A STUDY OF THE ABILITY OF PRIMARY AND ELEMENTARY SCHOOL CHILDREN TO GENERALIZE SELECTED SCIENCE CONCEPTS

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A STUDY OF THE ABILITY OF PRIMARY AND ELEMENTARY SCHOOL CHILDREN TO GENERALIZE SELECTED SCIENCE CONCEPTS

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ABSTRACT

The study investigated the ability of primary and elementary school subjects to generalize two science concepts, <u>Insect</u> and <u>Animal</u> with and without instruction in the form of a mental set. It also examined the effects of age, IQ and sex on the ability of the children to generalize these concepts. Two instruments measuring the ability to generalize the concepts <u>Insect</u> and <u>Animal</u> were developed. Each instrument contained three sets of instances, each set displaying a progressively reduced number of attributes of the concept under study. The total number of instances from which a subject could generalize a given concept was taken as an index of his ability to generalize. The scores of the ability to generalize were analysed using multiple regression analysis.

The results indicate that of the independent variables investigated, only age and mental set significantly affected the ability to generalize the concepts <u>Insect</u> and <u>Animal</u>. It was found that the younger children's concepts were least developed and with age these concepts became more developed and more conceptual in nature. The ability to use information given in a mental set was found to be a function of age. The children in this study were more able to generalize the concept <u>Insect</u> than the concept <u>Animal</u>. This was because the concept <u>Insect</u> contained

instances more perceptually homogenous in nature than that of the concept Animal, whose instances were more perceptually diverse and therefore afforded a greater difficulty to the children to generalize.

The children's concepts of Insect and Animal were both undergeneralized and overgeneralized. The kindergarten children undergeneralized the concept Insect more than the older children by not including peripheral instances of the concept. These younger children were not able to benefit from a mental set. The result being that their concept of Insect was undergeneralized to the same extent with or without a mental set. The control group of subjects in each grade overgeneralized the concept Insect to the same extent by including non-instances perceptually similar in general appearance to instances of the concept. Only the older children (11-12 years) were able to benefit from the mental set. This suggests that the younger children were more perceptually bound than the older children.

In the control group the younger kindergarten subjects included more non-insect animals as instances of the concept Insect than the older children. No subject was able to benefit from a mental set for the concept Insect. As a result, the younger children's concept of Insect was more overgeneralized than that of the older children suggesting that the older children had a better notion of the criterial attributes of insects than the younger children.

The concept Animal was undergeneralized to a small extent by the control group of subjects in each grade, by not including peripheral instances of the concept. Only the older children benefitted from a mental set. It was found that the subjects in this study had some idea of the characteristics of animals as none selected a plant or an inanimate object as instances of the concept. In the control group, the kindergarten and grade three subjects' concept of Animal was overgeneralized more than that of the fifth grade subjects. The fifth grade subjects rarely selected non-instances perceptually similar in general appearance to instances of the concept Animal. Unlike the younger kindergarten children, the older grade three subjects were able to make use of the information given in the mental set and thus overgeneralized to a lesser extent. It was suggested that the younger children's concept of Animal was more overgeneralized as they were more perceptually bound than the older children.

The results suggest that children are better able to master less general concepts than more general ones. As such it was suggested that curricular materials especially in the sciences should be sequenced from the simple to the more complex. In addition, the study demonstrated that children are able to improve their learning of general concepts provided a great number and variety of instances and non-instances of the concept are used in instruction.

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CHAPTER I

INTRODUCTION

In recent years, a great deal of attention has been focused on the development of concepts in children. Investigations have been directed in this area in hopes of gaining a better understanding of the cognitive processes children use in their interactions with the environment. In part, a knowledge of this interaction would provide a more in-depth understanding of the nature of children's concepts and the meanings to which they subscribe.

It has been reported that children are unable to form generalizations and attain 'true' concepts until the age of about 12 years (Vygotsky, 1962). What they are capable of forming are complexes or preconcepts. A word for the child does not function as the carrier of a concept, as in the case of an adult, but as a 'family name' for groups of concrete objects which belong together factually (Vygotsky, 1962). Word meanings as perceived by the child refer to the same objects the adult has in mind, which ensures understanding between child and adult, but the child thinks the same thing in a different way, by means of different mental operations (Vygotsky, 1962). Thus, for an adult, the word mammal brings to mind not only the referents or extension of the concept label (Anglin, 1977), such as, dog, cat, horse, tiger and the like, but also the properties or intention of the concept label 'mammal' (Anglin, 1977), such as, that it lives, breathes, digests, is capable of spontaneous motion and the like. Furthermore, if an object is recognized as a mammal, the adult is able to generalize that it possess a furry body, milk glands, viviparity and a four-chambered heart. The adult's concepts are thus formed through a process of abstraction, discrimination and generalization (Ausubel, 1965). However, the child forms complexes which are associations of concrete objects. The child is unable to render unequal treatment to the attributes of an object; objects enter a complex in toto with all their attributes (Vygotsky, 1962). The adult on the other hand discriminates salient category attributes in forming concepts. Vygotsky refers to the child's concepts as primitive generalizations and that of adults as generalizations of a higher level; generalization being defined here as the treatment of perceptually discriminable objects and events, sharing some specific properties, as equivalent.

Since the child's complexes ultimately develop into the concepts of adults, the ability to form generalizations is presumed to increase with age. Moreover, the ability to generalize is considered to be the most important aspect of categorization (Bruner et al., 1956) and concept development (Ausubel, 1965). Vygotsky (1962) equates word meanings with concepts and equates concepts with generalizations. Since word meanings 'evolve' with the child's development this implies that semantic development proceeds through a process of increasing generalizations.

Furthermore, the ability to generalize enables the child to form superordinate concepts (Vygotsky, 1962) which being more inclusive in nature subsume a hierarchy of related concepts and allow the child to simplify his environment, thus reducing the necessity of constant learning. In addition, to generalize is to be able to 'go beyond' the information given. If one is shown a thing having two legs and a beak, one can infer or generalize that the object is very likely to be a bird. One could further generalize that the object should possess feathers, lay eggs, be able to fly and build a nest. This ability to generalize thus plays a very important role in the cognition of children. However, few studies have explored this dimension of thought in children.

Thomson (1941) has shown that the generalizing ability of older children (grades 4-6) is significantly higher than that of younger children (grades 1-3). Younger children were less able than older children to infer the basis of grouping of sets of perceptually dissimilar objects. Results from Neimark's (1974) study of categorization of pictures according to four natural concepts suggests that there is no difference in the generalizing ability of younger (grade 2) children and older (grade 6) children for some concepts. Studies have shown that the younger children's concepts are overgeneralized (Gibson & Gibson, 1955; Clark, 1973) while other studies suggest that the older children's concepts are overgeneralized (Saltz, Soller & Sigel, 1972). A recent study by Anglin (1977) indicates that the younger children's concepts are both overgeneralized and undergeneralized.

In view of the inconsistencies of previous research findings and the paucity of research in this field, it is clear that more studies are needed in this area before any decision can be made regarding the ability of children to generalize concepts. Knowledge of the extent to which children are able to generalize concepts could very well influence the kinds of concepts children can be taught as well as how they should be taught. Clearly, if the young child is unable to generalize and attain concepts as advocated by Vygotsky (1962) and others, then the present curriculum in the elementary schools which is based on the teaching of general concepts may have to be reappraised.

The purpose of this study is to determine the extent to which children are able to generalize selected science concepts with and without instruction in the form of a mental set. In addition it will examine the nature of the concepts children use with and without instruction. This information has the potential of providing greater insight into the cognitive functioning of children and thus enabling educators to plan instruction and prepare curricular materials more appropriate to the cognitive capabilities of children.

STATEMENT OF THE PROBLEM

This is an experimental study which will determine the ability of children of three different age groups to generalize two science concepts. The experimental or treatment group will receive instruction in the form of a mental set. The control group will receive no instruction. The two science concepts are Insect and Animal. In addition, the nature of these concepts used by the children with and without instruction will be examined. The following research questions will be addressed:

1. What is the effect of age, IQ, sex and mental set on the ability of children to generalize the concepts Insect and Animal?
2. Which of the two concepts Insect or Animal is more generalizable within the limitations of this study?
3. What is the nature of the concepts Insect and Animal as used by the children?

The instrument developed and employed as part of this study affords a unique and novel approach to investigate these questions. Specifically, the child will be confronted with three sets of colored pictures of representations of a concept (either Insect or Animal) at three degrees of increasing stimulus complexity.* The child's ability to infer the given concept from instances of each of these three degrees of complexity will be investigated under two conditions: a) without being given a prior mental set for the task, and b) being given a mental set for the task.

The three degrees of complexity mentioned above have been defined on the basis of the relative number of criterial attributes available and the immediacy of these attributes to the concept. Thus, pictures of complete representations of instances of a concept would be representative of the First Degree of Complexity. Pictures of a cat or a horse would fall in this category as examples of the concept Animal. These pictures display the most number of criterial attributes and are of the greatest immediacy to the concept Animal. Pictures of incomplete representations of instances of a concept would be representative of the Second Degree of Complexity. A fish's tail or the beak of a bird would be examples of incomplete representations of the concept Animal. These representations

*Stimulus complexity will be referred to as just complexity, complexity being defined as a reduction in the salient number of criterial attributes available to the sense perception.

present a relatively lesser number of criterial attributes and can be considered to be of lesser immediacy to the concept to be attained. The child in this case has to infer the concept Bird from the picture of a beak and then generalize from there to the concept Animal.

The Third Degree of Complexity was taken to be represented by a product of either an animal or an insect's natural activity. Pictures of a bird's nest or a bee's hive would be examples of this category, for the concept Animal. The picture of a nest does not present the physical presence of a bird but implies the criterial attributes of 'birdness'. It also can be considered to have the least immediacy while still related to the concept Animal. Such pictures were presumed to be the most difficult for the child to recognize and utilize as cues to infer the concept Animal. In this case the child must first infer the concept of 'birdness' which was only tacitly implied by the presence of a nest and then generalize to the concept Animal. For the purpose of this study, the concept Animal is considered to include all things which are living or which were once living that are not plants and all parts of the bodies of such things as well as the products of their natural activities. Thus, included in the concept Animal would be things like a cat, a bird, a spider or parts of an animal's body, for example, a beak, a frog's hind limb, an alligator's trunk and tail as well as products of the natural activities of animals, such as a spider's web, a bird's nest, a bird's eggs, the moulted skin of a reptile or insect and a beaver's dam. The concept Insect will be considered to include all things which are living or were once living, that are not plants whose bodies consist of three parts and which possess three pairs of legs, as well as all parts of their bodies and the products of their natural activities. This would include such things as a house-fly, a dragon-fly, a bee, a butterfly and a beetle. It would also include an insect's wing or legs or part of its abdomen as well as an insect's nest such as a bee's hive or a hornet's nest or an ant's hill.

DEFINITION OF TERMS

The following definitions will serve to point out the context in which a number of otherwise common terms will be used throughout this study.

Concept — In this study a concept is defined as all the knowledge an individual possesses about a category of objects or events. The knowledge includes both information about what objects or events are instances of the concept, that is, knowledge of its extension and also information about the properties which can be predicted of the instances of that concept, that is, knowledge of its intention' (Anglin, 1977, p. 4).

<u>Abstraction</u> This term is considered here as 'a cognitive process of discriminating specific attributes from the environment that can be combined to form generalized representations of experience' (Lowell, 1974, p. 3).

<u>Concept formation</u> This term will refer to the identification of important relationships of objects or events which will enable one to group these into categories.

<u>Concept attainment</u> This term will be used to refer to 'the process of finding predictive defining attributes that distinguish exemplars from non-exemplars of the class one seeks to discriminate' (Bruner, 1956, p. 22).

<u>Overgeneralization</u> This is defined as the inclusion of a non-exemplar as an instance of a concept.

