of the picture stimuli and the greater involvement of effort and attention this form of stimuli creates.

The interaction analyses yielded very interesting results: It was found that the factors of increase, pictures and six grade had singular and combinatorial effects in facilitating more low level responses in comparison with the factors which facilitate high cognitive functioning, decrease, words (and perhaps pictures), and college level. The more of these factors there are in the interactions the greater effect they have on influencing the cognitive level of grouping structure. It is not clear concerning the effects of the picture and word stimuli. Children appear to handle pictures more efficiently than words in producing their lower category responses. Freshmen appear to use pictures more efficiently than words, and perhaps more efficiently than juniors and seniors, in producing their high level category responses. Juniors and seniors appear to use words as efficiently as pictures in producing their high level category responses. In any case, the factors when used in combinations have a cumulative effect on facilitating or debilitating cognitive functioning. As a result of knowing the effects of the individual factors the effects of interactions can be predicted.

More study is needed to clarify the role of different forms of stimuli in classifying. It is clear that there are no main effect differences between words and pictures. However, there certainly appears to be some interaction effects, and these need further clarification. In addition, it is recommended that a lower group (third or fourth graders) and a higher group (Master's level candidates) be added to the present experimental design. In addition, the elaborate word descriptions in Appendix F should be added to the design for further clarification of the role of different forms of stimuli on classifying.

LITERATURE CITED

Anglin, Jeremy M. 1970. The growth of word meaning. Research Monograph No. 63. The M. I. T. Press, Cambridge, Mass. 108 p.

Berlyne, D. E. 1957. Recent developments in Piaget's work. British Journal of Educational Psychology 27:1-12.

Boring, Edwin G. 1957. A history of experimental psychology. Appleton-Century-Crofts, Inc., New York. 777 p.

Braine, Martin D. S. 1959. The ontogeny of certain logical operations: Piaget's formulation examined by nonverbal methods. Psychological Monograph 73:1-43. (5, whole #475)

Brown, Roger. 1958. How shall a thing be called? Psychological Review 65:14-21.

Bruner, Jerome S. 1957. On perceptual readiness. Psychological Review 64: No. 2, 123-152.

Bruner, Jerome S. 1964. The course of cognitive growth. American Psychologist 19:1-15.

Bruner, Jerome S. 1965. The growth of the mind. American Psychologist 20, 1007-1017.

Bruner, Jerome S. et al. 1966. Studies in cognitive growth. John Wiley and Sons, Inc., New York. 343 p.

Bruner, Jerome S., and R. Olver. 1970. Development of equivalence transformations in children. In Cognitive Development in Children: Society for Research in Child Development. The University of Chicago Press, Chicago, 243-259.

Carson, Gary L. 1965. Cognitive equivalence transformations in concept formation. Doctoral Dissertation, Utah State University, Logan, Utah.

Church, Joseph. 1961. Language and the discovery of reality. A developmental psychology of cognition. Random House, New York. 245 p.

Cohen, Morris R. 1944. A preface to logic. Henry Holt and Company, New York. 209 p.

Dattman, Priscilla E., and Harold E. Israel. 1951. The order of dominance among conceptual capacities: an experimental test of Heidbreder's hypothesis. Journal of Psychology 31:147-160.

Davidon, R. 1952. The effects of symbols, shift, and manipulation upon the number of concepts attained. Journal of Experimental Psychology 44,70-80.

Fillenbaum, Samuel and Annon Rapoport. 1971. Structures in the subjective lexicon: an experimental approach to the study of semantic fields. Academic Press. 266 p.

Flavell, John H. 1971. Stage-related properties of cognitive development. Cognitive Psychology, Vol. 2(4) 421-453.

Futterman, Linda D. 1971. The development of cognitive equivalence with visual and verbal stimuli. Dissertation Abstracts Intl. Oct., Vol. 32(4-B) 2377.

Hayser, Robert J. S., Charles C. Anderson, Clifford M. Christensen and Stephen M. Hunka. 1964. The cognitive processes, readings. Prentice-Hall, Inc., Englewood Cliffs, New Jersey. 714 p.

Haw, Gwen H. 1970. Handbook for preparing dissertations, reports, and theses. Educational Printing Service, Logan, Utah. 82 p.

Hearnshaw, L. S. 1954. The psychological study of conceptual thinking. British Journal of Psychology 45:1-6.

Hebb, D. O. 1960. The American revolution. American Psychologist 15:735-745.

Heidbreder, E. 1946a. The attainment of concepts: I. Terminology and methodology. Journal of Genetic Psychology 35:173-189.

Heidbreder, E. 1946b. The attainment of concepts: II. The problem. Journal of Genetic Psychology 35:191-223.

Heidbreder, E. 1947. The attainment of concepts: III. The process. Journal of Psychology 24:93-138.

Heidbreder, E. 1948. The attainment of concepts: VI. Exploratory experiments on conceptualization at perceptual levels. Journal of Psychology 26:122-193.

Heidbreder, E. 1949a. The attainment of concepts: VII. Conceptual achievements during card sorting. Journal of Psychology 27:3-39.

Heidbreder, E. 1949b. The attainment of concepts: VIII. The conceptualization of verbally indicated instances. Journal of Psychology 27:263-309.

Hood, Blair H. 1962. An experimental study of Piaget's theory of the development of number. British Journal of Psychology 53(3):273-286.

Johnson, Donald M. 1955. The psychology of thought and judgement. Harper and Brothers, New York. 515 p.

Kemp, Kenneth E. 1972. Least squares analysis of variance, a procedure, a program, and examples of their use, part one--the least squares procedure. Contribution 168, Department of Statistics and the Statistical Laboratory, Kansas Agricultural Experiment Station, Kansas State University, Manhattan, Kansas, May 1972.

Kling, J. W., and L. Riggs. 1971. Woodworth and Schlosberg's experimental psychology. Holt, Rinehart and Winston, Inc., New York. 1279 p.

Komachiya, Megumi. 1957. A note on concept attainment. Journal of Psychology 43:261-263.

L'Abate, Luciano. 1962. Concensus of choice among children: A test of Piaget's theory of cognitive development. Journal of Genetic Psychology 100:143-149.

Lindquist, E. F. 1956. Design and analysis of experiments in psychology and education. Houghton Mifflin Company, Boston. 393 p.

Locke, J. 1960. An essay concerning human nature. London: Routledge.

Low, Jay B. 1970. Categorization trends under conditions of set-breakup for two age groups. Master Thesis, Utah State University, Logan, Utah.

McNeill, D. 1968. Development of the semantic system. Unpublished.

Muuss, Rolf E. 1967. Jean Piaget's cognitive theory of adolescent development. Adolescence, 2(7),285-310.

Olver, Rose Rishardson. 1961. A developmental study of cognitive equivalence. Doctoral Dissertation, Radcliffe College, Cambridge, Mass.

Osgood, C. E., G. Suci, and P. Tannenbaum. 1957. The measurement of meaning. Urbana: University of Illinois Press. 346 p.

Phillips, John L. 1969. The origins of intellect: Piaget's theory. W. H. Freeman and Company, San Francisco. 149 p.

Rhine, Ramon J. 1958. A concept-formation approach to attitude acquisition. Psychological Review 65:362-370.

Rigney, Joan C. 1962. A developmental study of cognitive equivalence. Transformations and their use in the acquisition and processing of information. Senior honors thesis. Radcliffe College, Cambridge, Mass.

Rommetveit, Ragnar. 1960. Stages in concept formation and levels of cognitive functioning. Scandinavian Journal of Psychology 1:115-124.

Rowland, G. Thomas, and J. Carson McGuire. 1971. The mind of man: some views and a theory of cognitive development. Englewood Cliffs, New Jersey, Prentice Hall. 167 p.

Sigel, Irving E. 1953. Developmental trends in the abstraction ability of children. Child Development 24: No. 2, 131-144.

Sigel, Irving E. 1963. Sex differences in cognitive functioning reexamined: a functional point of view. The Merrill-Palmer Institute. As presented at the 1963 Biennial Meeting of the Society for research in child development. Berkely, California. 1-14.

Smoke, K. L. 1935. The experimental approach to concept learning. Psychological Review 42:274-279.

Snedecor, George W., and W. G. Cochran. 1967. Statistical methods. The Iowa State University Press, Ames, Iowa. 593 p.

Vinacke, Edgar W. 1954. Concept formation in children of school ages. Education 74:527-534.

Vygotsky, L. S. 1962. Thought and language. M. I. T. Press, Cambridge Mass. 168 p.

Wadsworth, Barry J. 1971. Piaget's theory of cognitive development. David McKay Company, Inc., New York. 140 p.

Welch, L. 1940. A preliminary investigation of some aspects of the hierarchical development of concepts. Journal of Genetic Psychology 22:359-378.

Werner, Heinz. 1937. Process and achievement. A basic problem of educational and developmental psychology. Harvard Educational Review 7.

APPENDIXES

Appendixes

Appendix | Page

APPENDIX A

Start Sheet for Placing Stimuli in An Array

1	2	3	4	5	6
7	8	9	10	11	12
13	14	15	16	17	18
19	20	21	22	23	24

APPENDIX B

Response Sheets for Grouping the Stimuli

Name: ______________________________

Card Numbers: ______________________________
Reasons for Grouping:

Card Numbers: ______________________________
Reasons for Grouping:

Card Numbers: ______________________________
Reasons for Grouping:

Card Numbers: ______________________________
Reasons for Grouping:

Card Numbers: ______________________________
Reasons for Grouping:

Card Numbers: ______________________________
Reasons for Grouping:

Name: ____________________

Card Numbers: ____________________

Reasons for Grouping:

____

Card Numbers: ____________________

Reasons for Grouping:

____

Card Numbers: ____________________

Reasons for Grouping:

____

Card Numbers: ____________________

Reasons for Grouping:

____

Card Numbers: ____________________

Reasons for Grouping:

____

Card Numbers: ____________________

Reasons for Grouping:

APPENDIX C

Instructions for Grouping

Instructions for Decreasing Groups (Words)

Don't begin until told to do so. Write your name on these sheets. In front of you is an envelope containing twenty four words. They are numbered one to twenty four. Take them out of the envelope and place them in the numbered squares on the top sheet that is in front of you. For example, place the word that is numbered one in the number one square and so forth with the others.

I would like you to choose six words from the twenty four above that you think are alike or go together in some way and put them together in this rectangle (first one). There are no right or wrong reasons for grouping the words together.

You can put together whatever words you want to. When you put them together in the rectangle, leave them there in that rectangle.

Below the rectangle where you put together the words there is a space called Card Numbers. Here you are to write the numbers of the words you grouped together. Below that you see Reasons for Grouping: Here I would like you to write at least one reason, and as many reasons as you can for grouping the words together. Remember, you are to write at least one reason, and as many reasons as you can for grouping the words together.

When you have finished with this one, leave the words in the rectangle. Go on to do the same thing with this rectangle (#2). That is, choose six more words that you think are alike or go together in some way, and put them into this rectangle. Write the card numbers here and write at least one reason, and as many reasons as you can for grouping the words together. When you are finished with that one, do the same thing here and also here (pointing). When you are done with this first section you should have four rectangles with six words in each one. At that time raise your hand and I'll tell you what to do next. Do not write in these down here until told to do so later on.

Now go ahead and start here. Choose your six words, place them in the rectangle, write the numbers and the reasons.

If you have any questions or problems at any time, raise your hand and I'll answer them individually.

(The experimenter will then circulate to be sure the instructions are being followed.)

For Decreasing Groups

Now that you have groups of six I would like you to take two words away from this group and put them in the envelope. You will then have four words that you have left here. Then write at least one, and as many reasons as you can for grouping these four together. Do the same thing here, here, and here (pointing) until you have only four words left in each group. Then raise your hand and I'll tell you what to do next.

Now that you have groups of four I would like you to take two words from this group and put them in the envelope. Write the numbers of the two words here. Then write at least one, and as many reasons as you can, here, for grouping the two together. Do the same thing here, here, and here (pointing) until you have two words in each group. Then raise your hand.

(Check the paper to see that everything is in order. Clip them together.)

Instructions for Increasing Groups (Words)

Don't begin until told to do so. Write your name on these sheets. In front of you is an envelope containing twenty four words. They are numbered one to twenty four. Take them out of the envelope and place them in the numbered squares on the top sheet that is in front of you. For example, place the word that is numbered one in the number one square and so forth with the others.

I would like you to choose two words from the twenty four above that you think are alike or go together in some way and put them together in this rectangle (first one). There are no right or wrong reasons for grouping the squares of words together.

You can put together whatever words you want to. When you put them together in the rectangle, leave them there in that rectangle.

Below the rectangle where you put together the words there is a space called Card Numbers. Here you are to write the numbers of the words you grouped together. Below that you see Reasons for Grouping: Here I would like you to write at least one reason, and as many reasons as you can for grouping the words together. Remember, you are to write at least one reason, and as many reasons as you can for grouping the words together.

When you have finished with this one, leave the words in the rectangle. Go on to do the same thing with this rectangle (#2). That is, choose two more words that you think are alike or go together in some way, and put them into this rectangle. Write the card numbers here and write at least one reason, and as many reasons as you can for grouping the words together. When you are finished with that one, do the same thing here and also here. (pointing) When you are done with this first section you should have four rectangles with two words in each one. At that time raise your hand and I'll tell you what to do next. Do not write in these down here until told to do so later on.

Now go ahead and start here. Choose your two words, place them in the rectangle, write the numbers and the reasons.

If you have any questions or problems at any time, raise your hand and I'll answer them individually.

(The experimenter will then circulate to be sure the instructions are being followed.)

For Increasing Groups

Now that you have groups of two I would like you to take two more squares of words and add them to this group for a total of four squares of words. Write the numbers of all four of the squares of words here. Then write at least one and as many reasons as you can, here, for grouping all four of these squares of words together. Do the same thing, here, here, and here (pointing) until you have four squares of words in each group. Then raise your hand and I'll tell you what to next.

Now that you have groups of four I would like you to take two more squares of words and add them to this group for a total of six squares of words. Write the numbers of all six of the squares of words here. Then write at least one and as many reasons as you can here for grouping all six of these squares of words together. Do the same thing here, here, and here (pointing) until you have six squares of words in each group. Then raise your hand.

(Check the paper to see that everything is in order. Clip them together.)

Instructions for Decreasing Groups (Pictures)

Don't begin until told to do so. Write your name on these sheets. In front of you is an envelope containing twenty four pictures. They are numbered one to twenty four. Take them out of the envelope and place them in the numbered squares on the top sheet that is in front of you. For example, place the picture that is numbered one in the number one square and so forth with the others.

I would like you to choose six pictures from the twenty four above that you think are alike or go together in some way and put them together in this rectangle (first one). There are no right or wrong reasons for grouping the pictures together.

You can put together whatever pictures you want to. When you put them together in the rectangle, leave them there in that rectangle.

Below the rectangle where you put together the pictures there is a space called Card Numbers. Here you are to write the numbers of the pictures you grouped together. Below that you see Reasons for Grouping: Here I would like you to write at least one reason, and as many reasons as you can for grouping the pictures together. Remember, you are to write at least one reason, and as many reasons as you can for grouping the pictures together.

When you have finished with this one, leave the pictures in the rectangle. Go on to do the same thing with this rectangle (#2). That is, choose six more pictures that you think are alike or go together in some way, and put them into this rectangle. Write the card numbers here and write at least one reason, and as many reasons as you can for grouping the pictures together. When you are finished with that one, do the same thing here and also here. (pointing) When you are done with this first section you should have four rectangles with six pictures in each one. At that time raise your hand and I'll tell you what to do next. Do not write in these down here until told to do so later on.

Now go ahead and start here. Choose your six pictures, place them in the rectangle, write the numbers and the reasons.

If you have any questions or problems at any time, raise your hand and I'll answer them individually.

(The experimenter will then circulate to be sure the instructions are being followed.)

For Decreasing Groups

Now that you have groups of six I would like you to take two pictures away from this group and put them in the envelope. You will then have four pictures left in this group. Write the numbers of the four pictures that you have left here. Then write at least one, and as many reasons as you can for grouping these four together. Do the same thing here, here, and here (pointing) until you have only four pictures left in each group. Then raise your hand and I'll tell you what to do next.

Now that you have groups of four I would like you to take two pictures from this group and put them in the envelope. Write the numbers of the two pictures here. Then write at least one, and as many reasons as you can, here, for grouping the two together. Do the same thing here, here, and here (pointing) until you have two pictures in each group. Then raise your hand.

(Check the paper to see that everything is in order. Clip them together.)

Instructions for Increasing Groups (Pictures)

Don't begin until told to do so. Write your name on these sheets. In front of you is an envelope containing twenty four pictures. They are numbered one to twenty four. Take them out of the envelope and place them in the numbered squares on the top sheet that is in front of you. For example, place the picture that is numbered one in the number one square and so forth with the others.