<u>Undergeneralization</u>	This is defined as the non-inclusion of an exemplar as an instance of a concept.
<u>Production paradigm</u>	This is the condition where the subject is given a concept and is asked to spontaneously produce instances and properties of the given concept from memory.
<u>Comprehension paradigm</u>	This is the condition whereby on being presented with a finite, predetermined group of category instances, the subject is asked to identify concept members or common attributes.
<u>Natural concepts</u>	These are concepts of classes of objects denoted by terms of reference and are part of a system of hierarchically related concepts. They have both perceptual and functional attributes, e.g., animal, mammal, dog, cat.
<u>Artificial concepts</u>	These concepts are well defined by

their perceptual attributes. They frequently have no functional attributes and are not a part of a system of hierarchically related concepts, e.g., Two black dots or A triangle with one dot.

Spontaneous concepts	These are the ideas developed by children through their own mental efforts. In operating with spontaneous concepts the child is not conscious of them because his attention is always centered on the object to which the concept refers, never on the act of thought itself (Vygotsky, 1962).
Scientific concepts	These are concepts attained by children which are decisively influenced by adults as during instruction in school. Such concepts have a certain position and level of generality and as such form a system of hierarchically related concepts, for example, Animal, bird, pigeon.

Independent Variables

<u>Age</u> This is defined as the number of years and months since the subject's birth.

<u>IQ</u> The IQ of a subject will be determined from the subject's score on Form I of the Quick Test.

<u>Sex</u> Sex will be defined as being male or female.

<u>Mental set</u> This will be a form of instruction limited to the presentation of positive and negative instances of a concept together with verbal cues indicating these as such.

Dependent Variables

<u>Ability to generalize</u> The total score obtained by summing the number of instances selected by a subject of each of the three degrees of complexity of a given concept will be taken as an index of his ability to generalize that concept. The higher the total score the greater the ability to generalize.

HYPOTHESES

The four questions asked in Chapter One together with a review of the related literature on concept attainment suggest the following null hypotheses.

1. Age will have no effect on the ability of children to generalize the concept <u>Insect</u>.
2. Age will have no effect on the ability of children to generalize the concept <u>Animal</u>.
3. IQ will have no effect on the ability of children to generalize the concept <u>Insect</u>.
4. IQ will have no effect on the ability of children to generalize the concept <u>Animal</u>.
5. Sex will have no effect on the ability of children to generalize the concept <u>Insect</u>.
6. Sex will have no effect on the ability of children to generalize the concept <u>Animal</u>.
7. Mental set will have no effect on the ability of children to generalize the concept <u>Insect</u>.
8. Mental set will have no effect on the ability of children to generalize the concept <u>Animal</u>.
9. There will be no difference in the ability of children to generalize the concept <u>Insect</u> and the concept <u>Animal</u>.

LIMITATIONS OF THE STUDY

This study is concerned with one aspect of cognition in children, specifically to determine the nature of two science concepts held by three different groups of children and the extent to which they could generalize these concepts. The limitations of this study are as follows:

1. This study examines only two concepts that are used by children.
2. Only children in kindergarten, grade three and grade five in one school were tested.
3. The concept of degrees of stimulus complexity is based on the notion of reduction in the relative number of criterial attributes and immediacy of the instances of the concepts under study. Hence the second and third degrees of stimulus complexity are not quantitative in nature. This is because no control over the number of criterial attributes presented to the subjects was attempted.
4. The number of instances and non-instances used for the concept Insect is less than that used for the concept Animal. This discrepancy may have resulted in a greater variability of error scores for the concept Animal than for the concept Insect.

SIGNIFICANCE OF THE STUDY

In learning, the child builds and attains new concepts and skills upon those he has already mastered. Hence, curricular activities must be sequential and be based on a meaningful continuity of learning experiences. Violation of this rule is bound to leave gaps in the child's understanding, and may adversely affect his later progress. What often passes for learning may be sheer rote verbalism without comprehension; in no subject is this more common than science. Therefore, instruction must begin at the stage where the child is capable of understanding and utilizing the basic concepts of the discipline. The nature of this stage should be determined on the basis of sound empirical evidence.

A number of studies have attempted to determine the nature of the child's natural language concepts. These studies have included the study of science concepts like Dog, Animal, Insect, Flower, Fruit, Food, and Vegetable through categorizing experiments involving a sorting technique (Anglin, 1977; Neimark, 1974; Saltz et al., 1972) or free recall (Nelson, 1974a). Nonetheless few of these studies have attempted to determine the extent to which children are able to generalize concepts with some form of instruction. Since the ability to generalize is crucial to the attainment of concepts (Vygotsky, 1962), it is difficult to see how an adequate understanding of cognition can be achieved unless studies in this field are furthered. The present study was an attempt to determine the nature of concepts held by children and the extent to which they were able to generalize these concepts with and without instruction. This study was therefore an attempt to obtain a better understanding of the child's capabilities and limitations in the area of generalization. A knowledge of the nature of concepts and the extent to which children can generalize them with and without instruction will not only facilitate a better understanding of the child's cognition, it will also aid in the development of curricular materials and instruction more appropriate to the child's cognitive ability.

CHAPTER II

REVIEW OF THE LITERATURE

A review of the literature reveals few studies that attempt to determine the nature of concepts children use and the ability with which they can generalize these concepts. Very few have attempted to determine the effect of instruction on the nature of children's concepts nor its effect on the ability to generalize. A majority of the earlier studies deal with the attainment of artificial concepts while more of the recent studies deal with the attainment of natural concepts. A large number of studies on the development of natural concepts in children have resorted to the use of sorting techniques where children categorize pictures of objects according to some conceptual label. These studies were very helpful in providing the groundwork for the development of the instruments used in this study.

The studies reviewed here can be considered under one of two general categories. The first category contains studies that deal with the nature of the concepts children use in their daily lives. The second category involves studies concerned with the ability of children to generalize concepts and the effects of age, IQ, sex, instruction and stimulus complexity on this ability.

STUDIES ON THE NATURE OF CHILDREN'S CONCEPTS

The Types of Concepts Children Attain

Traditionally, research in concept development has focused on how children and adults form artificial concepts, such as ALL RED TRIANGLES or ALL FIGURES WITH TWO DOTS, and the like. However, recent research has questioned the relevance of such work to the formation and attainment of natural language concepts (Nelson, 1974; Anglin, 1973; Rosch, 1973; Fodor, 1972). The result has been that more of the recent studies in the field of concept development have tended to focus on the attainment of natural concepts by children, i.e., concepts which children form in their daily lives such as Animals, Plants, Trees, etc.

Natural concepts, unlike artificial ones, are part of a system of hierarchically related concepts (Vygotsky, 1962; Bruner et al., 1956; Anglin, 1977; Lowell, 1974). Animals, Invertebrates, Arthropods, Insects, Bees, would exemplify such a hierarchy. In this hierarchy of concepts the concept Animal would be the most general as it would subsume the other concepts below it. It would also be relatively more abstract in nature in relation to the other concepts. Thus, an abstract concept like Animal, being at a higher level of abstraction than the other concepts

(Lowell, 1974) and therefore demanding a greater ability to conceptualize, would appear to be more difficult to be attained by young children than say a less general concept like Insect. However, there is little consensus regarding the issue of the type of concepts (i.e., specific or general and abstract) that young children are capable of acquiring.

Welch (1940) and Lowell (1974) have shown that young children have difficulty in attaining highly inclusive abstract concepts. The reason being that these higher order abstractions are farther removed from the direct stimulus. Welch (1940) describes several hierarchical levels of concept attainment. The first he refers to as the 'pre-abstract' stage at which the child learns the attributes of a class of objects (e.g., apple), the concepts at this stage being specific, not generic. The child next learns that one class may include another (e.g., fruit includes apple). This he refers to as the first hierarchy. He next learns that this class can include other classes, e.g., food includes fruit and apple. This he refers to as the second hierarchy and suggests that children aged 4½ years are able to attain this hierarchy. It is in this fashion, through a series of consecutive hierarchies, that a child's concept develops.

Vygotsky (1962) contends that children less than 12 years of age are deficient in forming 'true concepts' based upon a conjunctive set of sensory invariants. That is, they are unable to deal with two or more criterial attributes (e.g., tall and thin of the Vygotsky's blocks) at one time to form concepts. He has found that the concepts pre-school children form on their own, which he calls 'spontaneous' concepts as distinct from 'scientific' or non-spontaneous concepts (which children form in school) lack a system of internal relationship. For example, the pre-school child's spontaneous concept of Plant does not include the subordinate concept of Flower nor the concept of Rose. To him these concepts are interchangeable and there is no hierarchical system involved. On the other hand, a 'scientific' concept implies that the concept has a certain position and level of generality in relation to other concepts. Thus the concept Rose is a subset of the concept Flower which is in turn a subset of the concept Plant.

Vygotsky (1962) refers to the child's 'spontaneous' concepts as complexes or pre-concepts to distinguish them from 'true concepts.' Such 'spontaneous' concepts may coincide with the concepts of adults only in their referents or extension but not in their meanings or intention (Vygotsky, 1962; Anglin, 1977). This suggests that the processes by which children and adults form concepts are somewhat different in nature. Vygotsky (1962) claims that the young child's concepts are 'primitive' generalizations as they are unable to form abstractions. The child's concepts are more akin to a 'family name' for groups of concrete objects which belong together factually, suggesting that their concepts were specific or concrete in nature. At the conceptual level or the level of 'true concepts,' the child perceives an object as one instance of a class or category, but at the concrete level he does not. On the other hand, he refers to the concepts of adults as generalizations of an advanced nature. This is because adults are considered to form concepts through a process of abstraction, discrimination and generalization (Vygotsky, 1962; Ausubel, 1965).

Inhelder and Piaget (1964) concur with Vygotsky's statement that children are unable to form (multiple) abstractions and attain 'true concepts' until the age of about 12 years. According to Piaget, it is only at the stage of formal operations (approximately 12 years) that a child is able to think in abstract terms and propositions. In Piaget's opinion the child progresses towards hierarchical classification in the following stages: from 'graphic collections' where objects which seem to belong together are placed in groups (e.g., children might group a woman with a fur coat instead of classifying a woman with people and a fur coat with clothes) through the second stage of 'non-graphic collections' in which objects may be grouped together on the basis of similarity done without any notion of hierarchical classification involving class inclusion;

then to classification involving inclusion of objects he can see, which is acquired around the age of 11-12 years; it is only at the formal stage that he is able to classify absent objects.

Thomson (1941) found that children between 9-11 years of age were usually able to form groupings of perceptually dissimilar objects, demanding abstraction or generalization. However, children between 6-8 years of age were most likely to bring things together in a concrete fashion, suggesting that their concepts were what Vygotsky would term pre-concepts and therefore concrete in nature. Nelson (1973a,b, 1974b) argues, however, that the child forms concepts even prior to his learning of language, and when he does first learn to speak the words of the language, he simply affixes them to concepts which have already been well formed. For example, in the formation of the concept Ball, the child synthesizes from his everyday experiences a functional set of properties such as, a ball rolls, bounces, can be thrown, etc. which according to her are the essence of the concept Ball. The physical attribute of roundness is later thought to be abstracted. Finally, the child may learn a name for his concept--that is, Ball. However, Nelson worked with small samples of children (7 per group) and her results should be interpreted with some caution. Russel (1956) claims that children are able to discriminate, abstract and generalize about environmental data from infancy and that by the age of three or four a child 'knows literally hundreds of concepts.' But the concepts that he refers to are at different hierarchical levels and therefore not of the nature of 'true concepts' but rather 'concrete' concepts. In this context, Gagne (1968) refers to 'concrete' concepts as those which have object referrents or forms to which one can point--for example, 'color,' 'tree,' 'cat,' 'shape,' etc.