I would like you to choose two pictures from the twenty four above that you think are alike or go together in some way and put them together in this rectangle (first one). There are no right or wrong reasons for grouping the pictures together.

You can put together whatever pictures you want to. When you put them together in the rectangle, leave them there in that rectangle.

Below the rectangle where you put together the pictures there is a space called Card Numbers. Here you are to write the numbers of the pictures you grouped together. Below that you see Reasons for Grouping: Here I would like you to write at least one reason, and as many reasons as you can for grouping the pictures together. Remember, you are to write at least one reason, and as many reasons as you can for grouping the pictures together.

When you have finished with this one, leave the pictures in the rectangle. Go on to do the same thing with this rectangle (#2). That is, choose two more pictures that you think are alike or go together in some way, and put them into this rectangle. Write the card numbers here and write at least one reason, and as many reasons as you can for grouping the pictures together. When you are finished with that one, do the same thing here and also here (pointing). When you are done with this first section, you should have four rectangles with two pictures in each one. At that time raise your hand and I'll tell you what to do next. Do not write in these down here until told to do so later on.

Now go ahead and start here. Choose your two pictures, place them in the rectangle, write the numbers and the reasons.

If you have any questions or problems at any time, raise your hand and I'll answer them individually.

(The experimenter will then circulate to be sure the instructions are being followed.)

For Increasing Groups

Now that you have groups of two I would like you to take two more pictures and add them to this group for a total of four pictures. Write the numbers of all four of the pictures here. Then write at least one and as many reasons as you can, here, for grouping all four of these pictures together. Do the same thing here, here, and here (pointing) until you have four pictures in each group. Then raise your hand and I'll tell you what to do next.

Now that you have groups of four I would like you to take two more pictures and add them to this group for a total of six pictures. Write the numbers of all six of the pictures here. Then write at least one and as many reasons as you can here for grouping all six of these pictures together. Do the same thing here, here, and here (pointing) until you have six pictures in each group. Then raise your hand.

(Check the paper to see that everything is in order. Clip them together.)

APPENDIX D

Memory Response Sheet

Name ______________________________

List below as many of the names of the squares that were used in the study as you can recall.

APPENDIX E

Semantic Differential for Evaluating Stimuli and Tasks

E_1 Pictures and Tasks Semantic Differential

E_2 Words and Tasks Semantic Differential

APPENDIX E_1

Pictures and Tasks Semantic Differential

INSTRUCTIONS

The purpose of this study is to measure the meanings of certain things to various people by having them judge them against a series of descriptive scales (words). In taking this test, please make your judgments on the basis of what these things mean to you. On each page of this booklet you will find a different concept to be judged and beneath it a set of scales. You are to rate the concept on each of these scales in order.

Here is how you are to use these:

If you feel that the concept at the top of the page is very closely related to one end of the scale, you should place your check-mark as follows:

THE TASKS USED IN THIS EXPERIMENT

fair__X__:______:______:______:______:______:______unfair

or

fair______:______:______:______:______:______:___X__unfair

If you feel that the concept is quite closely related to one or the other end of the scale (but not extremely), you should place your check-mark as follows:

strong______:__X__:______:______:______:______:______:weak

strong______:______:______:______:______:__X__:______:weak

If the concept seems only slightly related to one side as opposed to the other side (but is not really neutral), then you should check as follows:

active______:______:__X__:______:______:______:______passive

active______:______:______:______:__X__:______:______passive

The direction toward which you check, of course, depends upon which of the two ends of the scale seem most characteristic of the thing you're judging.

If you consider the concept to be neutral on the scale, both sides of the scale equally associated with the concept, or if the scale is completely irrelevant, unrelated to the concept, then you should place your check-mark in the middle space.

safe______:______:______:__X___:______:______:______dangerous

IMPORTANT: (1) Place your check-marks in the middle of the spaces, not on the boundaries; (this) (not this)

______:______:______:______:__X___:______X______

(2) Be sure you check every scale for every concept--do not omit any.

(3) Never put more than one check-mark on a single scale.

(4) IF YOU HAVE ANY QUESTIONS RAISE YOUR HAND.

THE PICTURES USED IN THIS EXPERIMENT

good								bad
cruel								kind
ugly								beautiful
clean								dirty
light								dark
painful								pleasurable
high								low
important								unimportant
false								true
wise								foolish
sick								healthy

THE TASKS USED IN THIS EXPERIMENT

good______:______:______:______:______:______:______bad

cruel______:______:______:______:______:______:______kind

ugly______:______:______:______:______:______:______beautiful

clean______:______:______:______:______:______:______dirty

light______:______:______:______:______:______:______dark

painful______:______:______:______:______:______:______pleasurable

high______:______:______:______:______:______:______low

important______:______:______:______:______:______:______unimportant

false______:______:______:______:______:______:______true

wise______:______:______:______:______:______:______foolish

sick______:______:______:______:______:______:______healthy

APPENDIX E_2

Words and Tasks Semantic Differential

INSTRUCTIONS

The purpose of this study is to measure the meanings of certain things to various people by having them judge them against a series of descriptive scales (words). In taking this test, please make your judgments on the basis of what these things mean to you. On each page of this booklet you will find a different concept to be judged and beneath it a set of scales. You are to rate the concept on each of these scales in order.

Here is how you are to use these:

If you feel that the concept at the top of the page is very closely related to one end of the scale, you should place your check-mark as follows:

THE TASKS USED IN THIS EXPERIMENT

fair__X__:______:______:______:______:______:______unfair

or

fair______:______:______:______:______:______:__X__unfair

If you feel that the concept is quite closely related to one or the other end of the scale (but not extremely), you should place your check-mark as follows:

strong______:__X__:______:______:______:______:______weak

strong______:______:______:______:______:__X__:______weak

If the concept seems only slightly related to one side as opposed to the other side (but is not really neutral), then you should check as follows:

active______:______:__X__:______:______:______:______passive

active______:______:______:______:__X__:______:______passive

The direction toward which you check, of course, depends upon which of the two ends of the scale seem most characteristic of the thing you're judging.

If you consider the concept to be neutral on the scale, both sides of the scale equally associated with the concept, or if the scale is completely irrelevant, unrelated to the concept, then you should place your check-mark in the middle space.

safe______:______:______:__X__:______:______:______dangerous

IMPORTANT; (1) Place your check-marks in the middle of spaces, not on the boundaries;

(this) (not this)

______:______:______:______:__X___:_____X______

(2) Be sure you check every scale for every concept--do not omit any.

(3) Never put more than one check-mark on a single scale.

(4) IF YOU HAVE ANY QUESTIONS RAISE YOUR HAND.

THE WORDS USED IN THIS EXPERIMENT

good______:______:______:______:______:______:______bad

cruel______:______:______:______:______:______:______kind

ugly______:______:______:______:______:______:______beautiful

clean______:______:______:______:______:______:______dirty

light______:______:______:______:______:______:______dark

painful______:______:______:______:______:______:______pleasurable

high______:______:______:______:______:______:______low

important______:______:______:______:______:______:______unimportant

false______:______:______:______:______:______:______true

wise______:______:______:______:______:______:______foolish

sick______:______:______:______:______:______:______healthy

THE TASKS USED IN THIS EXPERIMENT

good______:______:______:______:______:______:______bad

cruel______:______:______:______:______:______:______kind

ugly______:______:______:______:______:______:______beautiful

clean______:______:______:______:______:______:______dirty

light______:______:______:______:______:______:______dark

painful______:______:______:______:______:______:______pleasurable

high______:______:______:______:______:______:______low

important______:______:______:______:______:______:______unimportant

false______:______:______:______:______:______:______true

wise______:______:______:______:______:______:______foolish

sick______:______:______:______:______:______:______healthy

APPENDIX F

Elaborate Word Descriptions

A HAT Front view-male hat-hat band-feather-groove in top-medium brim. -1-	A SHEEP Standing left side view-wooly body-bare four legs and face-tail-ear eye-nose-mouth-hoofs-background grass. -2-	A CAR Right side view-old model-two side doors with windows showing-fenders half covering the two wheels-front and rear bumpers-right headlight and tail light-patch on rear tire- hood, side of top, and part of front and rear windshields visible. -3-
A GLASS Transparent (clear)-cylinder shaped-larger at open top-approximately half filled-standing on a surface. -4-	A TREE Medium thick trunk-bushy with a lot of leaves-two main branches in a V from the trunk-branches -top of roots visible-on level ground. -5-	A JUDGE Front view-looking to his right-seen from chest up-holding wooden gavel in right hand on surface before him-wearing robe, collar, tie, bowless glasses-stern looking-mouth-nose-ear-hair thin and parted on the left. -6-
A RATTLE SNAKE Front view of head-two eyes-forked tongue out-coiled body on a surface-head erect-dark triangular markings on light background-rattle on tail. -7-	AN AIRPLANE Top view-nose pointed slightly upward to viewer's right-four propeller motors-USAF on right wing-on left wing a circled star-two wings-each side has six windows-front window-rudder-tail has dark line markings. -8-	A MAN IN JAIL Front view-seen from chest up in window-three bars in thick window-wearing hat-grasping bars-stern looking-mouth-nose-eyes-part of hair and left ear visible-unshaven or rough full face-horizontal striped shirt with numbers 1242 on chest. -9-
A CHAIR Front view-facing slightly to the right-wood patterned-solid wooden seat-five spaced slats on the back with a solid board at the top-four legs connected with four rungs. -10-	A GLOVE Top view-fingers pointed slightly upward to viewer's right-left handed-four fingers and thumb-three lengthwise pleats on top-stitching at seams-fur sticking out opening. -11-	A RAG DOLL Standing front view-smiling-shaggy hair-eyes-nose-mouth-dimples-eyebrows-arms hanging-wearing short sleeve blouse with a dress, jumper, or apron on top-legs-horizontally striped stockings-shoes-slip or panty showing on left leg. -12-

A CIRCLE Medium thick, dark circular ring-empty center. -13-	A COAT ON A HANGER Front view-a short coat with wide lapels- one pocket on its right side-two front buttons-strap on sleeve with button- patterned lining- draped on a triangular wire hanger-hanger hook at top with end to viewer's right. -14-	A HAMMER Side view-head pointed slightly down to the viewer's right-claw on the back for nail pulling-front of head circular with flat end for pounding nails- wood patterned handle. -15-
A CARROT Stock slanted upward to viewer's left- stock has bushy leaves at top-root is triangular cone shape, tapering to a point-root pointing right and down- patterned with circular markings. -16-	AN ALARM CLOCK Front view-two bells on top-round face- all numbers marked in position and dots indicate minutes- hands show about eight minutes before two o'clock-two front legs-standing on flat surface. -17-	A LION Right side view- standing high on four legs-head held high-bushy mane- mouth open-eye-ear- nose visible-tail curved and pointed upward-tall grass in background-four paws visible. -18-
AUTOS IN COLLISION Two autos in accident- left side of right car in view-top view of left car-fronts of both cars pushed in and dented-parts strewn around-body to right foreground below right car-tire off left car and below it and water shooting from radiator- door open on right car. -19-	A BEE Top view-head pointed up-two eyes- two veined wings- two antennae-six legs spread out- bands around body- tail stinger-thick rear legs. -20-	A BROKEN ARROW Broken and the front end is shorter than the tail-tail with feathers is pointing upward to the left-arrowhead end pointing steeper than tail upward to the right-lines suggesting impact where arrow is broken. -21-
A BABY Face view-smiling- leaning on pillows- feet pointed downward and to his left-left arm up in a wave-right arm on pillow-wearing a diaper-a little wavy hair on head-hands- eyes-nose-ears-legs- feet-bellybutton- eyebrows-dimpled. -22-	A MONKEY Smiling left side view-flat top head- standing high on four limbs grasping branch- tail pointed upward with end curled toward rear-trees in background-eye-nose- ear visible. -23-	THREE BANANAS Side view-attached together at one end- curved and pointed upward to the right- front one largest- rear smallest- bruise or ripe spots. -24-

APPENDIX G

Hypotheses Derived from The Data Sheet

Hypotheses Derived from the Data Sheet (Figure 4)

1. I. Q. Score;

   Are there differences among the experimental groups?

   [The I.Q's. are used in the analysis of covariance.]

2. Scored by category, all groupings:

   Is there a difference between $\overbrace{2,\ 4,\ 6}^{2}$ and Grouping Structure A to C?

   Is there a difference between $\overbrace{2,\ 4,\ 6}^{2}$ and Attributes D to T?

   Is there a difference between $\overbrace{2,\ 4,\ 6}^{2}$ and Supplemental Aspects U to X?

   Is there a difference between $\overbrace{2,\ 4,\ 6}^{2}$ and Level of Specificity (1) to (3)?

3. Total of each category, all groupings (Total across #2):

   Is there a difference between 3 and Grouping Structure A to C?

   Is there a difference between 3 and Attributes D to T?

   Is there a difference between 3 and Supplemental Aspects U to X?

   Is there a difference between 3 and Level of Specificity (1) to (3)?

4. Total of all first responses by category:

   Is there a difference between 4 and Grouping Structure A to C?

   Is there a difference between 4 and Attributes D to T?

   Is there a difference between 4 and Supplemental Aspects U to X?

   Is there a difference between 4 and Level of Specificity (1) to (3)?

5. Scored by code numbers (Figure 5), all responses:

Is there a difference between $\overbrace{2, 4, 6}^{5}$ and Grouping Structure A to C?

Is there a difference between $\overbrace{2, 4, 6}^{5}$ and Attributes D to T?

Is there a difference between $\overbrace{2, 4, 6}^{5}$ and Supplemental Aspects U to X?

Is there a difference between $\overbrace{2, 4, 6}^{5}$ and Level of Specificity (1) to (3)?

6. Total by code numbers, all groupings:

Is there a difference between 6 and Grouping Structure A to C?

Is there a difference between 6 and Attributes D to T?

Is there a difference between 6 and Supplemental Aspects U to X?

Is there a difference between 6 and Level of Specificity (1) to (3)?

7. Scored by code numbers, first responses:

Is there a difference between $\overbrace{2, 4, 6}^{7}$ and Grouping Structure A to C?

Is there a difference between $\overbrace{2, 4, 6}^{7}$ and Attributes D to T?

Is there a difference between $\overbrace{2, 4, 6}^{7}$ and Supplemental Aspects U to X?

Is there a difference between $\overbrace{2, 4, 6}^{7}$ and Level of Specificity (1) to (3)?

8. Total by code number, first groupings:

Is there a difference between 8 and Grouping Structure A to C?

Is there a difference between 8 and Attributes D to T?

Is there a difference between 8 and Supplemental Aspects U to X?

Is there a difference between 8 and Level of Specificity (1) to (3)?

9. Scored by code number, compiled responses into a single score:

Is there a difference between $\overbrace{2, 4, 6}^{9}$ and Grouping Structure A to C?

Is there a difference between $\overbrace{2, 4, 6}^{9}$ and Attributes D to T?

Is there a difference between $\overbrace{2, 4, 6}^{9}$ and Supplemental Aspects U to X?

Is there a difference between $\overbrace{2, 4, 6}^{9}$ and Level of Specificity (1) to (3)?

10. Total by code number, compiled responses into single score:

Is there a difference between 10 and Grouping Structure A to C?

Is there a difference between 10 and Attributes D to T?

Is there a difference between 10 and Supplemental Aspects U to X?

Is there a difference between 10 and Level of Specificity (1) to (3)?

11. Totals for Grouping Structure:

Is there a difference between 11 and $\overset{2}{2,\ 4,\ 6}$ (scored by category, all groupings). This would allow us to test differences in the experimental groups in the total number of reasons for each grouping of 2, 4 and 6 stimuli.

Is there a difference between 11 and 3 (total of each category, all groupings). This would give us the total number of reasons for grouping and allow us to test differences among the experimental groups.

Is there a difference between 11 and 4 (total of first reasons given for grouping). This would detect differences in the experimental groups in failures to give a reason for grouping.

Is there a difference between 11 and $\overbrace{2, 4, 6}^{5}$ (scored by code number, all groupings)?

Is there a difference between 11 and 6 (total by code numbers, all groupings)?

Is there a difference between 11 and $\overbrace{2, 4, 6}^{7}$ (scored by code number first groupings)?

Is there a difference between 11 and 8 (total by code number, first groupings)?

Is there a difference between 11 and $\overbrace{2, 4, 6}^{9}$ (scored by code number, compiled responses into a single score)?

Is there a difference between 11 and 10 (total by code number, compiled responses into a single score)?

12. Total for Simple Association Attributes:

Is there a difference between 12 and $\overbrace{2, 4, 6}^{2}$? This would tell us if there is a difference in the number of simple association used from 2 to 4 to 6.

Is there a difference between 12 and 3? This would tell us if there is a difference in the total usage of simple association.