The most extensive studies of children's science concept learning have been carried out by the Research and Development Center of the University of Wisconsin. The research group at this university report that children can acquire simple and abstract concepts at ages younger than would be suggested from narrow interpretations of the work of Piaget and his co-workers. The work of Pella and Ziegler (1967) will be quoted here. They determined the relative effectiveness of the use of static and dynamic mechanical models in teaching 88 children from grades 2 through 6 four concepts related to the particulate nature of matter. These concepts were 1) matter is made up of particles, 2) particles making up matter are in motion, 3) when matter is heated, rate of motion of particles increases, and 4) when matter is heated the particles move faster and farther apart. By individual interview, testing, teaching and retesting the authors ascertained if students were able to explain observations on expansion, contraction, solution, diffusion and change of phase by means of a theoretical concept. A theoretical concept was defined as an abstraction developed in the human mind to explain observations of phenomena or to predict the outcome of an experiment. Hence, in asking questions they tried to determine whether a) students could describe what they saw, and b) not only explain why it happened, but also to indicate what the material was imagined to be like to allow the phenomenon to take place. The control groups were given no instruction whereas one experimental group had instruction in which a static model was used and another received instruction in which a dynamic model was used. Both these models gave implicit indications of the particulate nature of matter.

A demonstration was performed in which the total volume of two liquids when mixed was less than the arithmetic sum of the separate volumes prior to mixing (alcohol and water). The questions posed were, "What happened?" and "What could the alcohol and water be like for this to happen?" The experimental group given a static model were presented with a beaker full of marbles and a beaker of BB shot (rifle pellets 0.17 inches in diameter) to represent alcohol and water. The BB shot was poured into the beaker full of marbles. The BB's moved to the bottom of the beaker through the spaces between the marbles. Attention was directed to the model and how it explained the alcohol and water phenomenon.

The experimental group shown a dynamic model were presented with a cylinder over which a piece of rubber dam was stretched. A metal washer was fastened to the rubber dam and centered over a Thompson coil. Styrofoam balls 3/4 in diameter were placed in the cylinder and vibrated. Subjects noted the spaces between the balls. The analogy between the balls and the particle idea of matter was pointed out. Then another layer of pith balls of a smaller size was added. The pupils were told that this condition was analogous to the water and alcohol demonstration. The balls were vibrated and then stopped. The pupils observed that the spaces between the balls were now filled with the smaller balls.

Eight test demonstrations concerning natural phenomena based on the concepts mentioned earlier were set up. One example will be given here. A teaspoonful of sugar was added to 100ml. of water in a flask and agitated to form a solution. The pupil collected a sample of the mixture and tasted. He was then questioned, "What did you see happen?" and "What do you think the material is like so this can happen?" Based on the responses of these children to the above questions the authors conclude that the grade 2 and grade 3 subjects unlike the older children do not use abstract models to explain the observed phenomena but can be taught to do so. They conclude that children from grades 2-6 can form theoretical (abstract) concepts if provided with concrete experience analogies.

Anderson (1965) also a member of the research group from the University of Wisconsin carried out a similar study to that mentioned above. He tested 180 children from grades 3 to 6 for their ability to form mental models of an abstract nature to explain observations of natural phenomena. The children were presented with demonstrations which illustrated the following phenomena: 1) A mixture of alcohol and water occupies less space than the sum of their separate volumes, 2) An appropriate increase in temperature causes ice to change to water, 3) An appropriate increase in temperature causes water to change to water vapor, 4) Surface tension is present in water, and 5) An increase in temperature causes water to expand. Along with these demonstrations questions were asked to ascertain the child's ability to formulate a mental model that would explain what had been observed. Next a mechanical model of alcohol and water was presented. This was the same as described earlier in the case of Pella and Ziegler's (1967) demonstration of a static model, using a beaker full of marbles and BB shots. After the demonstration the child was asked why this could happen. Then the demonstration of mixing alcohol and water was reviewed again and the child was asked if the marbles and BB shots gave him any idea about what alcohol and water could be like so that alcohol and water take up less space when they are mixed. The responses of the children to this question were classified as to whether they were a) atomistic, i.e., the liquid was composed of small particles, b) non-atomistic, i.e., descriptions which did not include the idea that the liquid was made up of particles, c) magical and animistic, and d) no explanation. Based on these responses Anderson concludes that the ability to formulate atomistic or abstract models increased with age.

Hibbard & Novak (1975) attempted to probe the cognitive differentiation limits of each of the 192 first grade children's concepts of solids, liquids and air, which they had developed on their own or through formal instruction by way of audio-tutorial means. They report that the instructed children used somewhat better explanatory models for comparing the molecular structure of solids, liquids and air than the uninstructed children, indicating that these children had the ability of understanding abstract concepts. In another study carried out by Povey and Hill (1975), they report that children around the age of 4 years are capable of forming generic concepts. Fifty-six children aged 2.4 to 4.10 years were administered two instruments which measured the extent to which subjects had acquired specific and generic concepts. Each subject was presented with 18 pictures of common objects which could be sorted into two groups under the heading People and Food. There were also an equal number of distractors. To assess the child's grasp of specific concepts he was asked to identify the pictures, e.g., 'egg,' 'girl,' 'spoon,' etc. To assess the degree to which a subject had acquired a generic concept he was asked to select the pictures which depicted a certain concept, e.g., food, from amongst a number of distractors. The pictures used were drawn in ink on a white card. They found that most of the children identified the items correctly suggesting that they had acquired specific concepts, and half of the subjects responded appropriately to the generic concepts. They conclude that this indicates that these subjects are able to attain generic concepts.

Saltz, Soller and Sigel (1972) working with children aged 5-12 years on a sorting technique to categorize instances and non-instances according to six concept labels found that the younger children's concepts were subconcepts of those attained by older children. This dependence of younger children on perceptual attributes was interpreted as a sign of the concreteness of the younger child's concepts. They found that with age the child's concepts became more abstract. The inference here is that the younger children's concepts are not as well developed and therefore concrete or specific in nature compared to those of the older children whose concepts were of an abstract nature.

Concept Typicality

One finding that has been consistently reported by various authors regarding the nature of the concepts attained by children is that younger children tend to select more of the typical or central instances of a concept compared to older children and adults. In the case of the category Animal, mammals have been found to be typical instances of this concept (Smith, Shoben & Ripps, 1974; Rosch, 1973), while non-mammals are atypical or peripheral. Rosch (1973) suggests that semantic categories possess an internal structure dominated by a 'core meaning' derived from typical or central examples of the category. She maintains that attributes of core items or instances may be irrelevant to the formal definition of criteria for a category. Four-leggedness is considered to be a core attribute of animals in the case of younger children. It is, however, irrelevant to the formal definition of animal. In addition, Rosch found that adults also considered certain instances to be more typical of a given concept than other instances. She demonstrated that adults took a longer time to verify statements such as "a butterfly is an animal" compared to a statement like "a bear is an animal." In the case of young children, a robin, for example, was not considered an animal; neither was a butterfly nor a bee an animal. Such instances were considered to be atypical or peripheral instances of the category Animal, the typical animal being considered as a four-legged furry creature.

Anglin (1977) reports a similar finding in his work with children aged 2-6 years old. The younger children would not include a praying mantis or butterfly as animals. They included a horse, dog, tiger, which were familiar mammals as well as an armadillo, aardvack and anteater (unfamiliar mammals) as instances of the concept Animal. Furthermore Anglin found that adults were willing to rate or scale instances according to the degree to which they represented exemplars of a given concept. These findings further support the notion of concept typicality.

Saltz et al. (1972) found that younger children tended to fragment adult categories into 'core' and 'non-core' subclasses. The 'core' instances were those that were selected by 75% or more of all the children. The adult superordinate concept label was applied to only the core items. Thus the younger children generally selected four-footed mammals as animals (e.g., cat, cow, lamb, lion). However, the younger children selected a duck, a rooster, a turkey and a turtle less frequently than the older children. Based on these findings, it appears that the core instances are mainly those rated as typical or central while non-core items are those rated as atypical or peripheral.

Piaget's study of class inclusion problems involving the animal category could be interpreted as supporting the notion of concept typicality. Inhelder and Piaget (1964) reported a discrepancy in class inclusion questions involving animals. They found children under 12 years could not answer class-inclusion questions involving animals but most 8-year-olds could answer class-inclusion questions involving plants. They attributed this discrepancy to the fact that children had little practical experience with animals and that the category 'animal' was more abstract than the category 'plant'. However, other researchers replicating Piaget's study (Ahr & Youniss, 1970; Kohnstamm, 1963) found no such discrepancy in students' answers to the class-inclusion questions involving 'plant' and 'animals'. These two researchers used only mammals in their studies (except for one question) whereas Piaget used several exemplars of non-mammals, e.g., ducks and other birds. Thus the discrepancy could have been due to the choice of atypical as against typical exemplars of the concept Animal. Carson and Abrahamson (1976) give conclusive evidence that children (aged 7-10) experience greater difficulty in answering class-inclusion questions involving atypical animals such as bees and flies than questions involving typical animals such as dogs, horses, etc. This finding supports the contention that the discrepancy mentioned earlier was in fact due to the use of atypical instances of the concept Animal.

Overgeneralization and Undergeneralization in Children's Thinking

What is the nature of the concepts children form, are they overgeneralized or undergeneralized? Evidence from various studies seems to suggest that the younger children's concepts are both overgeneralized and undergeneralized. Brown (1958) argues that with age concept differentiation occurs enabling the child to view categories with the same referents as an adult. Results of diary studies in which the young children's words were recorded along with the contexts in which they were used is offered as evidence for the above contention (Leopold, 1948; Moore, 1896; Stern, 1920). These studies show that children aged 2-4 years tend to apply the term 'mama' to many different women (Leopold, 1948), the term 'bird' to apply to cows, dogs, cats and other animals (Moore, 1896). Stern (1930) indicates that his son used the word 'psee' for leaves, trees and flowers and the term 'bebau' for all animals. Children around the age of two years or so have applied the term 'daddy' to all men (Gibson & Gibson, 1955). In fact, the Gibsons suggest that children systematically overgeneralize their concepts.

Saltz et al. (1972) found that the younger children in their study (5-6 years old) overgeneralized the concept <u>Animal</u> more than the older (8-12 years old) children. This they did by selecting non-instances which were perceptually similar in general appearance to instances of the concept <u>Animal</u> (e.g., a teddy bear, and a stuffed donkey). They maintain that in general the older children overgeneralized more than the younger children over all the six concepts. For example, the older children included pictures of a lamb, a lion, a turtle, a telephone, a wheelbarrow and a watch as instances of the concept Toys. Overgeneralization or overextension is defined here as the inclusion of a non-exemplar as an instance of a given concept. Undergeneralization or underextension is defined as the non-inclusion of an exemplar as an instance of the concept. Saltz et al. (1972) found that the younger children selected less frequently a duck, a rooster, a turkey and a turtle as instances of the concept Animal than the older children. Similarly, the younger children included items such as an ice cream, a sucker, and cookies less frequently than the older children, as instances of the concept Food. Saltz et al. interpret these results as suggesting that the younger children's concepts are fragmented. These results, however, also suggest that the younger children's concepts are undergeneralized as they were frequently not including exemplars as instances of the concepts under study.

Nelson (1974a) analysed the verbal responses made by children aged 5 years and 8 years with regard to the composition of nine natural language categories. These categories were Animals, Clothes, Colors, Flowers, Fruit, Furniture, Insects, Tools and Vegetables. She found that for the category Flowers, 5-year-olds overgeneralized, giving 10% of non-instances which were from related classes as compared to only 3% of such responses made by 8-year-olds. On another category, Insects, both groups of children overgeneralized to the same extent by naming instances which were not insects but members of a related class (e.g., worms).