Is there a difference between 12 and 4 (first responses)? This would tell if there is a difference in the usage of simple association for first responses.

Twelve and 2, $\overset{5}{4}$, 6 would come out the same as 12 and 2, $\overset{2}{4}$, 6 because simple association is code scored as 1.

Twelve and 6 would come out the same as 12 and 3 because simple association is code scored as 1.

Is there a difference between 12 and 2, $\overset{7}{4}$, 6 (scored by first groupings)?

Is there a difference between 12 and 8?

Twelve and 9 is the same as 12 and 7.

Is there a difference between 12 and 10?

13. Total for Concrete Attributes:

This generates hypotheses about Concrete Attributes similar to 12.

14. Total for Representational Attributes:

This generates hypotheses about Representational Attributes similar to 12.

14b. Comparing the totals of 12, 13, and 14:

Is there a significant difference between the totals of 12, 13 and 14? This would tell us if there are any differences in the usage of simple association, concrete, and representational attributes among the experimental groups.

15. Total of attribute totals (summing 12 + 13 + 14):

Are there differences between 15 and $\overbrace{2, 4, 6}^{5}$, between 15 and 6, between 15 and $\overbrace{2, 4, 6}^{7}$, between 15 and 8, between 15 and $\overbrace{2, 4, 6}^{9}$, and between 15 and 10? These would give us differences in level of attributes used by the experimental groups.

16. Total of Supplementary Aspects:

Are there any differences in the experimental groups in the Supplemental Aspects used?

Sixteen and $\overbrace{2, 4, 6}^{5}$ gives difference in level of quality for all groupings from 2 to 4 to 6.

Sixteen and 6 gives us the total differences in quality levels for all groupings.

Sixteen and 7 gives us the difference in level of quality from 2 to 4 to 6 for first groupings.

Sixteen and 8 gives us the total difference in quality level for first groupings.

Sixteen and 9 gives us the difference in quality level for single highest reasons for grouping from 2 to 4 to 6.

Sixteen and 10 gives us the total level of quality of single highest reasons for grouping.

17. Level of specificity:

Are there any differences in the experimental groups in the Level of Specificity used?

The hypotheses generated here are similar to those above.

18. Total number of unique reasons given for grouping:

Are there any differences among the experimental groups in the number of unique reasons given?

19. Memory (Total number of words or pictures recalled):

Are there any differences among the experimental groups in the total number of words or pictures recalled?

20. Attitude score toward stimuli:

Are there any differences among the experimental groups in their attitudes toward the stimuli?

21. Attitude score toward tasks:

Are there any differences among the experimental groups in their attitudes toward the tasks?

APPENDIX H

Example of a Printout of a Thema Analysis

DEPARTMENT OF STATISTICS AND THE STATISTICAL LABORATORY - UNEQUAL SUBCLASS ANALYSIS OF VARIANCE DATE OF RUN 06/16/73

ALL GROUPS CARD 17

JOB -- XPPS3571 USER -- P403-ARHEART

I N V E R S E

INVERSION TIME = 0.33

1	0.94147027E-02							
2	-0.28855954E-02	0.94393558E-02						
3	-0.25569927E-03	-0.12043536E-03	0.96981451E-02					
4	0.21023643E-03	0.23557108E-03	-0.13001333E-03	0.20697907E-01				
5	-0.11906256E-02	-0.69703441E-03	0.28210119E-02	-0.84274895E-02	0.17640937E-01			
6	-0.22121923E-04	-0.20349343E-03	-0.29538637E-02	0.60434663E-03	-0.22805859E-02	0.94221979E-02		
7	0.44300524E-03	0.27670199E-03	0.79888105E-03	-0.52025989E-02	0.31339880E-02	-0.81603043E-03	0.19129567E-01	
8	-0.70631597E-03	-0.12451140E-02	-0.20868690E-02	0.35664346E-02	-0.64515546E-02	0.27442072E-02	-0.94819676E-02	0.17755549E-01
9	-0.86456793E-03	0.57577740E-03	0.80861198E-03	-0.44927379E-04	-0.16347118E-02	0.34750137E-03	0.73794779E-03	0.18939343E-02
10	0.23149446E-02	-0.21813476E-02	-0.14711034E-02	-0.24241880E-02	0.22984119E-02	-0.62738844E-02	0.15031497E-02	-0.25147684E-02
11	0.31105330E-03	-0.60984399E-03	-0.15998754E-03	-0.74904319E-03	0.14782788E-02	0.41768886E-03	-0.13744826E-02	-0.21497116E-02
12	-0.23080530E-02	0.26357744E-02	-0.33426556E-03	0.22652980E-02	-0.22390475E-02	-0.12459620E-02	-0.16930769E-02	0.25317513E-02
13	-0.16355290E-04	-0.44164466E-04	0.13268333E-03	0.32522646E-03	0.19133493E-04	-0.27729766E-04	0.29830269E-04	0.89639172E-04
	1	2	3	4	5	6	7	8

9	0.20032290E-01				
10	-0.90292953E-02	0.17913356E-01			
11	-0.64310580E-02	0.37358401E-02	0.20411436E-01		
12	0.36662908E-02	-0.67743433E-02	-0.91573820E-02	0.17948870E-01	
13	0.24745567E-03	-0.13758200E-03	-0.29428490E-03	0.14481221E-03	0.66912238E-04
	9	10	11	12	13

ALL GROUPS CARD 17

JOB -- X2253571 USER -- P403-ARHEART

SUBMATRIX DISTRIBUTION

```
      DIRECTN
81     45

      STIMULI
63     63

      CLASS
37     53     36

      DIRECTN  * STIMULI
41     40     22     23

      DIRECTN  * CLASS
23     35     22     14     17     14

      STIMULI  * CLASS
20     22     21     17     31     15

      DIRECTN  * STIMULI  * CLASS
12     17     12     11     10     1[illegible]     [illegible]     5     9     6     12     5
```

DEPARTMENT OF STATISTICS AND THE STATISTICAL LABORATORY - UNEQUAL SUBCLASS ANALYSIS OF VARIANCE DATE OF RUN 06/16/73

ALL GROUPS CARD 17

JOB -- XPRS3571 USER -- P403-ARHEART

ANALYSIS OF VARIANCE FOR VARIABLE NO. 7 - THEMA

SOURCE	D.F.	SUMS OF SQUARES	MEAN SQUARES	F-RATIO	PROB.
DIRECTN	1	76.14461529	76.14460754	4.875	0.0293
STIMULI	1	43.23929608	43.23928833	2.768	0.0989
CLASS	2	153.82604663	76.91300964	4.924	0.0089
DIRECTN * STIMULI	1	5.61957608	5.61957550	0.360	0.5498
DIRECTN * CLASS	2	3.59126530	1.79563236	0.115	0.8915
STIMULI * CLASS	2	40.44740089	20.22369325	1.295	0.2776
DIRECTN * STIMULI * CLASS	2	138.50041868	69.25019836	4.434	0.0140
IQ	1	7.42898680	7.42898655	0.476	0.4918
RESIDUAL	113	1764.91894531	15.61875153		
TOTAL	125	2256.44433594			

BETA VECTOR

1	2	3	4	5	6	7	8
4.97374249	0.84781742	0.64756542	1.22575569	-1.57347775	-0.23010600	-0.04800271	0.24167722

9	10	11	12	13
0.34284121	-0.84654278	-1.47378063	-0.00522240	0.02229552

ANOVA EXEC TIME = 2.3 SECONDS

MEANS AND STANDARD ERRORS FOR VARIABLE NO. 7 - THEMA

SOURCE	SUBCLASS LEVELS			MEAN	STANDARD ERROR
	DIRECTN				
DIRECTN	1			5.8215599	0.452046
DIRECTN	2			4.1259251	0.620180
	STIMULI				
STIMULI	1			5.6213074	0.539010
STIMULI	2			4.3261766	0.553630
	CLASS				
CLASS	1			6.1994982	0.690707
CLASS	2			3.4002647	0.620792
CLASS	3			5.3214645	0.716264
	DIRECTN	STIMULI			
DIRECTN * STIMULI	1	1		6.2390184	0.626030
DIRECTN * STIMULI	1	2		5.4040995	0.655369
DIRECTN * STIMULI	2	1		5.0035954	0.875008
DIRECTN * STIMULI	2	2		3.2482529	0.886240
	DIRECTN	CLASS			
DIRECTN * CLASS	1	1		6.9993124	0.83[illegible]44
DIRECTN * CLASS	1	2		4.4897585	0.660107
DIRECTN * CLASS	1	3		5.9756069	0.883055
DIRECTN * CLASS	2	1		5.3996830	1.078610
DIRECTN * CLASS	2	2		2.3107700	1.052023
DIRECTN * CLASS	2	3		4.6673203	1.106322
	STIMULI	CLASS			
STIMULI * CLASS	1	1		7.1899042	0.962408
STIMULI * CLASS	1	2		3.2012863	1.005300
STIMULI * CLASS	1	3		6.4727297	0.885979
STIMULI * CLASS	2	1		5.2090902	1.003567
STIMULI * CLASS	2	2		3.5992413	0.728630
STIMULI * CLASS	2	3		4.1701965	1.093555
	DIRECTN	STIMULI	CLASS		
DIRECTN * STIMULI * CLASS	1	1	1	6.2858315	1.153872
DIRECTN * STIMULI * CLASS	1	1	2	4.0554504	0.961892
DIRECTN * STIMULI * CLASS	1	1	3	8.3757687	1.154990
DIRECTN * STIMULI * CLASS	1	2	1	7.7127905	1.196733
DIRECTN * STIMULI * CLASS	1	2	2	4.9240627	0.907293
DIRECTN * STIMULI * CLASS	1	2	3	3.5754404	1.291465
DIRECTN * STIMULI * CLASS	2	1	1	8.0039751	1.483616
DIRECTN * STIMULI * CLASS	2	1	2	2.3471193	1.769074
DIRECTN * STIMULI * CLASS	2	1	3	4.5696869	1.324834
DIRECTN * STIMULI * CLASS	2	2	1	2.7053881	1.624048

DIRECTN * STIMULI * CLASS	2	2	2	2.2744159	1.141409
DIRECTN * STIMULI * CLASS	2	2	3	4.7649488	1.763143

MEANS EXECUTION TIME = 5.62 SECONDS

APPENDIX I

Example of the Least Significant Differences (LSD) Calculations Using the Inverse Matrix Formula for the Significant Class Interactions from the Printout in Appendix H

Table 106. Summary of the least significant differences between the class means on the total number of thema responses scored according to the single highest category cognitive level score

Comparison	$\lvert\overline{Y}_i - \overline{Y}_j\rvert$	$\sqrt{V(\overline{Y}_i - \overline{Y}_j = (C_{ii} + C_{jj} - 2(C_{ij})MS_e}$	t	LSD	Conclusion
$\overline{Y}_1$ vs $\overline{Y}_2$	6.199 - 3.400 2.799	$\sqrt{15.619 \quad (0.021) + (0.018) - 2(-0.008)}$	2.000	1.854	$P < 0.05$
$\overline{Y}_1$ vs $\overline{Y}_3$	6.199 - 5.321 0.878	$\sqrt{15.619 \quad 4(0.021) + (0.018) + 4(-0.008)}$	2.000	2.090	N.S.
$\overline{Y}_2$ vs $\overline{Y}_3$	3.400 - 5.321 1.921	$\sqrt{15.619 \quad (0.021) + 4(0.018) + 4(-0.008)}$	2.000	1.952	N.S.

APPENDIX J

The Least Significant Difference Equations for Calculations Involving the Inverse Matrix with the Class, Direction by Stimuli, Direction by Class, and Stimuli by Class Interactions

The Least Significant Difference Equations
For Calculations Involving
The Inverse Matrix

CLASS	LSD
$\bar{Y}_1$ v $\bar{Y}_2$	$1.96^{*}\sqrt{MS_E\ [(4,4) + (5,5) - 2(5,4)]}$
$\bar{Y}_1$ v $\bar{Y}_3$	$1.96\sqrt{MS_E\ [4(4,4) + (5,5) + 4(5,4)]}$
$\bar{Y}_2$ v $\bar{Y}_3$	$1.96\sqrt{MS_E\ [(4,4) + 4(5,5) + 4(5,4)]}$

DIRECTION X STIMULI	LSD
$\bar{Y}_{11}$ v $\bar{Y}_{12}$	$1.96\sqrt{MS_E\ [4(3,3) + 4(6,6) + 8(6,3)]}$
$\bar{Y}_{11}$ v $\bar{Y}_{21}$	$1.96\sqrt{MS_E\ [4(2,2) + 4(6,6) + 8(6,2)]}$
$\bar{Y}_{11}$ v $\bar{Y}_{22}$	$1.96\sqrt{MS_E\ [4(2,2) + 4(3,3) + 8(3,2)]}$
$\bar{Y}_{12}$ v $\bar{Y}_{21}$	$1.96\sqrt{MS_E\ [4(2,2) + 4(3,3) - 8(3,2)]}$
$\bar{Y}_{12}$ v $\bar{Y}_{22}$	$1.96\sqrt{MS_E\ [4(2,2) - 8(6,2) + 4(6,6)]}$
$\bar{Y}_{21}$ v $\bar{Y}_{22}$	$1.96\sqrt{MS_E\ [4(3,3) - 8(6,3) + 4(6,6)]}$

*1.96 depends on the sample size and α level.

DIRECTION X CLASS LSD

$\bar{Y}_{11}$ v $\bar{Y}_{12}$ $1.96\sqrt{MS_E[(4,4)+(5,5)+(7,7)+(8,8)-2(5,4)+2(7,4)-2(8,4) -2(8,4)-2(7,5)+2(8,5)-2(8,7)}$

$\bar{Y}_{11}$ v $\bar{Y}_{13}$ $1.96\sqrt{MS_E[4(4,4)+(5,5)+4(5,4)+4(7,7)+8(7,4)+4(8,4)+4(7,5) +2(8,5)+4(8,7)+(8,8)}$

$\bar{Y}_{11}$ v $\bar{Y}_{21}$ $1.96\sqrt{MS_E[4(2,2)+4(7,7)+8(7,2)]}$

$\bar{Y}_{11}$ v $\bar{Y}_{22}$ $1.96\sqrt{MS_E[4(2,2)+(4,4)+(5,5)+(7,7)+(8,8)+4(4,2)-4(5,2) +4(7,2)+4(8,2)-2(5,4)+2(7,4)+2(8,4)-2(7,5)-2(8,5) +2(8,7)]}$

$\bar{Y}_{11}$ v $\bar{Y}_{23}$ $1.96\sqrt{MS_E[4(2,2)+4(4,4)+(5,5)+4(5,4)+(8,8)+8(4,2)+4(5,2) -4(8,2)-4(8,4)-2(8,5)]}$

$\bar{Y}_{12}$ v $\bar{Y}_{13}$ $1.96\sqrt{MS_E[(4,4)+4(5,5)+4(5,4)+(7,7)+4(8,8)+4(8,7)+8(8,5) +4(7,5)+4(8,4)+2(7,4)]}$

$\bar{Y}_{12}$ v $\bar{Y}_{21}$ $1.96\sqrt{MS_E[4(2,2)+(4,4)+(5,5)+(7,7)+(8,8)+4(5,2)-4(4,2) +4(8,2)+4(7,2)-2(5,4)+2(8.5)-2(7,5)-2(8,4)-2(7,4) +2(8,7)]}$

$\bar{Y}_{12}$ v $\bar{Y}_{22}$ $1.96\sqrt{MS_E[4(2,2)+4(8,8)+8(8,2)]}$

$\bar{Y}_{12}$ v $\bar{Y}_{23}$ $1.96\sqrt{MS_E[4(2,2)+(4,4)+4(5,5)+4(5,4)+(7,7)+8(5,2)+4(4,2) -4(7,2)-4(7,5)-2(7,4)]}$

$\bar{Y}_{13}$ v $\bar{Y}_{21}$ $1.96\sqrt{MS_E[4(2,2)+4(4,4)+(5,5)+4(5,4)+(8,8)-8(4,2)-4(5,2) -4(8,2)+4(8,4)+2(8,5)]}$

$\bar{Y}_{13}$ v $\bar{Y}_{22}$ $\quad 1.96\sqrt{MS_E[4(2,2)+(4,4)+4(5,5)+4(5,4)+(7,7)-4(4,2)-8(5,2) -4(7,2)+2(7,4)+2(7,5)]}$

$\bar{Y}_{13}$ v $\bar{Y}_{23}$ $\quad 1.96\sqrt{MS_E[4(2,2)-8(7,2)-8(8,2)+4(7,7)+4(8,8)+8(8,7)]}$

$\bar{Y}_{21}$ v $\bar{Y}_{22}$ $\quad 1.96\sqrt{MS_E[(4,4)+(5,5)+(7,7)+(8,8)-2(5,4)-2(7,4)+2(8,4) +2(7,5)-2(8,5)-2(8,7)]}$

$\bar{Y}_{21}$ v $\bar{Y}_{22}$ $\quad 1.96\sqrt{MS_E[(4,4)+(5,5)+(7,7)+(8,8)-2(5,4)-2(7,4)+2(8,4) +2(7,5)-2(8,5)-2(8,7)]}$

$\bar{Y}_{21}$ v $\bar{Y}_{23}$ $\quad 1.96\sqrt{MS_E[4(4,4)+(5,5)+4(5,4)+4(7,7)+(8,8)+4(8,7)-8(7,4) -4(8,4)-4(7,5)-2(8,5)]}$

$\bar{Y}_{22}$ v $\bar{Y}_{23}$ $\quad 1.96\sqrt{MS_E[(4,4)+4(5,5)+4(5,4)+4(8,8)+(7,7)+4(8,7)-8(8,5) -4(7,5)-4(8,4)-2(7,4)]}$

STIMULI X CLASS LSD

$\bar{Y}_{11}$ v $\bar{Y}_{12}$

$$1.96\sqrt{MS_E[(4,4)+(5,5)+(9,9)+(10,10)-2(5,4)+2(9,9)-2(10,4)-2(9,5)+2(10,5)-2(10,9)]}$$

$\bar{Y}_{11}$ v $\bar{Y}_{13}$

$$1.96\sqrt{MS_E[4(4,4)+(5,5)+4(5,4)+4(9,9)+(10,10)+4(10,9)+8(9,4)+4(10,4)+4(9,5)+2(10,5)]}$$

$\bar{Y}_{11}$ v $\bar{Y}_{21}$

$$1.96\sqrt{MS_E[4(3,3)+4(9,9)+8(9,3)]}$$

$\bar{Y}_{11}$ v $\bar{Y}_{22}$

$$1.96\sqrt{MS_E[4(3,3)+(4,4)+(5,5)+(9,8)+(10,10)+4(4,3)-4(5,3)+4(9,3)+4(10,3)-2(5,4)+2(9,4)+2(10,4)-2(9,5)-2(10,5)+7(10,9)]}$$

$\bar{Y}_{11}$ v $\bar{Y}_{23}$

$$1.96\sqrt{MS_E[4(3,3)+4(4,4)+(5,5)+4(5,4)+(10,10)+8(4,3)+4(5,3)-4(10,3)-4(10,4)-2(10,5)]}$$

$\bar{Y}_{12}$ v $\bar{Y}_{13}$

$$1.96\sqrt{MS_E[(4,4)+4(5,5)+4(5,4)+(9,9)+4(10,10)+4(10,9)+8(10,5)+4(9,5)+4(10,4)+2(9,4)]}$$

$\bar{Y}_{12}$ v $\bar{Y}_{21}$

$$1.96\ \overline{MS_E[4(3,3)+(5,5)+(4,4)+(10,10)+(9,9)+4(5,3)-4(4,3)+4(10,3)+4(9,3)-2(5,4)+2(10,5)-2(9,5)-2(10,4)-2(9,4)+2(10,9)]}$$

$\bar{Y}_{12}$ v $\bar{Y}_{22}$

$$1.96\sqrt{MS_E[4(3,3)+4(10,10)+8(10,3)]}$$

$\bar{Y}_{12}$ v $\bar{Y}_{23}$

$$1.96\sqrt{MS_E[4(3,3)+(4,4)+4(5,5)+4(5,4)+(9,9)+8(5,3)+4(4,3)-4(9,3)-4(9,5)-2(9,4)]}$$

$\bar{Y}_{13}$ v $\bar{Y}_{21}$

$$1.96\sqrt{MS_E[4(3,3)+4(4,4)+(5,5)+4(5,4)+(10,10)-8(4,3)-4(5,3)-4(10,3)+4(10,4)+2(10,5)]}$$

$\bar{Y}_{13}$ v $\bar{Y}_{22}$ $\quad 1.96 \sqrt{MS_E[4(3,3)+(4,4)+4(5,5)+4(5,4)+(9,9)-4(4,3)-8(5,3) -4(9,3)+2(9,4)+4(9,5)]}$

$\bar{Y}_{13}$ v $\bar{Y}_{23}$ $\quad 1.96 \sqrt{MS_E[4(3,3)+4(9,9)+4(10,10)+8(10,9)-8(9,3)-8(10,3)]}$

$\bar{Y}_{21}$ v $\bar{Y}_{22}$ $\quad 1.96 \sqrt{MS_E[(4,4)+(5,5)+(9,9)+(10,10)-2(5,4)-2(9,4)+2(10,4) +2(9,5)-2(10,5)-2(10,8)]}$

$\bar{Y}_{21}$ v $\bar{Y}_{23}$ $\quad 1.96 \sqrt{MS_E[4(4,4)+(5,5)+4(5,4)+4(9,9)+(10,10)+4(10,9)-8(9,4) -4(10,4)-4(9,5)-2(10,5)]}$

$\bar{Y}_{22}$ v $\bar{Y}_{23}$ $\quad 1.96 \sqrt{MS_E[(4,4)+4(5,5)+4(5,4)+(9,9)+4(10,10)+4(10,9) -4(9,5)-8(10,5)-4(10,4)-2(9,4)]}$

APPENDIX K

Data Analyses for Number Four on the Data Sheet

Which Lists the Total Score, by Category, of

all First Reasons Given for Grouping

Table 61. Summary of the analysis of covariance between the experimental groups on the total number of first superordinate responses

Source of variation	df	Sums of squares	Mean squares	F-ratio	Probability
Direction	1	372.229	327.229	37.903	0.0000*
Stimuli	1	7.517	7.517	0.765	0.3831
Class	2	3.891	1.945	0.198	0.8205
Direction by stimuli	1	0.189	0.189	0.019	0.8897
Direction by class	2	52.120	26.060	2.654	0.0735
Stimuli by class	2	37.166	18.583	1.892	0.1541
Direction by stimuli by class	2	23.580	11.790	1.201	0.3037
I.Q. (covariant)	1	0.506	0.506	0.052	0.8208
Residual	159	1561.467	9.821		
Total	171	2122.157			

*Significant beyond the .05 level.
Increase = 4.795
Decrease = 7.808

Table 62. Summary of the analysis of covariance between the experimental groups on the total number of first complex responses

Source of variation	df	Sums of squares	Mean squares	F-ratio	Probability
Direction	1	4.215	4.215	1.286	0.2588
Stimuli	1	0.005	0.005	0.001	0.9695
Class	2	22.044	11.022	3.363	0.0376*
Direction by stimuli	1	0.850	0.850	0.259	0.6114
Direction by class	2	2.271	1.135	0.346	0.7079
Stimuli by class	2	1.536	0.768	0.234	0.7914
Direction by stimuli by class	2	13.176	6.588	2.010	0.1380
I.Q. (covariant)	1	1.902	1.902	0.580	0.4477
Residual	134	439.210	3.278		
Total	146	493.850			

*Significant beyond the .05 level.

Table 63. Summary of the least significant differences between the class adjusted means on the total number of first complex responses

Comparison of experimental group means		Absolute difference between means	t	Least significant difference between means	Conclusion
Six grade	= 2.982				
versus		0.497	1.96	0.776	N.S.
freshmen	= 3.479				
Six grade	= 2.982				
versus		0.445	1.96	0.847	N.S.
jr. and sr.	= 2.537				
Freshmen	= 3.479				
versus		0.942	1.96	0.702	$P < 0.05$
jr. and sr.	= 2.537				

Table 64. Summary of the analysis of covariance between the experimental groups on the total number of first thema responses

Source of variation	df	Sums of squares	Mean squares	F-ratio	Probability
Direction	1	51.743	51.743	5.991	0.0159*
Stimuli	1	19.756	19.756	2.287	0.1331
Class	2	142.663	71.331	8.259	0.0004*
Direction by stimuli	1	16.310	16.310	1.888	0.1720
Direction by class	2	36.127	18.063	2.091	0.1281
Stimuli by class	2	24.241	12.121	1.403	0.2498
Direction by stimuli by class	2	86.836	43.418	5.027	0.0080*
I.Q. (covariant)	1	7.804	7.804	0.904	0.3438
Residual	118	1019.186	8.637		
Total	130	1388.229			

*Significant beyond the .05 level.
Increase = 5.392
Decrease = 4.027

Table 65. Summary of the least significant differences between the class adjusted means on the total number of first thema responses

Comparison of experimental group means	Absolute difference between means	t	Least significant difference between means	Conclusion
Six grade = 6.147 versus freshmen = 3.397	2.750	2.000	1.340	P< 0.05
Six grade = 6.147 versus jr. and sr. = 4.586	1.561	2.000	1.488	P< 0.05
Freshmen = 3.397 versus jr. and sr. = 4.586	1.189	2.000	1.340	N.S.

Table 66. Summary of the least significant differences between the direction by stimuli by class adjusted means on the total number of first thema responses

Direction by stimuli by class ranked by means	No. of Ss.	Ranked means	Mean differences 12	11	10	9	8	7	6	5	4	3	2
(1) Decrease by pictures by six grade	8	7.854	5.775*	5.692*	5.138*	4.517*	3.494*	3.274*	3.079	2.867*	2.201	1.558	0.131
(2) Increase by words by six grade	11	7.723	5.644*	5.561*	5.007*	4.386*	3.363*	3.143*	2.948	2.736*	2.070	1.427	
(3) Increase by pictures by six grade	12	6.296	4.217*	4.134*	3.580*	2.959*	1.936	1.716	1.521	1.309	0.643		
(4) Increase by pictures by jr. and sr.	14	5.653	3.574*	3.491*	2.937*	2.316	1.293	1.073	0.878	0.666			
(5) Increase by words by freshmen	19	4.987	2.908*	2.825*	2.271	1.650	0.627	0.407	0.212				
(6) Decrease by words by jr. and sr.	5	4.775	2.696	2.613	2.059	1.438	0.415	0.195					
(7) Decrease by pictures by jr. and sr.	9	4.580	2.501	2.418	1.864	1.243	0.220						
(8) Increase by pictures by freshmen	17	4.360	2.281	2.198	1.644	1.023							
(9) Increase by words by jr. and sr.	11	3.337	1.258	1.175	0.621								
(10) Decrease by words by six grade	6	2.716	0.637	0.554									
(11) Decrease by words by freshmen	13	2.162	0.083										
(12) Decrease by pictures by freshmen	6	2.079											

Least significant difference values between means: *for .05 level of significance = 2.00

Table 67. Summary of the analysis of covariance between the experimental groups on the total of the first grouping structure responses

Source of variation	df	Sums of squares	Mean squares	F-ratio	Probability
Direction	1	2.189	2.189	4.947	0.0274*
Stimuli	1	0.645	0.645	1.458	0.2289
Class	2	0.093	0.046	0.105	0.9008
Direction by stimuli	1	0.019	0.019	0.043	0.8365
Direction by class	2	0.857	0.428	0.968	0.3819
Stimuli by class	2	0.284	0.142	0.321	0.7259
Direction by stimuli by class	2	0.392	0.196	0.443	0.6431
I.Q. (covariant)	1	0.585	0.585	1.322	0.2517
Residual	170	75.215	0.442		
Total	182	79.934			

*Significant beyond the .05 level.
Increase = 11.866
Decrease = 11.643

Table 68. Summary of the analysis of covariance between the experimental groups on the total number of first edge matching responses

Source of variation	df	Sums of squares	Mean squares	F-ratio	Probability
Direction	1	5.614	5.614	1.106	0.2962
Stimuli	1	1.135	1.135	0.224	0.6377
Class	2	4.440	2.220	0.437	0.6474
Direction by stimuli	1	4.273	4.273	0.842	0.3617
Direction by class	2	2.318	1.159	0.228	0.7964
Stimuli by class	2	15.724	7.862	1.549	0.2189
Direction by stimuli by class	2	42.603	21.301	4.196	0.0186*
I.Q. (covariant)	1	2.502	2.502	0.493	0.4847
Residual	78	395.946	5.076		
Total	90	459.033			

*Significant beyond the .05 level.

Table 69. Summary of the least significant differences between the direction by stimuli by class adjusted means on the total number of first edge matching responses

Direction by stimuli by class ranked by means	No. of Ss.	Ranked means	Mean differences 12	11	10	9	8	7	6	5	4	3	2
(1) Decrease by pictures by six grade	4	5.930	4.609*	3.869*	2.886	2.791	2.495	2.473	2.412	1.976	1.881	1.533	0.925
(2) Increase by words by six grade	7	5.005	3.684	2.944	1.961	1.866	1.570	1.548	1.487	1.051	0.956	0.608	
(3) Increase by pictures by jr. and sr.	11	4.397	3.076	2.336	1.353	1.258	0.962	0.940	0.879	0.443	0.348		
(4) Increase by words by freshmen	16	4.049	2.728	1.988	1.005	0.910	0.614	0.592	0.531	0.095			
(5) Decrease by words by jr. and sr.	4	3.954	2.633	1.893	0.910	0.815	0.519	0.494	0.436				
(6) Increase by pictures by freshmen	16	3.518	2.197	1.457	0.474	0.379	0.083	0.061					
(7) Decrease by words by freshmen	9	3.457	2.136	1.396	0.413	0.318	0.022						
(8) Increase by pictures by six grade	7	3.435	2.114	1.374	0.391	0.296							
(9) Decrease by pictures by jr. and sr.	5	3.139	1.818	1.078	0.095								
(10) Increase by words by jr. and sr.	7	3.044	1.723	0.983									
(11) Decrease by pictures by freshmen	3	2.061	0.740										
(12) Decrease by words by six grade	2	1.321											

Least significant difference values between means: *for .05 level of significance = 2.00

Table 70. Summary of the analysis of covariance between the experimental groups on the total of the simple association attribute responses

Source of variation	df	Sums of squares	Mean squares	F-ratio	Probability
Direction	1	31.879	31.879	6.706	0.0110*
Stimuli	1	0.120	0.119	0.025	0.8746
Class	2	1.061	0.530	0.112	0.8945
Direction by stimuli	1	1.379	1.379	0.290	0.5914
Direction by class	2	2.289	1.144	0.241	0.7865
Stimuli by class	2	14.660	7.330	1.542	0.2190
Direction by stimuli by class	2	44.359	22.180	4.665	0.0116*
I.Q. (covariant)	1	2.360	2.359	0.496	0.4828
Residual	100	475.408	4.754		
Total	112	560.141			

*Significant beyond the .05 level.
Increase = 3.798
Decrease = 2.645

Table 71. Summary of the least significant differences between the direction by stimuli by class adjusted means on the total number of first simple association attributes

Direction by stimuli by class ranked by means	No. of Ss.	Ranked means	Mean differences 12	11	10	9	8	7	6	5	4	3	2
(1) Increase by words by six grade	9	4.606	3.402*	3.102*	1.807	1.706	1.556	1.523	1.426	0.856	0.615	0.509	0.117
(2) Increase by pictures by jr. and sr.	11	4.489	3.285*	2.985*	1.690	1.589	1.439	1.406	1.309	0.739	0.498	0.392	
(3) Decrease by pictures by six grade	7	4.097	2.893*	2.593*	1.298	1.197	1.047	1.014	0.917	0.347	0.106		
(4) Increase by words by freshmen	18	3.991	2.787*	2.487*	1.192	1.091	0.941	0.908	0.811	0.241			
(5) Increase by pictures by freshmen	16	3.750	2.546*	2.246*	0.951	0.850	0.700	0.667	0.570				
(6) Decrease by words by freshmen	12	3.180	1.976	1.676	0.381	0.280	0.130	0.097					
(7) Decrease by words by jr. and sr.	7	3.083	1.879	1.579	0.284	0.183	0.033						
(8) Increase by words by jr. and sr.	7	3.050	1.846	1.546	0.251	0.150							
(9) Increase by pictures by six grade	9	2.900	1.696	1.396	0.101								
(10) Decrease by pictures by jr. and sr.	7	2.799	1.595	1.295									
(11) Decrease by pictures by freshmen	6	1.504	0.300										
(12) Decrease by words by six grade	4	1.204											

Least significant difference values between means: *for .05 level of significance = 2.00

Table 72. Summary of the analysis of covariance between the experimental groups on the total number of perceptual attribute responses

Source of variation	df	Sums of squares	Mean squares	F-ratio	Probability
Direction	1	4.712	4.712	1.149	0.2874
Stimuli	1	12.995	12.995	3.170	0.0795
Class	2	42.298	21.149	5.159	0.0082*
Direction by stimuli	1	0.641	0.641	0.156	0.6938
Direction by class	2	3.790	1.895	0.462	0.6318
Stimuli by class	2	17.159	8.579	2.093	0.1312
Direction by stimuli by class	2	3.308	1.654	0.403	0.6696
I.Q. (covariant)	1	19.003	19.003	4.636	0.0349
Residual	68	278.748	4.099		
Total	80	432.691			

*Significant beyond the .05 level.