In a series of ingeniously designed set of experiments, Anglin (1977) examined the nature of the pre-school child's concepts with respect to overgeneralization and undergeneralization. Anglin presented pictures of equal numbers of instances and non-instances of three general concepts, three intermediate concepts and three specific concepts to three groups of subjects (18 per group), aged 2-4 years, 4 -6 years and college undergraduates. The general concepts were Animal, Food and Plant. The concepts of intermediate generality were Dog, Fruit and Flower and the specific concepts were Collie, Apple and Tulip. Under these conditions there was equal opportunity for undergeneralizing or overgeneralizing a concept. Every subject was shown a total of 120 pictures. A given subject was shown 10 instances of a concrete concept in one hierarchy and 10 non-instances; he was shown 20 instances of an intermediate concept from a different hierarchy and 20 non-instances. Finally he was shown 30 instances of the general concept in the hierarchy as well as 30 non-instances. For every instance or non-instance of a given concept shown to a subject he was asked whether it was an instance of the concept being tested.

An analysis of the results showed that all of the children undergeneralized the concept Animal to some extent.

The children would rarely include pictures of a praying mantis and caterpillar as instances of the concept Animal. No subject included a picture of a woman as an instance of the concept Animal. Anglin suggests that children were undergeneralizing peripheral instances of this concept based on the assumption that typical or central instances were four-legged furry mammals. A similar result was obtained in the case of the other general concepts. He also found that these general concepts were overgeneralized to a small extent. The adults hardly undergeneralized or overgeneralized these concepts. The intermediate concepts Dog, Flower and Fruit were both undergeneralized and overgeneralized by the children although the concept Flower was more overgeneralized than undergeneralized. The concrete concepts Collie and Tulip were difficult for the children to identify and therefore the results cannot be interpreted with any certainty.

Anglin concludes that in general the younger children make more undergeneralization responses than overgeneralization responses compared to the 4 -6-year-old group. In addition, for children (both groups) as well as for adults, the number of undergeneralization responses is greater than the number of overgeneralization responses. Whether a child's concepts will be overgeneralized or undergeneralized seems to depend upon at least four factors: 1) The particular child in question, 2) The conditions under which the child's terms of reference are studied, 3) The nature of the concept under study, 4) The nature of the instances and non-instances available for inclusion (Anglin, 1977).

In discussing the first factor mentioned above, it is contended that no two children are the same in some respects. Each brings along with him a relatively different store of knowledge and experience. It is, therefore, quite plausible to contend that some children may undergeneralize and others overgeneralize and yet others neither undergeneralize nor overgeneralize the same terms. The second factor refers to the conditions under which the child's terms of reference are studied. Anglin (1977) is of the view that overgeneralization will be more obvious when the production paradigm is used and undergeneralization more emphasized in comprehension studies. In studies using the production paradigm, the child's limited vocabulary will result in stretching a word to include objects or events for which he does not have a name, even though he may not really think that the object is appropriately designated by that term (Anglin, 1977). For example, when a child refers to a cow, a sheep or a goat as a dog. His concept of dog will, therefore, be overgeneralized. On the other hand, in comprehension studies, when presented with instances of a concept, undergeneralization will be more striking if the subject does not select these as instances of the concept. For example, when the child does not include a butterfly or a praying mantis as instances of the concept Animal. His concept will thus be undergeneralized.

The third factor is the particular concept that is studied. Certain concepts appear to be more often overgeneralized by children whereas others are more often undergeneralized. Thus the concepts Flower, Insects are overgeneralized by younger children (Nelson, 1974a) and more general concepts like Animals, Plants (Anglin, 1977); Clothing, Food, Furniture (Saltz, 1972; Nelson, 1974a) are undergeneralized. The concept Animal is also overgeneralized (Saltz et al., 1972) by younger children. The concept Bird which is less general than the concept Animal is also undergeneralized (Anglin, 1977). There is, therefore, no pattern to suggest that general concepts are undergeneralized or that less general concepts are overgeneralized.

Perhaps the most potent factor influencing overgeneralization or undergeneralization of concepts in children seems to be the nature of the instances and non-instances of the concept being studied. Items considered typical of or central to the concept being studied were always included by children as instances of the concept (Saltz et al., 1972; Rosch, 1973; Anglin, 1977), be they familiar or unfamiliar to the children. Thus for the concept Animal children included familiar instances such as a dog or a cat or unfamiliar instances such as an aardvark or wombat with equal frequency (Anglin, 1977). However, instances considered atypical or non-core (Saltz et al., 1972) or peripheral to the concept were not included regardless of whether they were familiar, e.g., butterfly or ant to Animal, or unfamiliar, e.g., centipede or hydra to Animal, thus leading to undergeneralization (Anglin, 1977).

It appears that in most cases of undergeneralization the problem seems to be conceptual rather than perceptual as the children were able to identify the instances correctly but were unable to categorize it to the concept under study. Thus, a picture of a butterfly was recognized as a butterfly but it was denied that it was an animal; a duck or a hen was identified as such but were denied that they were birds.

Non-instances of a concept have been overgeneralized as instances of a concept due to perceptual similarity (Clark, 1973; Saltz et al., 1972; Anglin, 1977), association through contiguity and functional similarity in that order of importance (Anglin, 1977). In most cases where non-instances have been included as instances of a concept has been where the non-instances were perceptually similar in general appearance to exemplars of the concept (Clark, 1973) or the similarity may be in texture, parts, sound movement or size of an instance of the concept (Anglin, 1977). Overgeneralization due to association through contiguity, i.e., the non-instance has been seen in the presence of an instance of the category has been quoted by several authors (Vygotsky, 1962; Moore, 1896). These overgeneralizations have been made by very young children (2 years old); e.g., calling a saddle a horse or a lunch bag a piece of bread. Functional similarity, i.e., the non-instance serves the same function as an instance of the concept has not resulted in many such overgeneralizations and is considered rare.

STUDIES OF CHILDREN'S ABILITY TO GENERALIZE

The Relationship of Age and the Ability to Generalize Concepts

Saltz, Soller and Sigel (1972) working with 72 children from kindergarten, grade three and grade six asked the children (individually) to select pictures which they thought were instances of each of six different natural concepts. These concepts were Food, Animal, Transportation, Clothes, Toy and Furniture. They found that the concepts attained by younger children were fragmented sub-concepts of those held by older children. Thus for the concept Food older children included a greater variety of items than the younger children, who tended to include only meal time items as food. They disregarded such items as a sucker, an ice-cream cone and cookies which for these younger children formed a sub-concept 'Snack' which apparently was not considered as food. In general, their results show that the older children selected a significantly greater number of instances of the concepts mentioned earlier than the younger children. This result is interpreted to suggest that the older children had a greater ability to generalize than the younger children.

Thompson (1941) gave the BRL Test modified from Weigl's Sorting Test to 60 grammar school children ranging from the first to the sixth grade. The BRL Test consists of 34 objects which vary in size, color, form, use, material, etc. In Part I of the test, in response to six key objects, the subject is asked to form groups of objects that he thinks belong together for a reason. In Part II, the subject interprets the general basis for groups of objects placed together by the examiner. Based on the responses of the children on Part I of the test, she found that younger children tended to form groups of objects related in specific concrete situations, for example, a game to play in kindergarten, hammer to ring the bell, etc. The older children tended to make more classifications of objects into categories, for example, tools, toys, red objects; and according to use, for example: to set the table, to smoke, etc. than the younger children. From the responses of the children on Part II of the test, she found that the younger children were able to see fewer general relationships between objects than older children. The average number of correct generalizations given by the older children was 6.3 and by the younger children, 4.1. She concludes that there was a significant difference between the ability of older and younger children to generalize the basis of pertinence of the categories presented.

Goldman and Levine (1963) carried out a similar study. They examined the ability of 104 kindergarten, first grade, second grade, fourth grade, sixth grade, ninth grade, college students and scientists, a) to sort dissimilar objects according to some given criteria, and b) to generalize the basis of categorization for groups of objects placed together by the experimenter. The materials used were those given in the Goldstein-Scheerer Object Sorting Test and consist of 33 common items. Some examples are geometrical figures of different shapes and colors, padlock and two keys, two sugar cubes, cigar, two cigarettes, pipe, bubble gum cigar, toy fork, knife and spoon, red rubber ball, etc. Subjects were tested individually. In the first part of the test the subject was asked to find things which had something in common with a given object, e.g., a pencil. The subject was asked to explain the reason for each item selected. In Part II of the test the subject was asked to generalize the basis of pertinence of 15 groupings of objects. Examples of such groupings were, Edibles, Tools, Toys, etc. The responses of the subjects were categorized into three major groupings. The first was part-whole relationships, that is, when only a fraction of the stimulus items that made up a category were selected or when sorting was based exclusively on items which were identical (e.g., two sugar cubes). The second was for the concepts which were actually employed (e.g., Tools or Toys, etc.) that is the precise response, and the third was for formal characteristics of the concepts, where the subject's concept is independent of immediate perceptual qualities of objects (e.g., for Tools grouping--a response such as "They are Tools and they have a silver color)."

Based on the above categorizations, the researchers found that the younger children's concepts were fragmented in nature in that they were only part of what the adults' concepts comprised of. This finding supports the results of Saltz et al. (1972) who also came to the same conclusion. They also found that the precise response or the correct generalizations made by subjects increased with age. This suggests that the ability to generalize concepts increases with age. In the case of responses of the formal characteristics of concepts (i.e., where two or more criteria were abstracted from the objects displayed, to form a concept) they found that younger children were insensitive to multiple possibilities inherent in any grouping. The incidence of such responses was found to a great extent among college students and scientists, suggesting that the children's concepts were of a more specific nature and more perceptually bound.

Elkind et al. (1964) studied the ability of 195 children 4 to 9 years in age to perceive both parts and wholes in drawings of common objects wherein both parts and wholes had independent meanings. An example of the stimuli used is a picture of a scooter made of candy or a picture of fish made of carrots. They found that parts (e.g., carrots) were recognized at an earlier age than wholes (e.g., fish) and part-whole integration developed with age. They also found that older children were more able to recognize parts and wholes than younger children. This does suggest that the older children had a greater ability to generalize a category name from the stimuli presented than the younger children. Although they interpret their results in the light of Piaget's theory of decentration, their findings nevertheless lend support to the notion of the fragmented nature of the young child's concepts.

Neimark (1974) on the other hand in replicating the study of Salt et al. (1972) found no supporting evidence indicating that the younger child's concepts were sub-concepts of those held by older children. Neimark asked 76 subjects in grade 2, grade 6 and college, to sort 50 pictures with respect to the class labels Food, Things to Eat, Clothing and Things to Wear. The first and third categories and the general procedure employed were the same as that used by Saltz et al. The second and fourth categories are synonyms of the first and third categories but were used to test for effect of label specificity. It was assumed that for adults, Food and Things to Eat should mean the same thus they would include the same set of specific items under each of those labels. However, if young children did have fragmented sub-concepts, they should include more or at least different specific items under the category Things to Eat than under the category Food. She found, however, that the classes Food and Things to Eat are functionally equivalent at all ages. The category Clothing and Things to Wear were functionally the same for second graders. There was, however, a decrease in the size and composition of Clothing with age. These results do not suggest that the younger subjects' concepts are fragmented nor that concept integration takes place with age. However, her results show that for Clothing sixth graders and college students selected fewer instances than grade two subjects. For Things to Eat sixth graders and second graders selected significantly fewer instances than college students. This suggests that for the concept Clothing the older subjects generalized to a greater extent than the younger children, whereas for Things to Eat the adults generalized to a greater extent than the sixth and second graders.

Carson and Abrahamson (1976) in exploring the effect of concept typicality upon performance on class-inclusion tests of 96 children aged between 7-10 years, report that their findings show no evidence for concept integration with age. This finding was obtained from the children's sorting of pictures into six categories identified by the following concept labels: Animals, Birds, Buildings, Clothes, Food and Plants. Since they found no differences in the responses of children for each of the six concepts it is suggested that the children were generalizing these concepts to the same extent. That is, there was no difference in the ability of children aged 7-10 years in generalizing the concepts mentioned above, from instances which were represented pictorially.

All the above studies have used a comprehension or performance paradigm in that the experimenter presented positive and negative instances of a concept which the subjects identified or sorted according to their notions of the concept. Nelson (1974a) used a production paradigm, i.e., students were given a concept label and children were asked to name items from semantic memory which they thought were instances of the concept. She asked 131 children aged 5 years and 8 years to verbalize instances of nine concepts. These concepts were Animals, Clothes, Flowers, Fruit, Furniture, Insects, Tools and Vegetables. The children were tested individually. Her results show that the younger children on the average gave half the number of items given by the older children.

However, she found that although the categories of the younger children were smaller, they showed more diversity of membership. Based on these results she concluded that the young child's concepts were not fragmented in nature, nor was there concept integration with increase in age. Her results indicate that the greater number of instances cited by the older than the younger children was a function of the greater repertoire of knowledge held by the older children. In addition, since the older children gave more relevant instances of the concepts than the younger children, it may be suggested that the older children's concepts were more generalizable than those of the younger children.

Studies on Concept Attainment

A great number of studies which were reviewed also examined the effect of age on the ability of children to attain concepts. In a recent review of research studies dealing with concept attainment, Clark (1971) reports that of 19 studies using age as an independent variable 16 of these studies found it to be a significant variable, in that ease of concept attainment was found to increase with age.

Osler and Fivel (1961) in studying the role of age and intelligence in the attainment of the concepts Bird, Animal and Living Thing by induction, found age to produce significant differences in performance among children aged 6 years, 10 years and 14 years old. The measures used as the dependent variables were the number of trials to criterion and the number of successful cases of concept attainment. Both these measures were significantly affected by age. Osler and Weiss (1962) found that age again significantly affected the performance of children (aged 6, 10 and 14 years) in the attainment of the concept Bird. The stimuli consisted of 150 pairs of pictures, one member of each pair representing a positive instance of the concept and the other a negative instance. This study was in fact similar to the one carried out by Osler and Fivel. The results were analyzed in terms of three measures of performance: a) the mean number of errors to criterion, b) the number of subjects who attained the criterion, and c) the number of subjects who verbalized the concept at the point of success. The criterion of success for the two studies mentioned above was 10 consecutive correct responses. The results showed that age significantly affected concept attainment on each of the three measures of performance.

Other studies have shown that age appears to influence the selection of criterial attributes of a concept. Below 3 years of age, the form of the object appears to be the dominant criteria; from 3 to 6 years colour becomes dominant; from 6 years onwards, form becomes dominant again (Suchman & Trabasso, 1966; Lee, 1965). However, with further increase in age dominance of physical characteristics gives way to dominance of functional characteristics (Nelson, 1974a); Saltz et al., 1972).

It appears that the majority of studies maintain that age significantly affects the ability to generalize and attain concepts. However, there is some doubt as to what extent age actually influences the formation and attainment of concepts. This feeling is echoed by Piaget (1964) and Gagne (1965). Piaget is of the opinion that growth or maturation and experience both social and material is more likely to influence cognitive development in children. Gagne (1965) maintains that for a child to attain a concept he must possess the prerequisite knowledge to do so. This knowledge may be gained under certain conditions, some of which were internal to the learner (i.e., his motivation or desire to learn) and some external to him (e.g., instruction). He does not consider concept attainment as simply ascribable to the process of growth.

The Relationship of IQ and Ability to Generalize

No study has examined the effect of IQ on the ability to generalize concepts. However, a majority of studies have examined the effect of IQ on concept attainment. While it is quite reasonable to assume that intelligence and concept attainment are highly correlated, such a relationship has not been consistently demonstrated. Osler and Fivel (1961) worked with 180 children aged 6 years, 10 years, and 14 years at two levels of intelligence, $\bar{X}_{1IQ} = 101.6$ and $\bar{X}_{2IQ} = 121.3$, on concept attainment tasks involving a hierarchy of three naturalistic concepts viz, Bird, Animal and Living Thing. They found a significant effect of intelligence on the ability of children to attain the concepts. In a replication of the above study Osler and Weiss (1962) confirmed the earlier finding of the significant effect of intelligence on concept attainment. However, when the nature of the task was explicitly defined to the children, it was found that the effect of intelligence disappeared. They concluded that high intelligence gave subjects an advantage in problem definition but not in the concept attainment task.

It is the author's opinion that by explicitly defining the nature of the task the experimenters could very well have indicated to the children how to form the concept. What it amounts to is that Osler and Fivel were examining not only concept attainment but concept formation as well, and Osler and Weiss in the second part of the experiment, were studying concept attainment per se. This would mean that intelligence was significant in the abstraction of attributes for concept formation. That once the concept was formed for the children, the normal and high intelligence children were on the same footing in "finding predictive defining attributes that distinguish exemplars from non-exemplars of the class one seeks to discriminate" (Bruner, 1956) to attain the concepts. That the authors failed to distinguish between concept formation and concept attainment could very well be possible. There are not many authors who have distinguished concept formation from concept attainment in their studies. In addition, there are not many who have been able to distinguish between the two processes (Anglin, 1977; Bruner, 1956).

Weiner (1974) in his doctoral dissertation on concept attainment found that intelligence was significant in the attainment of concepts. That intelligence affects the ability to attain concepts not only in children is alluded to by Nicholson (1966) who, in his unpublished doctoral dissertation, reports that male high school freshmen's ability to attain concepts was significantly affected by intelligence.

Osler and Trautman (1961) in determining the effect of stimulus complexity upon children's concept attainment at two levels of intelligence ($\bar{X}_{1IQ}$=101.3, $\bar{X}_{2IQ}$= 119.7) found that intelligence produced no significant effect on the performance of 120 children aged 6, 10, and 14 years. However, in a replication of the above study, Wolff (1967) found significant effects of intelligence on the performance of 66 subjects of mean age 135.8 months, on the concept attainment task. He attributed this discrepancy in the results to procedural inconsistencies on the part of Osler and Trautman, in providing unequal numbers of negative stimuli to the control and experimental groups of subjects.

It thus appears that intelligence is sensitive in some cases to the conditions under which it operates. It appears to be unrelated to the ability of perceiving part-whole perceptions of naturalistic concepts (Elkind, 1964). Neither does it seem to have a significant effect in the identification of instances of natural concepts from stimuli with reduced number of cues (Gollin, 1960). Intelligence was again insignificant in its effect on concept attainment under conditions of partial reinforcement of responses of children aged 6 years, 8 years, 10 years and 14 years (Osler & Shapiro, 1964). However, it appears to have a significant effect on the formation of concepts (Katz, 1968; Inhelder & Piaget, 1958).

The Relationship of Sex and Ability to Generalize

Of the studies reviewed, only two determined the effect of sex on the ability of children to generalize concepts. Saltz et al. (1972) found no differences between the mean numbers of pictures selected by male and female subjects for each concept label studied. Nelson (1974a) used a production paradigm to determine the composition of nine natural language categories held by children aged 5 years and 8 years. She found no significant differences due to sex.

Clark (1971) conducted one of the most comprehensive reviews of research on the relation of sex and concept attainment. He reports that of 14 studies reviewed by him, 10 found sex to be insignificant in its effect on concept attainment.

The Relationship of Instruction and Ability to Generalize

No study has examined the effect of instruction on the ability to generalize concepts. However, in studies on concept attainment, instruction may vary according to purpose, method of presentation, amount of information presented, specificity of the information presented, and amount of non-verbal guidance (Klausmeier & Meinke, 1968). The method of presenting instructions may be aural, visual, or audio-visual. Instructions may be given: a) to acquaint subjects with the specific stimulus materials or responses that are desired by clarifying the nature of the task, b) to provide additional information in the form of a method or principle designed to facilitate performance, and c) to provide a set to recall or use information or abilities or to manipulate the level of motivation of subjects.

Osler and Weiss (1962) studied the effect of instruction on 180 subjects aged 6, 10 and 14 years to attain the concept Bird. The control group was given no explicit instructions whereas the experimental group was given explicit instructions as to the nature of the task. They found that instructions produced a significant difference in the performance of the 6-year-old subjects. The older subjects performed just as well with or without instruction due to a ceiling effect.

Anderson (1968) tested the ability of 53 first graders to attain concepts involving three attributes (number, color and figures). There were two treatment groups and one control group. One treatment group was trained to solve concept attainment problems by a small-step programmed part-task method and the other experimental group received instruction on how to attain concepts using the whole-task method where the subject attempted terminal problems early in training. All the subjects (treatment and control) were then tested on concept attainment problems which they had not seen before. Their results show that the part-task method of instruction was superior to the whole-task method. But what is more important is that subjects who received instruction performed significantly better than the control group.

Other studies which have shown that instruction has significant effects on the ability of children to attain concepts are those carried out by Pella and Ziegler (1967); Anderson (1965); Hibbard and Novak (1975). A study by Klausmeir and Meinke (1968) shows that instruction significantly affects the ability of adults to attain concepts.

The Relationship of Stimulus Complexity and Ability to Generalize

No studies have determined the effect of stimulus complexity on the ability to generalize. Most studies have studied this variable in relation to concept attainment. However, before a discussion of the literature on the above issue is entered into, it is perhaps pertinent that the notion of criterial and defining attributes be explained. Bruner (1956) defines an attribute as 'any discriminable feature of an event that is susceptible of some discriminable variation from event to event'. Thus colour, size and weight are attributes of apple. However, if changes in the values of any particular attribute do not result in changes in the probability of an object or event being called what it is, then that attribute is non-criterial. Thus the weight of an apple is non-criterial as a change in weight will not affect its being referred to as an apple. However, colour and shape would be criterial as a change in these attributes would affect an apple being called an apple. The criterial attributes are the attributes which the individual considers as pertinent to the attainment of the concept. The defining attributes of an object or event are those attributes considered 'officially' defining the object or event (Bruner, 1956). Thus, feathers and beak are defining attributes of a bird. They are also criterial attributes. A feather or beak is a signal or cue for categorizing. It is the signal of the whole concept of 'birdness' and therefore results in the attainment of the concept.

Archer (1962) suggests that concepts become more complex and therefore more difficult to attain, (a) when the non-critical attributes or irrelevant information is increased in proportion to the relevant attributes or information, b) when the criterial attributes or relevant information increases in proportion to the irrelevant information. Clark (1971) in a review of the relevant literature comes up with some general statements regarding criterial attributes and concept attainment. Generally, as the criterial properties of a concept become more obvious (Archer, 1962) or show less variation from instance to instance (Saltz & Sigel, 1967) ease of concept attainment generally increases. Decrease in the number of non-criterial properties or attributes results in an increase in the ease of concept attainment (Anderson, 1966). In other studies in this area various stimuli (words, nonsense syllables, pictures, objects, etc.) have been used which have been assumed to present different degrees of difficulty to subjects in identifying objects (Gollin, 1960), abstracting (Lowell, 1974), forming concepts (Katz, 1968) and attaining concepts (Osler & Trautman, 1961). The use of such stimuli has been referred to as the condition of stimulus complexity.

In most cases, increasing levels of stimulus complexity have been obtained by the addition of irrelevant cues or attributes (Katz, 1968; Archer et al., 1955; Reed, 1946) or irrelevant dimensions (Osler & Trautman, 1961; Wolff, 1967) to the relevant information presented as stimuli in the concept attainment task. There is only one study (in the writer's knowledge) where stimulus complexity has been achieved by a reduction in the number of relevant cues or attributes. Gollin (1960) achieved increasing degrees of stimulus complexity by reduction or removal of contour lines and internal details from representations consisting of drawings of some common objects like an umbrella, elephant, etc. Each object was represented five times to provide a gradation of completeness, from the most reduced representation consisting of only a few contour lines or internal details to representations of the complete object. His study was in the field of perception. He found that there was no difference between the ability of children around 5½ years old and adults to identify the objects from representations of the most reduced type. These two groups of subjects, however, differed significantly from the younger (2½-4½ years) children.