Table 73. Summary of the least significant differences between the class adjusted means on the total number of first perceptual attribute responses

Comparison of experimental group means		Absolute difference between means	t	Least significant difference between means	Conclusion
Six grade versus freshmen	= 3.063 = 1.364	1.699	2.000	1.152	$P < 0.05$
Six grade versus jr. and sr.	= 3.063 = 1.343	1.720	2.000	1.294	$P < 0.05$
Freshmen versus jr. and sr.	= 1.346 = 1.343	0.003	2.000	1.194	N.S.

Table 74. Summary of the analysis of covariance between the experimental groups on the total number of perceptual location responses

Source of variation	df	Sums of squares	Mean squares	F-ratio	Probability
Direction	1	0.556	0.556	0.534	0.4688
Stimuli	1	0.724	0.724	0.694	0.4090
Class	2	2.523	1.262	1.210	0.3074
Direction by stimuli	1	0.431	0.431	0.413	0.5236
Direction by class	2	0.856	0.428	0.411	0.6655
Stimuli by class	2	1.851	0.926	0.888	0.4185
Direction by stimuli by class	2	1.836	0.918	0.881	0.4214
I.Q. (covariant)	1	0.215	0.215	0.207	0.6515
Residual	46	47.954	1.042		
Total	58	58.576			

*Significant beyond the .05 level.

Table 75. Summary of the analysis of covariance between the experimental groups on the total number of functional association responses

Source of variation	df	Sums of squares	Mean squares	F-ratio	Probability
Direction	1	5.657	5.657	2.206	0.1406
Stimuli	1	0.389	0.389	0.152	0.6977
Class	2	1.863	0.932	0.363	0.6963
Direction by stimuli	1	1.529	1.529	0.596	0.4418
Direction by class	2	4.082	2.041	0.796	0.4540
Stimuli by class	2	0.935	0.467	0.182	0.8337
Direction by stimuli by class	2	1.622	0.811	0.316	0.7295
I.Q. (covariant)	1	1.319	1.319	0.514	0.4750
Residual	100	256.445	2.564		
Total	112	275.062			

*Significant beyond the .05 level.

Table 76. Summary of the analysis of covariance between the experimental groups on the total number of functional dependence (extrinsic) responses

Source of variation	df	Sums of squares	Mean squares	F-ratio	Probability
Direction	1	15.864	15.864	11.865	0.0009*
Stimuli	1	0.081	0.081	0.060	0.8066
Class	2	9.021	4.511	3.374	0.0389*
Direction by stimuli	1	0.002	0.002	0.002	0.9683
Direction by class	2	0.351	0.175	0.131	0.8772
Stimuli by class	2	1.539	0.770	0.576	0.5646
Direction by stimuli by class	2	0.698	0.349	0.261	0.7709
I.Q. (covariant)	1	5.908	5.908	4.419	0.0385
Residual	85	113.648	1.337		
Total	97	147.480			

*Significant beyond the .05 level.
Increase = 1.176
Decrease = 2.019

Table 77. Summary of the least significant differences between the class adjusted means on the total number of first functional dependence (extrinsic) responses

Comparison of experimental group means	Absolute difference between means	t	Least significant difference between means	Conclusion
Six grade = 1.887 versus freshmen = 1.192	0.695	2.000	0.562	$P < 0.05$
Six grade = 1.887 versus jr. and sr. = 1.713	0.174	2.000	0.690	N.S.
Freshmen = 1.192 versus jr. and sr. = 1.713	0.521	2.000	0.654	N.S.

Table 78. Summary of the analysis of covariance between the experimental groups on the total number of functional dependence (intrinsic) responses

Source of variation	df	Sums of squares	Mean squares	F-ratio	Probability
Direction	1	0.058	0.058	0.095	0.7598
Stimuli	1	1.921	1.921	3.144	0.0838
Class	2	6.224	3.112	5.093	0.0107*
Direction by stimuli	1	1.323	1.323	2.166	0.1490
Direction by class	2	0.146	0.073	0.119	0.8878
Stimuli by class	2	5.025	2.513	4.112	0.0238*
Direction by stimuli by class	2	1.118	0.559	0.915	0.4088
I.Q. (covariant)	1	0.792	0.792	1.297	0.2615
Residual	40	24.441	0.611		
Total	52	43.472			

*Significant beyond the .05 level.

Table 79. Summary of the least significant differences between the class adjusted means on the total number of first functional dependence (intrinsic) responses

Comparison of experimental group means	Absolute difference between means	t	Least significant difference between means	Conclusion
Six grade = 1.326 versus freshmen = 0.487	0.839	2.021	0.532	$P < 0.05$
Six grade = 1.326 versus jr. and sr. = 0.809	0.517	2.021	0.238	$P < 0.05$
Freshmen = 0.487 versus jr. and sr. = 0.809	0.398	2.021	0.596	N.S.

Table 80. Summary of the least significant differences between the stimuli by class adjusted means on the total number of first functional dependence (intrinsic) responses

Comparison of experimental group means	Absolute difference between means	t	Least significant difference between means	Conclusion
Pictures by six grade = 1.471 versus Pictures by freshmen = 0.306	1.165	2.021	0.857	$P < 0.05$
Pictures by six grade = 1.471 versus Pictures by jr. and sr. = 1.441	0.030	2.021	0.881	N.S.
Pictures by six grade = 1.471 versus Words by six grade = 1.180	0.291	2.021	0.748	N.S.
Pictures by six grade = 1.471 versus Words by freshmen = 0.669	0.802	2.021	0.502	$P < 0.05$
Pictures by six grade = 1.471 versus Words by jr. and sr. = 0.178	1.293	2.021	0.758	$P < 0.05$
Pictures by freshmen = 0.306 versus Pictures by jr. and sr. = 1.441	1.135	2.021	0.885	$P < 0.05$
Pictures by freshmen = 0.306 versus Words by six grade = 1.180	0.874	2.021	0.710	$P < 0.05$
Pictures by freshmen = 0.306 versus Words by freshmen = 0.669	0.363	2.021	0.780	N.S.
Pictures by freshmen = 0.306 versus Words by jr. and sr. = 0.178	0.128	2.021	0.784	N.S.
Pictures by jr. and sr. = 1.441 versus Words by six grade = 1.180	0.261	2.021	0.913	N.S.
Pictures by jr. and sr. = 1.441 versus Words by freshmen = 0.669	0.772	2.021	0.885	N.S.
Pictures by jr. and sr. = 1.441 versus Words by jr. and sr. = 0.178	1.263	2.021	0.859	$P < 0.05$
Words by six grade = 1.180 versus Words by freshmen = 0.669	0.511	2.021	0.809	N.S.
Words by six grade = 1.180 versus Words by jr. and sr. = 0.178	1.002	2.021	0.894	$P < 0.05$
Words by freshmen = 0.669 versus Words by jr. and sr. = 0.176	0.493	2.021	0.771	N.S.

Table 81. Summary of the analysis of covariance between the experimental groups on the total number of functional dependence (situational) responses

Source of variation	df	Sums of squares	Mean squares	F-ratio	Probability
Direction	1	3.009	3.009	1.239	0.2683
Stimuli	1	2.354	2.354	0.969	0.3273
Class	2	21.782	10.891	4.483	0.0136*
Direction by stimuli	1	0.001	0.001	0.000	0.9836
Direction by class	2	10.628	5.314	2.187	0.1174
Stimuli by class	2	2.523	1.262	0.519	0.5965
Direction by stimuli by class	2	1.940	0.970	0.399	0.6719
I.Q. (covariant)	1	0.801	0.801	0.330	0.5672
Residual	103	250.250	2.430		
Total	115	295.612			

*Significant beyond the .05 level.

Table 82. Summary of the least significant differences between the class adjusted means on the total number of first functional dependence (situational) responses

Comparison of experimental group means		Absolute difference between means	t	Least significant difference between means	Conclusion
Six grade	= 3.316				
versus		1.056	2.000	1.746	N.S.
freshmen	= 2.260				
Six grade	= 3.316				
versus		0.971	2.000	0.854	$P < 0.05$
jr. and sr.	= 2.345				
Freshmen	= 2.260				
versus		0.085	2.000	0.976	N.S.
jr. and sr.	= 2.345				

Table 83. Summary of the analysis of covariance between the experimental groups on the total of the concrete attribute responses

Source of variation	df	Sums of squares	Mean squares	F-ratio	Probability
Direction	1	0.019	0.019	0.004	0.9511
Stimuli	1	7.567	7.567	1.521	0.2190
Class	2	183.012	91.506	18.392	0.0000*
Direction by stimuli	1	2.702	2.702	0.543	0.4624
Direction by class	2	3.626	1.813	0.364	0.6952
Stimuli by class	2	0.375	0.188	0.038	0.9630
Direction by stimuli by class	2	10.887	5.444	1.094	0.3371
I.Q. (covariant)	1	18.448	18.448	3.708	0.0558
Residual	169	840.839	4.975		
Total	181	1129.516			

*Significant beyond the .05 level.

Table 84. Summary of the least significant differences between the class adjusted means on the total of the first concrete attribute responses

Comparison of experimental group means		Absolute difference between means	t	Least significant difference between means	Conclusion
Six grade versus freshmen	= 7.157 = 4.801	2.356	1.960	0.794	$P < 0.05$
Six grade versus jr. and sr.	= 7.157 = 5.021	2.136	1.960	0.896	$P < 0.05$
Freshmen versus jr. and sr.	= 4.801 = 5.021	0.220	1.960	0.794	N.S.

Table 85. Summary of the analysis of covariance between the experimental groups on the total number of simple representational responses

Source of variation	df	Sums of squares	Mean squares	F-ratio	Probability
Direction	1	19.363	19.363	9.113	0.0031*
Stimuli	1	3.907	3.907	1.839	0.1774
Class	2	0.522	0.261	0.123	0.8844
Direction by stimuli	1	0.249	0.249	0.117	0.7328
Direction by class	2	0.524	0.262	0.123	0.8841
Stimuli by class	2	3.186	1.593	0.750	0.4746
Direction by stimuli by class	2	0.599	0.300	0.141	0.8686
I.Q. (covariant)	1	1.502	1.502	0.707	0.4022
Residual	129	274.093	2.125		
Total	141	308.732			

*Significant beyond the .05 level.
Increase = 2.285
Decrease = 3.063

Table 86. Summary of the analysis of covariance between the experimental groups on the total number of compound representational responses

Source of variation	df	Sums of squares	Mean squares	F-ratio	Probability
Direction	1	13.828	13.828	7.240	0.0087*
Stimuli	1	0.159	0.159	0.083	0.7734
Class	2	3.470	1.735	0.909	0.4071
Direction by stimuli	1	0.390	0.390	0.204	0.6526
Direction by class	2	6.248	3.124	1.636	0.2011
Stimuli by class	2	2.854	1.427	0.747	0.4769
Direction by stimuli by class	2	5.124	2.562	1.341	0.2672
I.Q. (covariant)	1	0.498	0.498	0.261	0.6111
Residual	81	154.691	1.910		
Total	93	200.000			

*Significant beyond the .05 level.
Increase = 1.491
Decrease = 2.364

Table 87. Summary of the analysis of covariance between the experimental groups on the total number of symbolic responses

Source of variation	df	Sums of squares	Mean squares	F-ratio	Probability
Direction	1	1.093	1.093	0.674	0.4175
Stimuli	1	5.334	5.334	3.289	0.0788
Class	2	0.207	0.103	0.064	0.9383
Direction by stimuli	1	0.655	0.655	0.404	0.5294
Direction by class	2	2.003	1.002	0.618	0.5454
Stimuli by class	2	0.599	0.300	0.185	0.8322
Direction by stimuli by class	2	4.592	2.297	1.416	0.2571
I.Q. (covariant)	1	0.012	0.012	0.007	0.9331
Residual	33	53.517	1.622		
Total	45	65.217			

*Significant beyond the .05 level.

Table 88. Summary of the analysis of covariance between the experimental groups on the total number of affective representational (simple) responses

Source of variation	df	Sums of squares	Mean squares	F-ratio	Probability
Direction	1	0.030	0.030	0.026	0.8761
Stimuli	1	0.438	0.438	0.377	0.5542
Class	2	0.116	0.058	0.050	0.9516
Direction by stimuli	1	0.032	0.032	0.028	0.8719
Direction by class	2	1.057	0.528	0.456	0.6478
Stimuli by class	2	0.569	0.284	0.245	0.7876
Direction by stimuli by class	2	0.298	0.149	0.129	0.8808
I.Q. (covariant)	1	0.031	0.031	0.027	0.8732
Residual	9	10.435	1.159		
Total	21	14.000			

*Significant beyond the .05 level.

Table 89. Summary of the analysis of covariance between the experimental groups on the total of the representational attribute responses

Source of variation	df	Sums of squares	Mean squares	F-ratio	Probability
Direction	1	71.453	71.453	10.903	0.0012*
Stimuli	1	5.998	5.998	0.915	0.3402
Class	2	78.544	39.272	5.992	0.0031*
Direction by stimuli	1	0.951	0.951	0.145	0.7038
Direction by class	2	45.855	22.928	3.498	0.0326*
Stimuli by class	2	9.472	4.736	0.723	0.4870
Direction by stimuli by class	2	14.862	7.431	1.134	0.3244
I.Q. (covariant)	1	6.519	6.519	0.995	0.3200
Residual	158	1035.494	6.554		
Total	170	1308.631			

*Significant beyond the .05 level.
Increase = 3.831
Decrease = 5.161

Table 90. Summary of the least significant differences between the class adjusted means on the total of the first representational attribute responses

Comparison of experimental group means	Absolute difference between means	t	Least significant difference between means	Conclusion
Six grade = 3.449 versus freshmen = 5.054	1.605	1.960	0.953	$P < 0.05$
Six grade = 3.449 versus jr. and sr. = 4.985	1.538	1.960	1.133	$P < 0.05$
Freshmen = 5.054 versus jr. and sr. = 4.985	0.069	1.960	0.992	N.S.

Table 91. Summary of the least significant differences between the direction by class adjusted means on the total of the first representational attribute responses

Comparison of experimental group means	Absolute difference between means	t	Least significant difference between means	Conclusion
Increase by six grade = 2.878 versus Increase by freshmen = 3.724	0.846	1.960	1.347	N.S.
Increase by six grade = 2.878 versus Increase by jr. and sr. = 4.890	2.012	1.960	1.603	$P < 0.05$
Increase by six grade = 2.878 versus Decrease by six grade = 4.019	1.141	1.960	1.454	N.S.
Increase by six grade = 2.878 versus Decrease by freshmen = 6.384	3.506	1.960	1.347	$P < 0.05$
Increase by six grade = 3.531 versus Decrease by jr. and sr. = 4.994	1.463	1.960	1.539	N.S.
Increase by freshmen = 3.724 versus Increase by jr. and sr. = 4.890	1.166	1.960	1.401	N.S.
Increase by freshmen = 3.724 versus Decrease by six grade = 4.019	0.295	1.960	1.309	N.S.
Increase by freshmen = 3.724 versus Decrease by freshmen = 6.384	2.660	1.960	1.145	$P < 0.05$
Increase by freshmen = 3.724 versus Decrease by jr. and sr. = 5.080	1.356	1.960	1.327	$P < 0.05$
Increase by jr. and sr. = 4.890 versus Decrease by six grade = 4.019	0.871	1.960	1.539	N.S.
Increase by jr. and sr. = 4.890 versus Decrease by freshmen = 6.384	1.494	1.960	1.364	$P < 0.05$
Increase by jr. and sr. = 4.890 versus Decrease by jr. and sr. = 5.080	0.190	1.960	2.417	N.S.
Decrease by six grade = 4.019 versus Decrease by freshmen = 6.384	2.365	1.960	1.309	$P < 0.05$
Decrease by six grade = 4.019 versus Decrease by jr. and sr. = 5.080	1.061	1.960	1.472	N.S.
Decrease by freshmen = 6.384 versus Decrease by jr. and sr. = 5.080	1.304	1.960	1.364	N.S.