The format used in Gollin's study was adapted in the present study to obtain three sets of instances, each set displaying a progressively decreasing number of attributes and immediacy of a concept. This afforded a novel format of examining the extent to which children could generalize a given concept.

SUMMARY OF RELATED LITERATURE

A great deal of attention has been given to research on concept attainment in children. Studies concerning the nature of the concepts attained by children suggest that the concepts of young children are more fragmented and concrete, less general and are tied to perceptual attributes more than those of older children. In addition, young children appear to make more use of perceptual attributes than functional criteria to attain concepts; with age, however, functional dominance takes over.

In general, it appears that the ability to generalize concepts increases with age. Furthermore, young children both overgeneralize and undergeneralize their concepts more than older children. The difference depending upon a number of factors, such as the individuality of the child, the research strategy and methodology employed, the nature of the concept studied and the nature of the instances and non-instances of the concept under investigation (Anglin, 1977).

Various other factors have been known to have an effect on the ability of children to attain concepts. Age seems to be the most important variable in this context. However, the extent age influences the attainment of concepts is a question yet to be answered. There appears to be a controversy with regard to the effect of intelligence on the attainment of concepts. That intelligence should be strongly related to concept attainment is based on the assumption that abstraction of critical attributes is a skill requiring the use of intelligence (Vinacke, 1951). Thus in studies dealing with concept formation per se, where abstraction of attributes is critical, intelligence seems to be a significant variable (Katz, 1968). Where concept attainment is the only task involved, that is, information is given to the subject on how to form a concept or the subject is aware of the concept, intelligence does not seem to be a significant variable (Osler & Weiss, 1962). In other studies where there is no differentiation between concept formation and concept attainment, intelligence appears to have a variable effect in that it may or may not be significant (Osler & Trautman, 1961; Wolff, 1967; Osler & Shapiro, 1964; Osler & Fivel, 1961; Gollin, 1960).

Sex has been shown to be insignificant as an independent variable in concept attainment studies. Nevertheless, it is often included as a variable in such studies as its inclusion does not entail any extra physical labor and there is always the possibility that it may be significant in some context as yet not investigated. It has also been found that instruction has in general significantly influenced the ability of children to attain concepts.

For the most part, attempts to determine the nature of the natural concepts attained by children have been based on sorting techniques (Anglin, 1977; Saltz, Soller & Sigel, 1972) or free recall (Nelson, 1974a) of instances of a concept. The instances that have usually been used in such studies appear to be pictures of common objects familiar to children. In some studies the instances have tended to range in complexity along a gradient of assumed difficulty of usage for inferring a concept. This condition has been referred to as stimulus complexity. In most cases, stimulus complexity has been obtained by increasing the amount of irrelevant criteria or dimensions (Archer, 1962). Only one study (Gollin, 1960) is reported where stimulus complexity has been attained through a reduced number of cues or relevant criteria. The present study will attempt to determine the nature of selected science concepts used by children and the ability of these children to generalize these concepts from instances displaying an increasingly reduced number of criterial attributes.

CHAPTER III

DEVELOPMENT OF INSTRUMENT, SAMPLE, PROCEDURES AND METHOD

This chapter deals with the development of the instruments used to measure the ability of children to generalize the concepts Insect and Animal. It also discusses the reliability and validity of these instruments, as well as the instrument used to measure the IQ of the subjects. This is followed by a statement of a pilot study carried out earlier using the above instruments. The population and sample used in this study are described together with the operational procedure, statistical design and method of analysis employed in this study.

The Development of the Instruments

Recent research on concept attainment has suggested that the concepts of young children are more concrete and less general than that of older children. Salt, Soller & Sigel (1972) suggest that younger children are heavily dependent on perceptual attributes in identifying a concept and that with age functional and abstract attributes become more important.

It was therefore reasoned that a subject having a good understanding of a given concept would not have much difficulty in identifying that concept from instances which displayed abstract attributes. For example, attributes which only implicitly suggested the given concept. He would, therefore, have even less difficulty in inferring a given concept from representations which displayed some or all the attributes of instances of that concept.

A subject whose concept was not well developed, and who therefore was heavily dependent on perceptual attributes in identifying a concept, should experience little difficulty in identifying a concept from representations displaying all or some of the attributes of instances of the concept. However, he would experience greater difficulty in generalizing a concept from instances which only implicitly suggested the concept.

An instrument developed along these lines would enable one to measure the extent to which children could generalize a given concept. This study attempted to employ this novel format to determine the extent to which children could generalize two hierarchically related science concepts. The concepts were Insect and Animal. Two instruments were developed, one measuring the ability of children to generalize the concept Insect and the other measuring the ability of children to generalize the concept Animal. Three types of instances were to be used. These instances were to display a progressively decreasing number of attributes and immediacy of the concepts under study.

It was hoped that in this way the instruments would be simple enough for the youngest group of children to work through but at the same time discriminating enough to distinguish between the generalizing abilities of all the children in the study.

Three degrees of stimulus complexity were posited based on the relative number of attributes displayed and the immediacy of these stimuli to the concept under study. The stimuli for each concept, therefore, consisted of three sets of instances each more difficult than the other. The first set of instances consisted of pictures of the whole insect or animal; these were referred to as instances of the First Degree of Complexity. The second set of instances consisted of pictures showing part of the insect or animal's body; these were referred to as instances of the Second Degree of Complexity. The third set of instances consisted of pictures of products of the natural activity of insects or animals. These were considered to only implicitly imply the attributes of the concepts. These were referred to as instances of the Third Degree of Complexity.

First Degree of Complexity

It was considered that pictures of complete representations of insects or animals displayed the most number of criterial attributes of each respective concept. These pictures were also of the greatest immediacy of the concepts under study. As such, these pictures would be easiest for children to recognize and use as cues to infer the respective concepts. Such stimuli were referred to as instances of the First Degree of Complexity.

Second Degree of Complexity

Pictures showing part of an insect's or animal's body were considered to be more complex than pictures of the complete representations of insects or animals. This was considered to be due to a reduction in the relative number of criterial attributes available for categorization and the fact that such representations obviously were of a lesser degree of immediacy to the concepts being attained. Examples of this category of instances of the concept Insect and Animal were a butterfly's wing and a bird's beak, respectively. Thus, a child had to 'fill in' the other criterial attributes to recognize the specific insect or animal and then generalize to the concept Insect or Animal. Such stimuli were referred to as instances of the Second Degree of Complexity.

Third Degree of Complexity

Pictures of products of the natural activity of insects and animals were considered to be representative of the Third Degree of Complexity. These stimuli were considered to be more complex than those of the Second Degree of Complexity, as these representations were considered to be relatively more 'distant' in terms of immediacy of the concepts to be attained. Furthermore, it was contended that a picture of a bee's hive or a bird's nest only implicitly suggests the attributes or knowledge of 'Beeness" or 'Birdness'. There is thus greater cognitive strain involved in inferring the specific insect or animal from such stimuli, respectively, and then generalizing to the concept Insect or Animal. One dimension of this study was the development of these two instruments. One, to measure the ability to generalize the concept Insect and the other to measure the ability to generalize the concept Animal.

Measure of the Ability to Generalize the Concept Insect

The stimuli used in this instrument consisted of 20 colored pictures of insects, insect parts and products of insects, cut from nature magazines. Specifically, there were 10 pictures of instances of the First Degree of Complexity and 5 pictures each of instances of the Second and Third Degrees of Complexity. None of these pictures were repeated as stimuli for the concept Animal.

Included in the instrument were an equal number of non-instances or distractors of the concept Insect. There were 5 pictures of inanimate objects perceptually similar in general appearance to instances of the concept Insect. Examples of these include a dragon-fly made out of paper; a paper bettle and a metal butterfly. There were 15 pictures of animals other than insects, such as a worm, a spider, a beaver and the like. The pictures of the instances and non-instances alike, were randomly placed six to a page 9.5" x 11.5" in size. The pages were then randomized and organized to form a book of pictures.

Measure of the Ability to Generalize the Concept Animal

The stimuli used in this instrument consisted of 52 colored pictures of various animals, animal parts and products of animals, cut out from nature magazines. Specifically, there were 24 pictures of a variety of animals including insects, which formed the instances of the First Degree of Complexity. There were 18 pictures of instances of the Second Degree of Complexity and 10 pictures of instances of the Third Degree of Complexity.

Also included in the instrument were an equal number of non-instances or distractors of the concept Animal. There were three types of distractors in almost equal numbers. There were 18 pictures of inanimate objects such as a clock, fan, etc. There were 17 pictures of various types of plants and 17 pictures of inanimate objects perceptually similar in general appearance to instances of the concept Animal. Examples of this last type of distractor were a reindeer and a hippopotamus made out of peanuts, a glass horse, a plastic dog and the like.

As was done in the first instrument, the instances and non-instances alike were randomly selected and placed 6 to a page measuring 9.5" x 11.5". These pages were then randomized and organized to form a book of pictures.

Validation of the Instruments Measuring the Ability to Generalize the Concepts Insect and Animal

To select the best pictures to represent instances of the First, Second, and Third Degrees of Complexity as well as the distractors for each concept, an initial pool of 138 pictures of the concept Animal and 40 pictures of the concept Insect was presented to a group of ~~five~~ judges, three elementary school teachers and two university professors. The stimuli to be used in the mental sets were also presented to these judges. The judges were asked to rate the extent to which each picture was representative of the different dimensions of complexity along a seven-point scale (see Appendix B). The average ratings for each picture were computed. Instances rated greater than 4.5 along the dimension of representativeness were only used in the instruments. This resulted in the rejection of 34 items of the concept Animal.

Reliability of the Instruments

The reliabilities of the two instruments was determined by a test-retest method. Two weeks after the initial testing eight subjects (4 boys and 4 girls) were randomly selected from each of the three grades for retesting. The objective of the retesting was to provide evidence of reliability of the two instruments used in the study. The criterion for test reliability used in this study was that retest performance would be identical to or slightly below or above original test performance. Thus, a high correlation coefficient was expected between the original and the retest performance of these children on each of the two instruments.

The results show that the Pearson product-moment correlation coefficient between the test-retest performance of these children on the instrument measuring the ability to generalize the concept Insect was 0.88. This value was highly significant (p = .0001). Furthermore, the results of a scattergram analysis carried out on the data showed that the slope of the regression line was 0.96. These results indicate that there was indeed a high reliability between the test-retest performance of these children on the above instrument.

In the case of the test-retest performance of the children on the instrument measuring the ability to generalize the concept Animal, the Pearson product-moment correlation obtained was 0.97 (p = .0001). A scattergram analysis of the data revealed that the slope of the regression line was 1.07. Again, these results indicated a high reliability between the performances of these children on the second instrument. The two tests were therefore considered to be reliable.

Other Instruments: The Quick Test (QT)

Description: The Quick Test is a screening instrument used for measuring verbal-perceptual intelligence. It is an individualized intelligence test developed by Ammons and Ammons (1962). The QT is published in three single forms, Form 1, Form 2, and Form 3, each comprising a set of four pictures (line drawings) and 50 word items listed in the order to increasing difficulty. The forms can be administered separately or in conjunction with each other. The QT provides norms for children of mental age 1.5 years to adults of mental age 18 years and above.

Validity of the QT

The validity of the QT was established by Ammons and Ammons (1962) by comparing it with the Full-Range Picture Vocabulary Test. They also reported correlations between the FRPV and several other instruments measuring intelligence. The correlation between the FRPV test and the Stanford-Binet test is .73; that with the Wechsler-Bellevue Vocabulary test is .86. Using these correlations as a validity criterion, they report correlations between the QT and the

FRPV (Forms A and B combined) as follows: Form 1, .79; Form 2, .80; Form 3, .64 and Forms 1 + 2 + 3 as .82. The two tests cover similar mental age ranges. The minimum being 1.5 years and the upper limit being 18 years, after which adult IQ norms are used (Standburg et al., 1969). In this study only Form 1 of the QT was administered.