Table 92. Summary of the analysis of covariance between the experimental groups on the total of the attribute responses

Source of variation	df	Sums of squares	Mean squares	F-ratio	Probability
Direction	1	3.547	3.547	4.672	0.0321*
Stimuli	1.	0.980	0.980	1.291	0.2573
Class	2	2.320	1.160	1.528	0.2200
Direction by stimuli	1	1.355	1.355	1.785	0.1833
Direction by class	2	2.447	1.223	1.611	0.2026
Stimuli by class	2	3.731	1.865	2.457	0.0887
Direction by stimuli by class	2	3.464	1.732	2.281	0.1053
I.Q. (covariant)	1	0.200	0.200	0.263	0.6084
Residual	170	129.075	0.759		
Total	182	144.852			

*Significant beyond the .05 level.
Increase = 11.990
Decrease = 11.707

Table 93. Summary of the analysis of covariance between the experimental groups on the total number of partial use of stimuli responses

Source of variation	df	Sums of squares	Mean squares	F-ratio	Probability
Direction	1	0.996	0.996	0.299	0.5865
Stimuli	1	8.332	8.332	2.500	0.1189
Class	2	42.884	21.442	6.433	0.0029*
Direction by stimuli	1	0.000	0.000	0.000	0.9977
Direction by class	2	4.940	2.470	0.741	0.4808
Stimuli by class	2	7.676	3.838	1.151	0.3227
Direction by stimuli by class	2	4.989	2.495	0.748	0.4773
I.Q. (covariant)	1	18.034	18.034	5.410	0.0232
Residual	63	209.991	3.333		
Total	75	342.987			

*Significant beyond the .05 level.

Table 94. Summary of the least significant differences between the class adjusted means on the total number of partial use of stimuli responses

Comparison of experimental group means	Absolute difference between means	t	Least significant difference between means	Conclusion
Six grade = 2.956 versus freshmen = 1.063	1.893	2.000	1.072	$P < 0.05$
Six grade = 2.956 versus jr. and sr. = 1.495	1.461	2.000	1.292	$P < 0.05$
Freshmen = 1.063 versus jr. and sr. = 1.495	0.432	2.000	1.194	N.S.

Table 95. Summary of the analysis of covariance between the experimental groups on the total number of exceptional responses

Source of variation	df	Sums of squares	Mean squares	F-ratio	Probability
Direction	1	0.542	0.542	0.141	0.7075
Stimuli	1	0.012	0.012	0.003	0.9552
Class	2	13.164	6.582	1.717	0.1835
Direction by stimuli	1	0.022	0.022	0.006	0.9397
Direction by class	2	34.629	17.314	4.516	0.0126*
Stimuli by class	2	18.241	9.120	2.379	0.0965
Direction by stimuli by class	2	20.453	10.227	2.667	0.0730
I.Q. (covariant)	1	8.744	8.744	2.280	0.1333
Residual	137	525.292	3.834		
Total	149	640.293			

*Significant beyond the .05 level.

Table 96. Summary of the least significant differences between the direction by class adjusted means on the total number of first exceptional quality responses

Comparison of experimental group means		Absolute difference between means	t	Least significant difference between means	Conclusion
Increase by six grade versus Increase by freshmen	= 3.200 = 2.681	0.519	1.960	1.094	N.S.
Increase by six grade versus Increase by jr. and sr.	= 3.200 = 3.515	0.315	1.960	1.207	N.S.
Increase by six grade versus Decrease by six grade	= 3.700 = 2.236	1.464	1.960	1.284	$P < 0.05$
Increase by six grade versus Decrease by freshmen	= 3.700 = 4.055	0.355	1.960	1.098	N.S.
Increase by six grade versus Decrease by jr. and sr.	= 3.700 = 3.487	0.213	1.960	1.280	N.S.
Increase by freshmen versus Increase by jr. and sr.	= 2.681 = 3.515	0.834	1.960	1.086	N.S.
Increase by freshmen versus Decrease by six grade	= 2.681 = 2.236	0.445	1.960	1.119	N.S.
Increase by freshmen versus Decrease by freshmen	= 2.681 = 4.055	1.374	1.960	2.634	N.S.
Increase by freshmen versus Decrease by jr. and sr.	= 2.681 = 3.487	0.806	1.960	1.111	N.S.
Increase by jr. and sr. versus Decrease by six grade	= 3.515 = 2.236	1.279	1.960	1.207	$P < 0.05$
Increase by jr. and sr. versus Decrease by freshmen	= 3.515 = 4.055	0.540	1.960	1.015	N.S.
Increase by jr. and sr. versus Decrease by jr. and sr.	= 3.515 = 3.487	0.028	1.960	1.190	N.S.
Decrease by six grade versus Decrease by freshmen	= 2.236 = 4.055	1.819	1.960	1.919	N.S.
Decrease by six grade versus Decrease by jr. and sr.	= 2.236 = 3.487	1.251	1.960	1.280	N.S.
Decrease by freshmen versus Decrease by jr. and sr.	= 4.055 = 3.487	0.568	1.960	1.111	N.S.

Table 97. Summary of the analysis of covariance between the experimental groups on the total number of poor quality responses

Source of variation	df	Sums of squares	Mean squares	F-ratio	Probability
Direction	1	16.866	16.866	4.395	0.0409*
Stimuli	1	0.282	0.282	0.073	0.7875
Class	2	8.801	4.401	1.147	0.3256
Direction by stimuli	1	0.565	0.565	0.147	0.7028
Direction by class	2	4.519	2.260	0.589	0.5587
Stimuli by class	2	8.607	4.303	1.121	0.3336
Direction by stimuli by class	2	5.183	2.591	0.675	0.5134
I.Q. (covariant)	1	1.747	1.747	0.455	0.5028
Residual	52	199.566	3.838		
Total	64	252.862			

*Significant beyond the .05 level.

Table 98. Summary of the analysis of covariance between the experimental groups on the total number of regular responses

Source of variation	df	Sums of squares	Mean squares	F-ratio	Probability
Direction	1	9.065	9.065	1.360	0.2450
Stimuli	1	4.456	4.456	0.669	0.4150
Class	2	0.190	0.095	0.014	0.9859
Direction by stimuli	1	5.119	5.119	0.768	0.3824
Direction by class	2	28.099	14.050	2.108	0.1246
Stimuli by class	2	11.290	5.645	0.847	0.4307
Direction by stimuli by class	2	0.464	0.232	0.035	0.9658
I.Q. (covariant)	1	1.120	1.200	0.180	0.6721
Residual	169	1126.476	1126.476		
Total	181	1191.341	1191.341		

*Significant beyond the .05 level.

Table 99. Summary of the analysis of covariance between the experimental groups on the total of the supplementary aspects responses

Source of variation	df	Sums of squares	Mean squares	F-ratio	Probability
Direction	1	0.491	0.491	2.165	0.1430
Stimuli	1	0.012	0.012	0.051	0.8209
Class	2	0.560	0.280	1.234	0.2935
Direction by stimuli	1	0.008	0.008	0.037	0.8474
Direction by class	2	0.892	0.446	1.965	0.1433
Stimuli by class	2	0.026	0.013	0.057	0.9443
Direction by stimuli by class	2	0.016	0.008	0.035	0.9653
I.Q. (covariant)	1	0.811	0.811	3.573	0.0604
Residual	169	38.345	0.227		
Total	181	41.648			

*Significant beyond the .05 level.

Table 100. Summary of the analysis of covariance between the experimental groups on the total number of specific responses

Source of variation	df	Sums of squares	Mean squares	F-ratio	Probability
Direction	1	164.457	164.457	17.659	0.0000*
Stimuli	1	6.890	6.890	0.740	0.3910
Class	2	10.530	5.265	0.565	0.5694
Direction by stimuli	1	3.797	3.797	0.408	0.5241
Direction by class	2	2.003	1.002	0.108	0.8981
Stimuli by class	2	47.249	23.625	2.537	0.0821
Direction by stimuli by class	2	8.902	4.451	0.478	0.6211
I.Q. (covariant)	1	2.115	2.115	0.227	0.6344
Residual	168	1564.549	9.313		
Total	180	1824.343			

*Significant beyond the .05 level.
Increase = 8.708
Decrease = 6.761

Table 101. Summary of the analysis of covariance between the experimental groups on the total number of middle level of specificity responses

Source of variation	df	Sums of squares	Mean squares	F-ratio	Probability
Direction	1	83.263	83.263	14.743	0.0002*
Stimuli	1	0.700	0.700	0.124	0.7254
Class	2	14.038	7.019	1.243	0.2918
Direction by stimuli	1	16.567	16.567	2.933	0.0890
Direction by class	2	8.250	4.125	0.730	0.4836
Stimuli by class	2	20.991	10.496	1.858	0.1598
Direction by stimuli by class	2	4.493	2.247	0.398	0.6726
I.Q. (covariant)	1	1.298	1.298	0.230	0.6324
Residual	138	779.383	5.648		
Total	150	933.179			

*Significant beyond the .05 level.
Increase = 3.574
Decrease = 5.104

Table 102. Summary of the analysis of covariance between the experimental groups on the total level of specificity responses

Source of variation	df	Sums of squares	Mean squares	F-ratio	Probability
Direction	1	3.151	3.151	6.328	0.0128*
Stimuli	1	0.595	0.595	1.195	0.2758
Class	2	0.021	0.011	0.021	0.9789
Direction by stimuli	1	0.069	0.069	0.138	0.7111
Direction by class	2	0.983	0.491	0.987	0.3752
Stimuli by class	2	0.644	0.322	0.647	0.5251
Direction by stimuli by class	2	0.403	0.201	0.404	0.6682
I.Q. (covariant)	1	0.991	0.991	1.990	0.1602
Residual	168	83.645	0.498		
Total	180	90.309			

*Significant beyond the .05 level.
Increase = 11.879
Decrease = 11.610

APPENDIX L

Data Analyses for Number Ten on the Data Sheet

Which Lists the Total of All the Single

Highest Cognitive Level Scores

Given by the Subjects

Table 103. Summary of the analysis of covariance between the experimental groups on the total number of superordinate responses scored according to the single highest category cognitive level score

Source of variation	df	Sums of squares	Mean squares	F-ratio	Probability
Direction	1	3067.680	3067.680	31.288	0.0000*
Stimuli	1	61.376	61.376	0.626	0.4300
Class	2	44.743	22.372	0.228	0.7962
Direction by stimuli	1	5.390	5.390	0.055	0.8149
Direction by class	2	463.081	218.041	2.224	0.1116
Stimuli by class	2	302.036	151.018	1.540	0.2175
Direction by stimuli by class	2	208.317	104.186	1.063	0.3480
I.Q. (covariant)	1	0.254	0.254	0.003	0.9595
Residual	158	15491.176	98.045		
Total	170	20100.102			

*Significant beyond the .05 level.
Increase = 14.958
Decrease = 23.625

Table 104. Summary of the analysis of covariance between the experimental groups on the total number of complex responses scored according to the single highest category cognitive level score

Source of variation	df	Sums of squares	Mean squares	F-ratio	Probability
Direction	1	6.116	6.116	0.425	0.5158
Stimuli	1	1.584	1.584	0.110	0.7407
Class	2	52.833	26.416	1.834	0.1639
Direction by stimuli	1	0.008	0.008	0.001	0.9810
Direction by class	2	29.761	14.880	1.033	0.3588
Stimuli by class	2	2.151	1.075	0.075	0.9281
Direction by stimuli by class	2	36.109	18.054	1.253	0.2889
I.Q. (covariant)	1	1.875	1.875	0.130	0.7189
Residual	130	1872.671	14.405		
Total	142	2030.364			

*Significant beyond the .05 level.

Table 105. Summary of the analysis of covariance between the experimental groups on the total number of thema responses scored according to the single highest category cognitive level score

Source of variation	df	Sums of squares	Mean squares	F-ratio	Probability
Direction	1	76.145	76.145	4.875	0.0293*
Stimuli	1	43.239	43.239	2.768	0.0989
Class	2	153.826	76.913	4.924	0.0089*
Direction by stimuli	1	5.620	5.620	0.360	0.5498
Direction by class	2	3.591	1.796	0.115	0.8915
Stimuli by class	2	40.447	20.224	1.295	0.2779
Direction by stimuli by class	2	138.500	69.250	4.434	0.0140*
I.Q. (covariant)	1	7.429	7.429	0.476	0.4918
Residual	113	1764.919	15.619		
Total	125	2256.443			

*Significant beyond the .05 level.
Increase = 5.821
Decrease = 4.126

Table 106. Summary of the least significant differences between the class adjusted means on the total thema score scored according to the single highest category cognitive level score

Comparison of experimental group means	Absolute difference between means	t	Least significant difference between means	Conclusion
Six grade = 6.199 versus freshmen = 3.400	2.799	2.000	1.854	$P < 0.05$
Six grade = 6.199 versus jr. and sr. = 5.321	0.878	2.000	2.090	N.S.
Freshmen = 3.400 versus jr. and sr. = 5.321	1.921	2.000	1.952	N.S.

Table 107. Summary of the least significant differences between the direction by stimuli by class adjusted means on the total of the thema response scores scored according to the single highest category cognitive level score

Direction by stimuli by class ranked by means	No. of Ss.	Ranked means	Mean differences 12	11	10	9	8	7	6	5	4	3	2
(1) Increase by pictures by jr. and sr.	12	8.376	6.102*	6.029*	5.671*	4.801*	4.321*	3.806*	3.611*	3.452*	2.090	0.663	0.282
(2) Decrease by pictures by six grade	8	8.094	5.820*	5.747*	5.389*	4.519*	4.039*	3.524	3.329	3.170	1.808	0.381	
(3) Increase by words by six grade	11	7.713	5.439*	5.366*	5.008*	4.138*	3.658*	3.143	2.948	2.789	1.427		
(4) Increase by pictures by six grade	12	6.286	4.012*	3.939	3.581	2.711	2.231	1.716	1.521	1.362			
(5) Increase by words by freshmen	19	4.924	2.650	2.577	2.219	1.349	0.869	0.354	0.159				
(6) Decrease by words by jr. and sr.	5	4.765	2.491	2.418	2.060	1.190	0.710	0.195					
(7) Decrease by pictures by jr. and sr.	9	4.570	2.296	2.223	1.865	0.995	0.515						
(8) Increase by pictures by freshmen	17	4.055	1.781	1.708	1.350	0.480							
(9) Increase by words by jr. and sr.	10	3.575	1.301	1.228	0.870								
(10) Decrease by words by six grade	6	2.705	0.431	0.358									
(11) Decrease by pictures by freshmen	5	2.347	0.073										
(12) Decrease by words by freshmen	12	2.274											

Least significant difference values between means: *for .05 level of significance = 2.00

Table 108. Summary of the analysis of covariance between the experimental groups on the total of the grouping structure responses scored according to the single highest category cognitive level score

Source of variation	df	Sums of squares	Mean squares	F-ratio	Probability
Direction	1	853.993	853.993	18.323	0.0000*
Stimuli	1	67.880	67.880	1.456	0.2291
Class	2	209.474	104.737	2.247	0.1088
Direction by stimuli	1	49.284	49.284	1.057	0.3052
Direction by class	2	165.421	82.711	1.775	0.1727
Stimuli by class	2	194.009	97.005	2.081	0.1279
Direction by stimuli by class	2	214.030	107.015	2.296	0.1038
I.Q. (covariant)	1	0.435	0.435	0.009	0.9232
Residual	170	7923.262	46.607		
Total	182	9730.992			

*Significant beyond the .05 level.
Increase = 24.147
Decrease = 28.544

Table 109. Summary of the analysis of covariance between the experimental groups on the total number of edge matching responses scored according to the single highest category cognitive level score

Source of variation	df	Sums of squares	Mean squares	F-ratio	Probability
Direction	1	6.821	6.821	1.324	0.2534
Stimuli	1	0.435	0.435	0.084	0.7721
Class	2	3.623	1.811	0.351	0.7048
Direction by stimuli	1	3.252	3.252	0.631	0.4294
Direction by class	2	2.015	1.008	0.196	0.8228
Stimuli by class	2	13.807	6.904	1.340	0.2679
Direction by stimuli by class	2	39.992	19.996	3.880	0.0247*
I.Q. (covariant)	1	1.745	1.745	0.339	0.5623
Residual	78	401.970	5.153		
Total	90	460.681			

*Significant beyond the .05 level.