Reliability of the QT

Ammons and Ammons (1962) indicate that scores on single forms of the QT are suitably reliable for screening intelligence at single age levels and very effective where wide ranges of ability are being handled. Direct and indirect estimates of reliability of the three forms indicate a high r ranging from .60 to .96 for mean inter-form. For two forms the r ranges from .75 to .98 for pre-school children to adults. Burgess (1959) working with kindergarten subjects in private schools found a correlation of .73 for mean interform.

Pilot Study

The pilot study served two functions: 1) to determine the appropriate protocol of task presentation for all grade levels, and 2) to determine what problems would be encountered in the administration of the two instruments measuring the ability to generalize the concepts Insect and Animal and the instrument measuring their IQ. Six subjects from each of the grades kindergarten through grade five of the St. Peter's Elementary School, St. John's, were tested. The pilot study was conducted over a period of one week.

The investigator was concerned whether the younger children would be able to identify the stimuli used as instances of the First, Second, and Third Degrees of Complexity. It was found that in general most children were able to recognize the pictures of the insects and animals. In cases where the children were unsure as to what a particular instance was, the specific name of the instance was supplied. There were a few items of the Second and Third Degrees of Complexity which the younger children could not identify. These items were subsequently substituted with more illustrative examples.

POPULATION AND SAMPLE

The population from which a sample was drawn consisted of elementary school children from grades kindergarten to five at the St. Peter's Elementary School, Mount Pearl, Newfoundland. The subjects forming the sample were 144 children randomly selected from kindergarten, grade three and grade five classes. Forty-eight children (24 boys and 24 girls) were thus selected from each of the three grades. The subjects in each grade were randomly assigned to control and experimental groups. The means and standard deviations of the age and IQ of each group of children by grade level and experimental treatment are summarized in Table 1. Table 2 gives the mean age of the subjects by sex, grade level and experimental treatment. Table 3 gives the mean IQ of the subjects by sex, grade level and experimental treatment. There were no statistically significant ($p = .01$) differences in IQ between all groups.

TESTING PROCEDURE

The protocol to be described below was refined and improved upon the one used in a pilot study. Each child was tested individually in a room in which the experimenter and the subject were alone. The subject and experimenter were seated at a table, adjacent to each other. The child was routinely asked for his name and favorite television programme and if he watched Sesame Street or Mr. Dressup. This was to put the child at ease, and at the same time solicit some information as to whether the child watched the two educational programmes mentioned earlier.

The experimenter then said to the subject, "We are going to play a game with pictures and at the end of the game, I am going to give you a prize." He was then shown a box filled with toys. The experimenter next said, "I am going to tell you a word and then show you some pictures in this book (showing him the book), then I want you to point

TABLE 1

THE MEANS AND STANDARD DEVIATIONS OF THE AGE AND IQ OF THE SAMPLE

Group		Kindergarten Mean	Kindergarten SD	Three Mean	Three SD	Five Mean	Five SD
EXPERIMENTAL	Age (in months)	64.3	3.1	102.8	8.4	126.0	5.9
	IQ	105.9	14.7	108.0	12.9	103.8	10.1
CONTROL	Age (in months)	65.1	3.2	101.8	7.3	126.2	7.7
	IQ	102.7	11.3	109.8	15.3	105.5	10.2

TABLE 2

THE MEAN AGE OF SUBJECTS BY SEX, GRADE LEVEL AND EXPERIMENTAL TREATMENT
(AGE IS GIVEN IN MONTHS)

	GRADE											
	Kindergarten				Three				Five			
	Male		Female		Male		Female		Male		Female	
Group	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
EXPERIMENTAL	63.5	2.9	65.1	3.2	104.8	11.1	100.8	3.8	127.5	6.9	124.6	4.6
CONTROL	65.8	3.4	64.3	2.8	97.7	2.7	105.8	8.2	127.7	5.5	124.7	9.4

TABLE 3

THE MEAN IQ OF SUBJECTS BY SEX, GRADE LEVEL AND EXPERIMENTAL TREATMENT
(IQ IS GIVEN IN %)

	GRADE											
	Kindergarten				Three				Five			
	Male		Female		Male		Female		Male		Female	
Group	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
EXPERIMENTAL	107.8	9.9	104.0	18.6	109.8	14.1	106.3	12.1	105.1	12.1	102.4	7.9
CONTROL	104.7	14.0	100.7	7.8	114.8	16.0	104.8	13.3	108.0	12.0	102.9	7.6

to all the pictures in the book that you think 'go' with the word I give you." He was then shown a card 3" x 6" on which the word Insert was written in bold type. He was then told, "The first word is insect." He was thus given an auditory and a visual stimulus of the concept label. He was next asked to name any insects that he knew. His answer was recorded. The above question was asked to ascertain that the subject had some notion of the concept being investigated. If a subject was unable to name at least one correct instance of the concept he was eliminated from the study. However, as it turned out all subjects tested were able to name at least two correct instances.

For the control group, the child was then shown the pictures in the instrument designed to test the ability to generalize the concept Insect. The subject was then told, "Now point to the pictures that you think 'go' with the word insect." His selections were recorded. The subject was not told if his selections were right or wrong. The subjects were not helped in any way. However, occasionally and when the experimenter deemed it necessary, subjects were asked for the identity of certain stimuli they had selected and why they selected them. Half the subjects were shown the pictures from left to right and half the other way round. The same procedure was repeated with the investigation of the concept Animal. Again half the children in each grade were tested on the instrument determining the ability to generalize the concept Insect first followed by that testing the ability to generalize the concept Animal. The other half of the children were tested on the concepts the other way around, i.e., Animal first, followed by Insect. This was done to avoid order effects.

In the case of the experimental group, after the subject had given one or more examples of the concept Insect, he was shown pictures of equal numbers of instances and non-instances of the concept Insect at each of the three degrees of complexity. The positive and negative instances were pointed out to the subject and he was specifically told that the positive instances 'go' with the word insect. The pictures shown were not included in the testing instrument. The purpose of showing the positive and negative instances of the concept Insect was to give the subject a mental set and to ensure that the subject understood the task.

The subject was then asked to point to all the pictures in the instrument that he thought 'went' with the word insect. His selections were recorded and again as and when deemed necessary the subject was asked to identify the stimuli he had selected and why he selected them. Once again the subject was not told if his selections were correct or not. The same strategy was repeated for the test of the ability to generalize the concept Animal and the same procedures undertaken earlier to avoid order effects were repeated again.

The subjects were also individually tested for their intelligence on Form 1 of the Quick Test. This was essentially a verbal and perceptual test of intelligence and was carried out a week after the children had been tested on their ability to generalize the concepts Insect and Animal.

STATISTICAL DESIGN

This study attempted to determine the nature of two concepts used by children and their ability to generalize these concepts from instances of increasing complexity, under two conditions: a) without a mental set, and b) after being given a mental set of the task. A posttest-only control group design (Design 6) as presented by Campbell and Stanley (1966) was employed in this study. This design is particularly strong in internal validity since random assignment to two groups controls the effect of the extraneous variables that could possibly affect the results of this study.

METHOD OF ANALYSIS

All scores obtained on the instruments measuring the ability to generalize the concepts Insect and Animal were subjected to a Guttman Scale analysis. This was done to establish that the organization of items in the two instruments constituted valid scales. The composite scores obtained by each subject on each of the two instruments were analyzed by means of multiple regression analysis. Regression analysis allows one to obtain an accurate estimate of the effect of one or more independent or predictor variables on the dependent or criterion variable, while taking into account or controlling for the effect of one or more of the independent variables.

In this study, multiple linear regression was employed as a descriptive tool by which the linear dependence of the ability to generalize a concept on age, IQ, sex and mental set was determined. It was also used for evaluating various hypotheses about the population in question.

Since the independent variables used in this study were measured on different units (e.g., age in months, IQ in percentages, sex and mental set in categorical units) standardized regression coefficients also known as beta weights were used to compare the relative effects of each independent variable on the dependent variable. These values were obtained based on the assumption that the sum of the squared differences between the estimated value of the dependent variable and its observed value for each case was minimal.

Statistics were also computed which indicated the strength and direction of the relationships between the independent variables and the dependent variable. Thus the proportion of variance in the dependent variable accounted for by differences in the independent variable(s) taken one at a time or together was indicated by the coefficient of determination or R^2; this is the square of the correlation r between an independent variable and the dependent variable. The sign of the correlation r indicated the direction of the relationship.

The significance of the contribution of any one variable in the presence of the other independent variables was obtained by computing an F ratio of the squared multiple correlations (R^2) of the appropriate regression models. The reader is referred to Nie et al., 1975 for a more detailed discussion of the analysis. Since the regression analysis tells only if there is a significant difference, one has to reexamine the means of the cells in the design to determine where that difference lies. In this context, t-tests ($p = .05$) and Scheffe tests ($p = .05$) for contrasting pairs of means were computed for the data.

All calculations in the study were done on a computer using the Statistical Package for the Social Sciences program (SPSS). The SPSS manual is available through the Newfoundland Computer Services terminal at Memorial University.

CHAPTER IV

ANALYSIS OF DATA

Overview

The purpose of this chapter is fourfold. First, to present the results of a Guttman Scale analysis carried out on the data to establish whether the organization of items in each of the two instruments measuring the ability to generalize the concepts Insect and Animal constituted a valid scale. Second, to examine a) the correlations that existed between the dependent and the independent variables, b) between the set of independent variables themselves, and c) between the set of dependent variables. Third, to examine the relative and simultaneous effects that age, IQ, sex and mental set have upon the total mean percentage scores measuring the ability to generalize the concepts Insect and Animal. Fourth, to examine the extent to which the concepts Insect and Animal were undergeneralized and overgeneralized by the children in this study. Pearson product-moment correlations are used as the measures of association between variables and regression analysis is used to identify the relative and simultaneous effects of the independent variables on the ability to generalize the given concepts. Finally, where t-tests or Scheffe tests are used for making multiple comparisons between contrasting pairs of means, a probability level of $p = .05$ was established as necessary for significance.

RESULTS OF THE ANALYSIS

The analysis to be presented in this section deals with the responses of 144 subjects on two instruments. The first instrument measured the ability to generalize the concept Insect. The second measured the ability to generalize the concept Animal. Specifically, the instruments determined the extent to which children could infer the concepts Insect and Animal from three sets of instances, each set displaying a progressively decreasing number of attributes of the two concepts.

These three sets of representations were referred to as instances of the First, Second and Third Degrees of Complexity, respectively, as explained in Chapter III. Pictures of the complete insect or animal were considered to represent instances of the First Degree of Complexity. There were 10 such pictures of insects and 24 pictures of animals. Pictures showing part of an insect's body or an animal's body were taken to represent instances of the Second Degree of Complexity. There were five such pictures of insects and 18 pictures of animals. Pictures of products of the natural activity of insects and animals were taken to represent instances of the Third Degree of Complexity. There were five such pictures of insects and 10 of animals. It should be borne in mind that an insect is also an animal. As such, pictures of insects were also included as instances of the concept Animal; however, no picture of an insect used as an instance of the concept Animal was repeated as an instance of the concept Insect.

Method of Quantifying Responses

For every correct instance of a concept that a subject selected, he was awarded one point. Thus the maximum number of points that a subject could obtain if he recognized all the instances of the concept Insect was 20. That is, 10 for the First Degree of Complexity and 5 each for the Second and Third Degrees of Complexity. Similarly for the concept Animal, the maximum score that a subject could obtain if he selected all the instances was 52. That is, 24 for the First Degree of Complexity, 18 for the Second Degree of Complexity, and 10 for the Third Degree of Complexity.

The Main Problem

The main problem of the study was to determine the extent to which generalization to the concepts Insect and Animal would take place as a function of experience with stimulus materials (i.e., the mental set) and as a function of various developmental criteria, age and IQ, as well as sex. The score obtained by a subject on each degree of complexity was considered to be a measure of the subject's ability to generalize a given concept. A composite score obtained by summing up an individual's scores on each degree of complexity would then be an overall crude measure of the extent to which an individual was able to generalize a concept. This is based on the assumption that the three degrees of complexity have an order of increasing difficulty. Support for this assumption would be provided if the data conformed to the requirements of scaling procedures. In this case, a Guttman scaling analysis was used to determine if the organization of the two instruments constituted valid scales.