Table 110. Summary of the least significant differences between the direction by stimuli by class adjusted means on the total of the edge matching scores scored according to the single highest category cognitive level score

Direction by stimuli by class ranked by means	No. of Ss.	Ranked means	Mean differences 12	11	10	9	8	7	6	5	4	3	2
(1) Decrease by pictures by six grade	4	5.651	4.300*	3.600	2.702	2.591	2.217	2.196	2.146	1.689	1.600	1.336	0.647
(2) Increase by words by six grade	7	5.004	3.653	2.953	2.055	1.944	1.570	1.549	1.499	1.042	0.953	0.689	
(3) Increase by pictures by jr. and sr.	11	4.315	2.964	2.264	1.366	1.255	0.881	0.860	0.810	0.353	0.264		
(4) Increase by words by freshmen	16	4.051	2.700	2.000	1.102	0.991	0.617	0.596	0.546	0.089			
(5) Decrease by words by jr. and sr.	4	3.962	2.611	1.911	1.013	0.902	0.528	0.507	0.457				
(6) Increase by pictures by freshmen	16	3.505	2.154	1.454	0.556	0.445	0.071	0.050					
(7) Decrease by words by freshmen	9	3.455	2.104	1.404	0.506	0.395	0.021						
(8) Increase by pictures by six grade	7	3.434	2.083	1.383	0.485	0.374							
(9) Increase by words by jr. and sr.	7	3.060	1.709	1.009	0.111								
(10) Decrease by pictures by jr. and sr.	5	2.949	1.598	0.898									
(11) Decrease by pictures by freshmen	3	2.051	0.700										
(12) Decrease by words by six grade	2	1.351											

Least significant difference values between means: *for .05 level of significance = 2.00

Table 111. Summary of the analysis of covariance between the experimental groups on the total of the simple association attribute responses scored according to the single highest category cognitive level score

Source of variation	df	Sums of squares	Mean squares	F-ratio	Probability
Direction	1	33.677	33.677	7.054	0.0092*
Stimuli	1	0.000	0.000	0.000	0.9934
Class	2	0.702	0.351	0.073	0.9292
Direction by stimuli	1	1.017	1.017	0.213	0.6454
Direction by class	2	2.041	1.020	0.214	0.8079
Stimuli by class	2	12.896	6.448	1.351	0.2638
Direction by stimuli by class	2	42.237	21.119	4.424	0.0144*
I.Q. (covariant)	1	1.791	1.791	0.375	0.5416
Residual	100	477.405	4.774		
Total	112	559.876			

*Significant beyond the .05 level.
Increase = 3.784
Decrease = 2.598

Table 112. Summary of the least significant differences between the direction by stimuli by class adjusted means on the total of the simple association attribute scores scored according to the single highest category cognitive level score

Direction by stimuli by class ranked by means	No. of Ss.	Ranked means	Mean differences 12	11	10	9	8	7	6	5	4	3	2
(1) Increase by words by six grade	9	4.600	3.390*	3.096*	1.936	1.701	1.537	1.510	1.422	0.857	0.658	0.608	0.194
(2) Increase by pictures by jr. and sr.	11	4.406	3.196*	2.902*	1.742	1.507	1.343	1.316	1.228	0.664	0.464	0.414	
(3) Increase by words by freshmen	18	3.992	2.782*	2.488*	1.328	1.093	0.929	0.902	0.814	0.250	0.050		
(4) Decrease by pictures by six grade	7	3.942	2.732	2.438	1.278	1.043	0.879	0.852	0.764	0.200			
(5) Decrease by pictures by freshmen	16	3.742	2.532*	2.238*	1.078	0.843	0.679	0.652	0.564				
(6) Decrease by words by freshmen	12	3.178	1.968	1.674	0.514	0.279	0.115	0.088					
(7) Decrease by words by jr. and sr.	7	3.090	1.880	1.586	0.426	0.191	0.027						
(8) Increase by words by jr. and sr.	7	3.063	1.853	1.559	0.399	0.164							
(9) Increase by pictures by six grade	9	2.899	1.689	1.395	0.235								
(10) Decrease by pictures by jr. and sr.	7	2.664	1.454	1.160									
(11) Decrease by pictures by freshmen	6	1.504	0.294										
(12) Decrease by words by six grade	4	1.210											

Least significant difference values between means: *for .05 level of significance = 2.00

Table 113. Summary of the analysis of covariance between the experimental groups on the total number of perceptual attribute responses scored according to the single highest category cognitive level score

Source of variation	df	Sums of squares	Mean squares	F-ratio	Probability
Direction	1	8.221	8.221	0.486	0.4882
Stimuli	1	58.180	58.180	3.439	0.0681
Class	2	191.739	95.869	5.666	0.0054*
Direction by stimuli	1	3.095	3.095	0.183	0.6703
Direction by class	2	6.489	3.245	0.192	0.8260
Stimuli by class	2	58.224	29.112	1.721	0.1869
Direction by stimuli by class	2	4.150	2.075	0.123	0.8848
I.Q. (covariant)	1	85.985	85.985	5.082	0.0275
Residual	66	1116.683	16.919		
Total	78	1738.937			

*Significant beyond the .05 level.

Table 114. Summary of the least significant differences between the class adjusted means on the total perceptual attributes score scored according to the single highest category cognitive level score

Comparison of experimental group means	Absolute difference between means	t	Least significant difference between means	Conclusion
Six grade = 5.883 versus freshmen = 2.169	3.714	2.000	2.370	$P < 0.05$
Six grade = 5.883 versus jr. and sr. = 2.381	3.502	2.000	2.690	$P < 0.05$
Freshmen = 2.169 versus jr. and sr. = 2.381	0.212	2.000	2.496	N.S.

Table 115. Summary of the analysis of covariance between the experimental groups on the total number of perceptual location responses scored according to the single highest category cognitive level score

Source of variation	df	Sums of squares	Mean squares	F-ratio	Probability
Direction	1	0.009	0.009	0.002	0.9625
Stimuli	1	0.418	0.418	0.104	0.7485
Class	2	19.989	9.995	2.484	0.0945
Direction by stimuli	1	2.169	2.169	0.539	0.4665
Direction by class	2	8.745	4.372	1.087	0.3458
Stimuli by class	2	12.171	6.086	1.513	0.2311
Direction by stimuli by class	2	2.858	1.429	0.355	0.7029
I.Q. (covariant)	1	4.597	4.597	1.143	0.2906
Residual	46	185.064	4.023		
Total	58	235.661			

*Significant beyond the .05 level.

Table 116. Summary of the analysis of covariance between the experimental groups on the total number of functional association responses scored according to the single highest category cognitive level score

Source of variation	df	Sums of squares	Mean squares	F-ratio	Probability
Direction	1	30.512	30.512	3.085	0.0820
Stimuli	1	2.427	2.427	0.245	0.6214
Class	2	5.710	2.855	0.289	0.7499
Direction by stimuli	1	8.760	8.760	0.886	0.3489
Direction by class	2	15.766	7.883	0.797	0.4535
Stimuli by class	2	3.784	1.892	0.191	0.8262
Direction by stimuli by class	2	1.342	0.671	0.068	0.9344
I.Q. (covariant)	1	11.348	11.348	1.147	0.2866
Residual	101	998.872	9.890		
Total	113	1084.105			

*Significant beyond the .05 level.

Table 117. Summary of the analysis of covariance between the experimental groups on the total number of functional dependence (extrinsic) responses scored according to the single highest category cognitive level score

Source of variation	df	Sums of squares	Mean squares	F-ratio	Probability
Direction	1	96.872	96.872	16.737	0.0001*
Stimuli	1	0.000	0.000	0.000	0.9990
Class	2	64.428	32.214	5.566	0.0054*
Direction by stimuli	1	0.368	0.368	0.064	0.8016
Direction by class	2	1.374	0.687	0.119	0.8883
Stimuli by class	2	15.595	7.797	1.347	0.2656
Direction by stimuli by class	2	15.084	7.542	1.303	0.2772
I.Q. (covariant)	1	38.004	38.004	6.566	0.0122
Residual	83	480.391	5.788		
Total	95	686.958			

*Significant beyond the .05 level.
Increase = 2.131
Decrease = 4.277

Table 118. Summary of the least significant differences between the class adjusted means on the total functional dependence (extrinsic) score scored according to the single highest category cognitive level score

Comparison of experimental group means	Absolute difference between means	t	Least significant difference between means	Conclusion
Six grade = 3.737 versus freshmen = 2.034	1.703	2.000	1.168	$P < 0.05$
Six grade = 3.737 versus jr. and sr. = 3.841	0.104	2.000	1.506	N.S.
Freshmen = 2.034 versus jr. and sr. = 3.841	1.797	2.000	1.436	N.S.

Table 119. Summary of the analysis of covariance between the experimental groups on the total number of functional dependence (intrinsic) responses scored according to the single highest category cognitive level score

Source of variation	df	Sums of squares	Mean squares	F-ratio	Probability
Direction	1	0.272	0.272	0.121	0.7295
Stimuli	1	13.495	13.495	6.013	0.0187*
Class	2	38.195	19.097	8.509	0.0008*
Direction by stimuli	1	7.508	7.508	3.345	0.0749
Direction by class	2	1.947	0.974	0.434	0.6511
Stimuli by class	2	13.910	6.955	3.099	0.0561
Direction by stimuli by class	2	3.220	1.610	0.717	0.4942
I.Q. (covariant)	1	0.760	0.760	0.338	0.5640
Residual	40	89.774	2.244		
Total	52	176.453			

*Significant beyond the .05 level.

Table 120. Summary of the least significant differences between the class adjusted means on the total functional dependence (intrinsic) score scored according to the single highest category cognitive level score

Comparison of experimental group means	Absolute difference between means	t	Least significant difference between means	Conclusion
Six grade = 2.814 versus freshmen = 0.737	2.077	2.021	1.019	$P < 0.05$
Six grade = 2.814 versus jr. and sr. = 1.537	1.277	2.021	1.180	$P < 0.05$
Freshmen = 0.737 versus jr. and sr. = 1.537	0.800	2.021	1.146	N.S.

Table 121. Summary of the analysis of covariance between the experimental groups on the total number of functional dependence (situational) responses scored according to the single highest category cognitive level score

Source of variation	df	Sums of squares	Mean squares	F-ratio	Probability
Direction	1	9.262	9.262	0.949	0.3324
Stimuli	1	9.003	9.003	0.922	0.3392
Class	2	108.127	54.064	5.538	0.0052*
Direction by stimuli	1	0.023	0.023	0.002	0.9615
Direction by class	2	36.707	18.354	1.880	0.1578
Stimuli by class	2	19.867	9.933	1.017	0.3651
Direction by stimuli by class	2	0.915	0.457	0.047	0.9543
I.Q. (covariant)	1	9.501	9.501	0.973	0.3262
Residual	103	1005.589	9.763		
Total	115	1198.207			

*Significant beyond the .05 level.

Table 122. Summary of the least significant differences between the class adjusted means on the total functional dependence (situational) score scored according to the single highest category cognitive level score

Comparison of experimental group means	Absolute difference between means	t	Least significant difference between means	Conclusion
Six grade = 6.704 versus freshmen = 4.450	2.254	2.000	1.492	$P < 0.05$
Six grade = 6.704 versus jr. and sr. = 4.362	2.342	2.000	1.712	$P < 0.05$
Freshmen = 4.450 versus jr. and sr. = 4.362	0.088	2.000	1.604	N.S.

Table 123. Summary of the analysis of covariance between the experimental groups on total of the concrete attribute responses scored according to the single highest category cognitive level score

Source of variation	df	Sums of squares	Mean squares	F-ratio	Probability
Direction	1	0.364	0.364	0.017	0.8955
Stimuli	1	53.572	53.572	2.549	0.1122
Class	2	864.894	432.447	20.575	0.0000*
Direction by stimuli	1	6.067	6.067	0.289	0.5919
Direction by class	2	46.690	23.345	1.111	0.3315
Stimuli by class	2	1.888	0.944	0.045	0.9561
Direction by stimuli by class	2	45.523	22.761	1.083	0.3408
I.Q. (covariant)	1	82.872	82.872	3.943	0.0487
Residual	169	3552.027	21.018		
Total	181	4918.063			

*Significant beyond the .05 level.

Table 124. Summary of the least significant differences between the class adjusted means on the total concrete attributes score scored according to the single highest category cognitive level score

Comparison of experimental group means	Absolute difference between means	t	Least significant difference between means	Conclusion
Six grade = 14.128 versus freshmen = 8.970	5.158	1.960	1.633	$P < 0.05$
Six grade = 14.128 versus jr. and sr. = 9.595	4.533	1.960	1.842	$P < 0.05$
Freshmen = 8.970 versus jr. and sr. = 9.595	0.625	1.960	2.068	N.S.

Table 125. Summary of the analysis of covariance between the experimental groups on the total number of simple representational responses scored according to the single highest category cognitive level score

Source of variation	df	Sums of squares	Mean squares	F-ratio	Probability
Direction	1	151.549	151.549	7.800	0.0060*
Stimuli	1	18.407	18.407	0.947	0.3323
Class	2	4.547	2.273	0.117	0.8897
Direction by stimuli	1	5.167	5.167	0.266	0.6070
Direction by class	2	20.892	10.446	0.538	0.5855
Stimuli by class	2	29.589	14.794	0.761	0.4691
Direction by stimuli by class	2	0.033	0.017	0.001	0.9991
I.Q. (covariant)	1	3.303	3.303	0.170	0.6808
Residual	130	2525.813	19.429		
Total	142	2791.888			

*Significant beyond the .05 level.
Increase = 6.782
Decrease = 8.955

Table 126. Summary of the analysis of covariance between the experimental groups on the total number of compound representational responses scored according to the single highest category cognitive level score

Source of variation	df	Sums of squares	Mean squares	F-ratio	Probability
Direction	1	151.684	151.684	7.685	0.0069*
Stimuli	1	9.690	9.690	0.491	0.4855
Class	2	36.649	18.325	0.928	0.3993
Direction by stimuli	1	30.548	30.548	1.548	0.2170
Direction by class	2	139.000	69.500	3.521	0.0341*
Stimuli by class	2	36.403	18.202	0.922	0.4017
Direction by stimuli by class	2	112.222	56.111	2.843	0.0640
I.Q. (covariant)	1	3.793	3.793	0.192	0.6622
Residual	82	1618.405	19.737		
Total	94	2250.947			

*Significant beyond the .05 level.
Increase = 5.416
Decrease = 8.298

Table 127. Summary of the least significant differences between the direction by class adjusted means on the total compound representational score scored according to the single highest category cognitive level score

Comparison of experimental group means	Absolute difference between means	t	Least significant difference between means	Conclusion
Increase by six grade = 4.469 versus Increase by freshmen = 4.840	0.371	2.000	6.672	N.S.
Increase by six grade = 4.469 versus Increase by jr. and sr. = 6.937	2.468	2.000	4.548	N.S.
Increase by six grade = 4.469 versus Decrease by six grade = 7.320	2.851	2.000	4.600	N.S.
Increase by six grade = 4.469 versus Decrease by freshmen = 10.506	6.037	2.000	4.270	$P < 0.05$
Increase by six grade = 4.469 versus Decrease by jr. and sr. = 7.067	2.598	2.000	4.616	N.S.
Increase by freshmen = 4.840 versus Increase by jr. and sr. = 6.937	2.097	2.000	3.014	N.S.
Increase by freshmen = 4.890 versus Decrease by six grade = 7.320	2.480	2.000	3.652	N.S.
Increase by freshmen = 4.840 versus Decrease by freshmen = 10.506	5.666	2.000	2.696	$P < 0.05$
Increase by freshmen = 4.840 versus Decrease by jr. and sr. = 7.067	2.227	2.000	3.116	N.S.
Increase by jr. and sr. = 6.937 versus Decrease by six grade = 7.320	0.383	2.000	4.072	N.S.
Increase by jr. and sr. = 6.937 versus Decrease by freshmen = 10.506	3.569	2.000	3.090	$P < 0.05$
Increase by jr. and sr. = 6.937 versus Decrease by jr. and sr. = 7.067	0.130	2.000	3.178	N.S.
Decrease by six grade = 7.320 versus Decrease by freshmen = 10.506	3.186	2.000	3.216	N.S.
Decrease by six grade = 7.320 versus Decrease by jr. and sr. = 7.067	0.253	2.000	3.532	N.S.
Decrease by freshmen = 10.506 versus Decrease by jr. and sr. = 7.067	3.439	2.000	3.066	$P < 0.05$

Table 128. Summary of the analysis of covariance between the experimental groups on the total number of symbolic responses scored according to the single highest category cognitive level score

Source of variation	df	Sums of squares	Mean squares	F-ratio	Probability
Direction	1	8.275	8.275	0.582	0.4510
Stimuli	1	44.217	44.217	3.109	0.0871
Class	2	2.883	1.441	0.101	0.9039
Direction by stimuli	1	2.031	2.031	0.143	0.7080
Direction by class	2	32.268	16.134	1.134	0.3339
Stimuli by class	2	9.846	4.923	0.346	0.7100
Direction by stimuli by class	2	40.116	20.058	1.410	0.2584
I.Q. (covariant)	1	0.158	0.158	0.011	0.9168
Residual	33	469.384	14.224		
Total	45	565.239			

*Significant beyond the .05 level.

Table 129. Summary of the analysis of covariance between the experimental groups on the total number of affective representational (simple) responses scored according to the single highest category cognitive level score

Source of variation	df	Sums of squares	Mean squares	F-ratio	Probability
Direction	1	0.000	0.000	0.000	0.9965
Stimuli	1	12.136	12.136	1.658	0.2243
Class	2	0.865	0.433	0.059	0.9429
Direction by stimuli	1	0.003	0.003	0.000	0.9848
Direction by class	2	1.753	0.877	0.120	0.8883
Stimuli by class	2	4.566	2.283	0.312	0.7384
Direction by stimuli by class	2	12.683	6.342	0.866	0.4474
I.Q. (covariant)	1	0.166	0.166	0.023	0.8829
Residual	11	80.534	7.321		
Total	23	120.000			

*Significant beyond the .05 level.

Table 130. Summary of the analysis of covariance between the experimental groups on the total of the representational attribute responses scored according to the single highest category cognitive level score

Source of variation	df	Sums of squares	Mean squares	F-ratio	Probability
Direction	1	727.292	727.292	11.282	0.0010*
Stimuli	1	111.690	111.690	1.733	0.1899
Class	2	777.151	388.575	6.028	0.0030*
Direction by stimuli	1	5.498	5.498	0.085	0.7707
Direction by class	2	494.866	247.433	3.838	0.0235*
Stimuli by class	2	122.116	61.058	0.947	0.3901
Direction by stimuli by class	2	225.027	112.514	1.745	0.1779
I.Q. (covariant)	1	58.400	58.400	0.906	0.3428
Residual	159	10249.535	64.462		
Total	171	13120.898			

*Significant beyond the .05 level.
Increase = 12.174
Decrease = 16.393

Table 131. Summary of the least significant differences between the class adjusted means on the total representational attributes score scored according to the single highest category cognitive level score

Comparison of experimental group means		Absolute difference between means	t	Least significant difference between means	Conclusion
Six grade versus freshmen	= 10.983 = 16.033	5.050	1.960	2.985	$P < 0.05$
Six grade versus jr. and sr.	= 10.983 = 15.835	4.852	1.960	3.553	$P < 0.05$
Freshmen versus jr. and sr.	= 16.033 = 15.835	0.198	1.960	3.109	N.S.

Table 132. Summary of the least significant differences between the direction by class adjusted means on the total representational attributes score scored according to the single highest category cognitive level score

Comparison of experimental group means		Absolute difference between means	t	Least significant difference between means	Conclusion
Increase by six grade versus Increase by freshmen	= 9.380 = 11.709	2.329	1.960	4.222	N.S.
Increase by six grade versus Increase by jr. and sr.	= 9.380 = 15.432	6.052	1.960	5.025	$P < 0.05$
Increase by six grade versus Decrease by six grade	= 9.380 = 12.585	3.205	1.960	4.561	N.S.
Increase by six grade versus Decrease by freshmen	= 9.380 = 20.357	10.977	1.960	4.222	$P < 0.05$
Increase by six grade versus Decrease by jr. and sr.	= 9.380 = 16.237	6.857	1.960	4.722	N.S.
Increase by freshmen versus Increase by jr. and sr.	= 11.709 = 15.432	3.723	1.960	4.394	N.S.
Increase by freshmen versus Decrease by six grade	= 11.709 = 12.585	0.876	1.960	4.040	N.S.
Increase by freshmen versus Decrease by freshmen	= 11.709 = 20.357	8.648	1.960	3.589	$P < 0.05$
Increase by freshmen versus Decrease by jr. and sr.	= 11.709 = 16.237	4.528	1.960	4.163	$P < 0.05$
Increase by jr. and sr. versus Decrease by six grade	= 15.432 = 12.585	2.847	1.960	4.826	N.S.
Increase by jr. and sr. versus Decrease by freshmen	= 15.432 = 20.357	4.925	1.960	4.281	$P < 0.05$
Increase by jr. and sr. versus Decrease by jr. and sr.	= 15.432 = 16.237	0.805	1.960	4.669	N.S.
Decrease by six grade versus Decrease by freshmen	= 12.585 = 20.357	7.772	1.960	4.104	$P < 0.05$
Decrease by six grade versus Decrease by jr. and sr.	= 12.585 = 16.237	3.652	1.960	4.616	N.S.
Decrease by freshmen versus Decrease by jr. and sr.	= 20.357 = 16.237	4.120	1.960	4.281	N.S.

Table 133. Summary of the analysis of covariance between the experimental groups on the total of the attribute responses scored according to the single highest category cognitive level score

Source of variation	df	Sums of squares	Mean squares	F-ratio	Probability
Direction	1	355.718	355.718	16.675	0.0001*
Stimuli	1	7.092	7.096	0.333	0.5648
Class	2	116.224	58.112	2.724	0.0685
Direction by stimuli	1	0.057	0.057	0.003	0.9589
Direction by class	2	80.816	40.408	1.894	0.1536
Stimuli by class	2	79.585	39.793	1.865	0.1580
Direction by stimuli by class	2	142.099	71.050	3.331	0.0381*
I.Q. (covariant)	1	1.691	1.691	0.079	0.7786
Residual	170	3626.577	21.333		
Total	182	4442.926			

*Significant beyond the .05 level.
Increase = 24.898
Decrease = 27.736

Table 134. Summary of the least significant differences between the direction by stimuli bv class adjusted means on the total attributes score scored according to the single highest category cognitive level score

Direction by stimuli by class ranked by means	No. of Ss.	Ranked means	Mean differences										
			12	11	10	9	8	7	6	5	4	3	2
(1) Decrease by pictures by freshmen	16	31.132	8.236*	6.577*	6.445*	6.188*	6.126*	5.410*	4.549*	4.310*	3.839*	3.511*	2.591
(2) Decrease by pictures by jr. and sr.	12	28.541	5.645*	3.984*	3.854*	3.597	3.535	2.819	1.958	1.719	1.248	0.920	
(3) Decrease by pictures by jr. and sr.	12	27.621	4.725*	3.064	2.934	2.677	2.615	1.899	1.038	0.799	0.328		
(4) Decrease by words by freshmen	20	27.293	4.397*	2.736	2.606	2.349	2.287	1.571	0.710	0.471			
(5) Decrease by words by six grade	15	26.822	3.926*	2.265	2.135	1.878	1.816	1.100	0.239				
(6) Increase by words by jr. and sr.	12	26.583	3.687*	2.026	1.896	1.639	1.577	0.861					
(7) Increase by pictures by six grade	15	25.722	2.826	1.165	1.035	0.778	0.716						
(8) Decrease by pictures by six grade	14	25.006	2.110	0.449	0.319	0.062							
(9) Increase by pictures by jr. and sr.	14	24.944	2.048	0.387	0.257								
(10) Increase by pictures by freshmen	18	24.687	1.791	0.130									
(11) Increase by words by freshmen	21	24.557	1.661										
(12) Increase by words by six grade	14	22.896											

Least significant difference values between means: *for .05 level of significance = 1.96

Table 135. Summary of the analysis of covariance between the experimental groups on the total number of partial use of stimuli responses scored according to the single highest category cognitive level score

Source of variation	df	Sums of squares	Mean squares	F-ratio	Probability
Direction	1	0.032	0.032	0.009	0.9261
Stimuli	1	9.157	9.157	2.491	0.1197
Class	2	43.264	21.632	5.885	0.0046*
Direction by stimuli	1	0.045	0.045	0.012	0.9122
Direction by class	2	1.670	0.835	0.227	0.7975
Stimuli by class	2	4.867	2.433	0.662	0.5196
Direction by stimuli by class	2	1.783	0.892	0.243	0.7854
I.Q. (covariant)	1	25.361	25.361	6.899	0.0109
Residual	60	220.564	3.676		
Total	72	351.315			

*Significant beyond the .05 level.

Table 136. Summary of the least significant differences between the class adjusted means on the total partial use of stimuli score scored according to the single highest category cognitive level score

Comparison of experimental group means	Absolute difference between means	t	Least significant difference between means	Conclusion
Six grade = 2.747 versus freshmen = 0.829	1.918	2.000	1.132	$P < 0.05$
Six grade = 2.747 versus jr. and sr. = 1.394	1.353	2.000	1.382	N.S.
Freshmen = 0.829 versus jr. and sr. = 1.394	0.565	2.000	1.300	N.S.

Table 137. Summary of the analysis of covariance between the experimental groups on the total number of exceptional responses scored according to the single highest category cognitive level score

Source of variation	df	Sums of squares	Mean squares	F-ratio	Probability
Direction	1	14.782	14.782	0.255	0.6146
Stimuli	1	0.494	0.494	0.009	0.9267
Class	2	243.215	121.607	2.095	0.1267
Direction by stimuli	1	93.371	93.371	1.609	0.2066
Direction by class	2	416.591	208.295	3.589	0.0301*
Stimuli by class	2	120.150	60.075	1.035	0.3577
Direction by stimuli by class	2	130.080	65.040	1.121	0.3288
I.Q. (covariant)	1	71.727	71.727	1.236	0.2680
Residual	145	8415.105	58.035		
Total	157	9596.832			

*Significant beyond the .05 level.

Table 138. Summary of the least significant differences between the direction by class adjusted means on the total exceptional response score scored according to the single highest category cognitive level score

Comparison of experimental group means		Absolute difference between means	t	Least significant difference between means	Conclusion
Increase by six grade versus Increase by freshmen	= 13.100 = 11.963	1.137	1.960	4.224	N.S.
Increase by six grade versus Increase by jr. and sr.	= 13.100 = 13.392	0.292	1.960	4.579	N.S.
Increase by six grade versus Decrease by six grade	= 13.100 = 9.257	3.843	1.960	4.908	N.S.
Increase by six grade versus Decrease by freshmen	= 13.100 = 16.406	3.306	1.960	4.224	N.S.
Increase by six grade versus Decrease by jr. and sr.	= 13.100 = 14.727	1.627	1.960	4.769	N.S.
Increase by freshmen versus Increase by jr. and sr.	= 11.963 = 13.392	1.429	1.960	3.949	N.S.
Increase by freshmen versus Decrease by six grade	= 11.963 = 9.257	2.706	1.960	4.224	N.S.
Increase by freshmen versus Decrease by freshmen	= 11.963 = 16.406	4.443	1.960	3.657	$P<0.05$
Increase by freshmen versus Decrease by jr. and sr.	= 11.963 = 14.727	2.764	1.960	4.061	N.S.
Increase by jr. and sr. versus Decrease by six grade	= 13.392 = 9.257	4.135	1.960	4.675	N.S.
Increase by jr. and sr. versus Decrease by freshmen	= 13.392 = 16.406	3.014	1.960	4.116	N.S.
Increase by jr. and sr. versus Decrease by jr. and sr.	= 13.392 = 14.727	1.335	1.960	4.328	N.S.
Decrease by six grade versus Decrease by freshmen	= 9.257 = 16.406	7.149	1.960	4.430	$P<0.05$
Decrease by six grade versus Decrease by jr. and sr.	= 9.257 = 14.727	5.470	1.960	4.861	$P<0.05$
Decrease by freshmen versus Decrease by jr. and sr.	= 16.406 = 14.727	1.679	1.960	4.277	N.S.

Table 139. Summary of the analysis of covariance between the experimental groups on the total number of regular responses scored according to the single highest category cognitive level score

Source of variation	df	Sums of squares	Mean squares	F-ratio	Probability
Direction	1	13.144	13.144	0.399	0.5286
Stimuli	1	0.079	0.079	0.002	0.9611
Class	2	50.185	25.092	0.761	0.4687
Direction by stimuli	1	0.000	0.000	0.000	0.9996
Direction by class	2	169.390	84.695	2.569	0.0796
Stimuli by class	2	54.981	27.490	0.834	0.4362
Direction by stimuli by class	2	5.338	2.669	0.081	0.9223
I.Q. (covariant)	1	8.191	8.191	0.248	0.6188
Residual	170	5604.926	32.970		
Total	182	5916.754			

*Significant beyond the .05 level.

Table 140. Summary of the analysis of covariance between the experimental groups on the total of the supplementary aspects responses scored according to the single highest category cognitive level score

Source of variation	df	Sums of squares	Mean squares	F-ratio	Probability
Direction	1	16.689	16.689	0.617	0.4333
Stimuli	1	27.701	27.701	1.024	0.3130
Class	2	419.075	209.537	7.744	0.0006*
Direction by stimuli	1	14.835	14.835	0.548	0.4600
Direction by class	2	81.853	40.926	1.513	0.2232
Stimuli by class	2	20.124	10.062	0.372	0.6900
Direction by stimuli by class	2	21.369	10.685	0.395	0.6744
I.Q. (covariant)	1	368.922	368.922	13.635	0.0003
Residual	171	4626.797	27.057		
Total	183	5929.910			

*Significant beyond the .05 level.

Table 141. Summary of the least significant differences between the class adjusted means on the total supplementary aspects score scored according to the single highest category cognitive level score

Comparison of experimental group means	Absolute difference between means	t	Least significant difference between means	Conclusion
Six grade = 23.213 versus freshmen = 26.777	3.564	1.960	1.795	$P < 0.05$
Six grade = 23.213 versus jr. and sr. = 26.269	3.056	1.960	2.187	$P < 0.05$
Freshmen = 26.777 versus jr. and sr. = 26.269	0.508	1.960	1.960	N.S.

Table 142. Summary of the analysis of covariance between the experimental groups on the total number of specific responses scored according to the single highest category cognitive level score

Source of variation	df	Sums of squares	Mean squares	F-ratio	Probability
Direction	1	159.625	159.625	19.923	0.0000*
Stimuli	1	6.222	6.222	0.777	0.3798
Class	2	19.492	9.746	1.216	0.2988
Direction by stimuli	1	1.317	1.317	0.164	0.6858
Direction by class	2	1.650	0.825	0.103	0.9023
Stimuli by class	2	31.440	15.720	1.962	0.1437
Direction by stimuli by class	2	8.337	4.169	0.520	0.5954
I.Q. (covariant)	1	8.621	8.621	1.076	0.3009
Residual	169	1354.063	8.012		
Total	181	1614.423			

*Significant beyond the .05 level.
Increase = 9.306
Decrease = 7.396

Table 143. Summary of the analysis of covariance between the experimental groups on the total number of middle level of specificity responses scored according to the single highest category cognitive level score

Source of variation	df	Sums of squares	Mean squares	F-ratio	Probability
Direction	1	346.158	346.157	19.332	0.0000*
Stimuli	1	1.069	1.069	0.060	0.8074
Class	2	122.178	61.089	3.412	0.0359*
Direction by stimuli	1	43.977	43.977	2.456	0.1194
Direction by class	2	17.046	8.523	0.476	0.6223
Stimuli by class	2	39.951	19.975	1.116	0.3307
Direction by stimuli by class	2	27.911	13.955	0.779	0.4607
I.Q. (covariant)	1	0.301	0.301	0.017	0.8971
Residual	135	2417.300	17.906		
Total	147	3058.973			

*Significant beyond the .05 level.
Increase = 5.951
Decrease = 9.097

Table 144. Summary of the least significant differences between the class adjusted means on the total middle level of specificity score scored according to the single highest category cognitive level score

Comparison of experimental group means	Absolute difference between means	t	Least significant difference between means	Conclusion
Six grade = 8.971 versus freshmen = 6.992	1.979	1.960	1.111	$P < 0.05$
Six grade = 8.971 versus jr. and sr. = 6.610	2.361	1.960	1.980	$P < 0.05$
Freshmen = 6.992 versus jr. and sr. = 6.610	0.382	1.960	1.760	N.S.

Table 145. Summary of the analysis of covariance between the experimental groups on the total of the level of specificity responses scored according to the single highest category cognitive level score

Source of variation	df	Sums of squares	Mean squares	F-ratio	Probability
Direction	1	54.686	54.686	4.505	0.0352*
Stimuli	1	0.481	0.481	0.040	0.8425
Class	2	52.010	26.005	2.142	0.1205
Direction by stimuli	1	13.070	13.070	1.077	0.3007
Direction by class	2	14.057	7.028	0.579	0.5617
Stimuli by class	2	29.659	14.829	1.222	0.2972
Direction by stimuli by class	2	1.306	0.653	0.054	0.9477
I.Q. (covariant)	1	11.710	11.710	0.965	0.3278
Residual	169	2051.527	12.139		
Total	181	2273.192			

*Significant beyond the .05 level.
Increase = 14.848
Decrease = 15.966

VITA

Christopher A. Joseph

Candidate for the Degree of

Doctor of Philosophy in Psychology

Dissertation: The Effects of Direction of Grouping, Type of Stimuli, and Class Level, on Cognitive Equivalence Transformations

Major Field: Experimental Psychology

Biographical Information:

Personal Data: Born at Owen Sound, Ontario, Canada, December 1, 1941, son of Thomas A. and Freda Joseph; married Carolyn Rae Colaw May 22, 1970.

Education: Attended elementary and high schools in Canada. Received Bachelor of Arts degree from Ohio State University with a major in psychology, in 1965; completed requirements for Master of Science degree, specializing in psychology, at Kansas State Teachers College in 1970.

Professional Experience: 1966 to 1968, prison psychologist, London, Ohio; 1969 to 1970 graduate teaching assistant, Kansas State Teachers College, Emporia, Kansas. January 1970 to September 1970 Lecturer in Psychology, Kansas State Teachers College; 1971 to 1973 Assistant Professor of Psychology, Kansas State Teachers College.