Guttman Scaling

Guttman scale analysis is a means of analyzing the underlying operating characteristics of three or more items in order to determine if their interrelationships meet several special properties. These properties are as follows: First, the scale must be unidimensional, with component items all measuring movement toward or away from the same single underlying object of study. In this study it would be ability to generalize. Secondly, the scale must be cumulative so that all the component items are ordered by degree of difficulty (they are intended to be in this study); the items of the Third Degree of Complexity being considered more difficult than the items of the Second Degree of Complexity, which in turn are considered more difficult than those of the First Degree of Complexity. This organization is determined by the coefficient of scalability.

Thus, individuals failing items which are less difficult are not expected to pass items which are more difficult. Conversely, individuals passing more difficult items are expected to pass the less difficult ones. Furthermore each item in a Guttman scale must be ordinal to the degree of having the capacity of being divided at some point into two portions--pass or fail. The cutting points used in this study were the mean scores* on each degree of complexity. Thus subjects having values equal to or greater than the selected cutting points are considered to have passed and those having values less than the cutting points are considered to have failed the items.

If a scale is valid, that is, it is truly unidimensional and cumulative, the coefficient of scalability should be over 0.6 (Nie et al., 1975). An additional statistic which may be used to determine the validity of a scale is the coefficient of reproducibility. Generally a coefficient

*The means were used as cutting points because it was felt that more than half of items correct indicated an understanding of the concept.

of reproducibility of around 0.9 is considered to indicate a valid scale (Nie et al., 1975).

The results of the Guttman analysis performed on the data of this study are displayed in Figures 1 and 2. As can be seen, the data conform to the requirements of the Guttman scale. The coefficient of scalability of the items for the concepts Insect and Animal are 0.61 and 0.70, respectively. The coefficients of reproducibility for the instruments measuring the ability to generalize the concept Insect and the concept Animal were 0.875 and 0.90, respectively. Although the value of 0.875 is slightly lower than the required value of 0.9 for the coefficient of reproducibility for the concept Insect, it was considered sufficiently high enough for the purposes of this study.

Since the data of this study meet the requirements of the Guttman scale, a total score obtained by summing up the scores obtained by a subject on each of the three degrees of complexity can be considered to be an index of the extent to which the subject could generalize a given concept; an index being any measure which combines the values of several variables or items into a composite measure. This measure could then be used to predict or gauge some underlying continuum, for example, the ability to generalize, which is only partially measured by any item, set of items, or variables which are included in the index. In this case, it would be each degree of complexity. Thus the basic datum

	1st Degree of Complexity		2nd Degree of Complexity		3rd Degree of Complexity		
ITEM	0	1	0	1	0	1	
RESP.	ERR		ERR		ERR		TOTAL
3	0	70	0	70	0	70	70
		ERR					
2	19	12	9	22	3	28	31
				ERR			
1	17	4	10	11	15	6	21
						ERR	
0	22	0	22	0	22	0	22
SUMS	58	86	41	103	40	104	144
PCTS	40	60	28	72	28	72	
ERRORS	0	16	9	11	18	0	54

144 cases were processed
0 (or 0.0 pct) were missing

Statistics:
Coefficient of Reproducibility = 0.875
Minimum Marginal Reproducibility = 0.6782
Percent Improvement = 0.1968
Coefficient of Scalability = 0.6115

Correlation Coefficients:

	3rd Degree of Complexity	2nd Degree of Complexity	1st Degree of Complexity
3rd Degree of Complexity	1.0000	0.8742	0.6795
2nd Degree of Complexity	0.8742	1.0000	0.8336
1st Degree of Complexity	0.6510	0.8365	0.6473
SCALE-ITEM	0.6510	0.8365	0.6473

Division point for 1st Degree of Complexity = 9.30
Division point for 2nd Degree of Complexity = 4.50
Division point for 3rd Degree of Complexity = 3.00

FIGURE 1. A GUTTMAN SCALE ANALYSIS FOR THE INSTRUMENT MEASURING THE ABILITY TO GENERALIZE THE CONCEPT INSECT.

	1st Degree of Complexity		2nd Degree of Complexity		3rd of Complexity		
ITEM	0	1	0	1	0	1	
RESP.	ERR		ERR		ERR		TOTAL
	0		0	48	0	48	48
		ERR					
	38	7	3	42	4	41	45
				ERR			
	23	4	17	10	14	13	27
						ERR	
	24	0	24	0	24	0	24
SUMS	85	59	44	100	42	102	144
PCTS	59	41	31	69	29	71	
ERRORS	0	11	3	10	18	0	42

144 cases were processed
0 (or 0.0 pct) were missing

Statistics:
Coefficient of Reproducibility = 0.9028
Minimum Marginal Reproducibility = 0.6644
Percent Improvement = 0.2384
Coefficient of Scalability = 0.7103

Correlation Coefficients:

	3rd Degree of Complexity	2nd Degree of Complexity	1st Degree of Complexity
3rd Degree of Complexity	1.0000	0.7027	0.6190
2nd Degree of Complexity	0.7027	1.0000	0.8298
1st Degree of Complexity	0.6190	0.8298	1.0000
SCALE-ITEM	0.4541	0.6810	0.6306

Division point for 1st Degree of Complexity = 21.5
Division point for 2nd Degree of Complexity = 15.0
Division point for 3rd Degree of Complexity = 4.10

FIGURE 2. A GUTTMAN SCALE ANALYSIS FOR THE INSTRUMENT MEASURING THE ABILITY TO GENERALIZE THE CONCEPT <u>ANIMAL</u>.

used in the analysis was the total score obtained by a subject of all the three degrees of complexity. To facilitate comparisons of the ability to generalize across concepts, the total percentage score of each subject was utilized.

Basic Zero-Order Relationships

Basic zero-order relationships (correlation coefficients) indicate the degree to which variation in one variable is related to variation in another. Table 4 displays all the intercorrelations obtained in this study and their associated levels of statistical significance.

Relationships Between Dependent and Independent Variables

The intercorrelations that are discussed in this section are as follows:

1. a) The correlation between the total mean per-percentage score on the instrument measuring the ability to generalize the concept Insect (CI), the dependent variable, and age.

   b) The correlation between the total mean percentage score on the instrument measuring the ability to generalize the concept Animal (CA), i.e., another dependent variable, and age.

2. a) The correlation between CI and IQ.

   b) The correlation between CA and IQ.

3. a) The correlation between CI and sex.

   b) The correlation between CA and sex.

4. a) The correlation between CI and mental set.

   b) The correlation between CA and mental set.

The Relationship Between the Dependent Variables CI, CA, and Age

The correlation between age and the total mean percentage score on the test of the ability to generalize the concept <u>Insect</u> was 0.57. The correlation between age and the total mean percentage score on the test of the ability to generalize the concept <u>Animal</u> was 0.50. Both coefficients were significant at the p = 0.001 level. This data supports the results of other studies, suggesting that age would contribute significantly in the regression equations of the scores on the tests of the ability to generalize the concept <u>Insect</u> and the concept <u>Animal</u>. The positive relationship between the independent and dependent variables indicates that ability to generalize increases with age.

The Relationship Between the Dependent Variables and IQ

The correlations between IQ and the total mean percentage scores on the tests of the ability to generalize the concept <u>Insect</u> and the concept <u>Animal</u> were rather low and negative in nature. They were not significant. This suggests that IQ does not have a significant effect on the ability to generalize the concept <u>Insect</u> and the concept <u>Animal</u>.

The Relationship Between the Dependent Variables and Sex

The correlations between sex and the total mean percentage scores on the tests of the ability to generalize the concept Insect and the concept Animal were low and insignificant. They were 0.09 and -0.04, respectively. This data supports the findings of previous studies on concept attainment which state that there is no significant relationship between sex and the ability to attain concepts.

The Relationship Between the Dependent Variables and Mental Set

The correlation between mental set and the total mean percentage score on the test of the ability to generalize the concept Insect was 0.15. This was significant at the p = 0.05 level. The correlation between mental set and the total mean percentage score on the test of the ability to generalize the concept Animal was 0.38. This was significant at the p = 0.001 level. This result indicated that mental set would contribute relatively more in the regression of the scores on the test of the ability to generalize the concept Animal than that of the concept Insect.

The Relationships Between the Independent Variables

The relationships between the independent variables age, IQ, sex and mental set are also presented in Table 4. It can be seen that there is a low negative correlation of -0.04 between age and IQ which is insignificant. Age and

TABLE 4

INTERCORRELATIONS BETWEEN THE VARIABLES USED IN THE STUDY OF THE ABILITY TO GENERALIZE THE CONCEPTS INSECT AND ANIMAL

Variable	CI	CA	Age	Mental Set	IQ	Sex
CI	--	0.529	0.573	0.151	-0.010	0.09
CA	.001	--	0.509	0.388	-0.054	-0.040
Age	.001	.001	--	-.001	-0.040	0.005
Mental Set	.036	.001	.497	--	-0.004	0.00
IQ	.454	.262	.320	.482	--	0.1919
Sex	.155	.334	.475	.5	.011	--

Note: correlation coefficients are above the diagonal; levels of significance are below the diagonal.

CI = Total mean percentage score on the instrument measuring the ability to generalize the concept Insect.

CA = Total mean percentage score on the instrument measuring the ability to generalize the concept Animal.

sex did not show any correlation nor did age and mental set. There is a low negative correlation between IQ and mental set; however, it is not significant. Sex showed a low positive correlation with IQ which is significant at the $p = 0.01$ level. Except for this one low but significant correlation, all the other correlations between the independent variables were low and insignificant. This data suggests that the regression analysis will not be confounded by the effects of multicollinearity (Nie et al., 1975).

The Relationship Between the Dependent Variables

There was a moderate but positive correlation of 0.52 between the total mean percentage scores on the tests of the ability to generalize the concept Insect and the concept Animal. This correlation was significant at the $p = 0.001$ level. This suggests that the two tests evaluate a somewhat related ability.

The Effect of Age, IQ, Sex and Mental Set on the Ability to Generalize the Concept Insect and the Concept Animal

In an effort to determine the effects of the independent variables on the ability to generalize the concept Insect and the concept Animal, separate regression analyses were carried out on the data for the two concepts. The total mean percentage scores for the two concepts, obtained by subjects in each grade with and without a mental set, were used in the analysis. These scores are displayed in

Table 5. Of the variables explored (age, IQ, sex and mental set) only age and mental set proved significant in influencing the ability to generalize the concept Insect and the concept Animal.

The Effect of Age on the Ability to Generalize the Concept Insect

Research in the field of concept development has quite consistently shown that age is significant in influencing the ability to generalize and attain concepts (Thompson, 1941; Clark, 1971). The results of the regression analysis of the scores on the test of the ability to generalize the concept Insect reported in Table 6 show that age was significant ($F = 71.5$; $p = 0.001$) in influencing the ability to generalize the concept Insect. The value of the standardized beta coefficient (β) for age was 0.57. This value indicated the relative extent to which age influenced the ability to generalize the concept Insect. This was interpreted to mean that a one standard deviation-unit change in the age variable produced a 0.57 standard deviation-unit change in the dependent variable. Furthermore, the value of R^2 for age was equal to 0.329. This indicated that when all other variables were held constant, age accounted for 32.9% of the variance in the dependent variable.

TABLE 5

TOTAL MEAN PERCENTAGE SCORES OF THE ABILITY TO GENERALIZE THE CONCEPTS INSECT AND ANIMAL BY GRADE LEVEL AND MENTAL SET

		Scores on Ability to Generalize					
		GRADES					
		Kindergarten		Three		Five	
Concept	Group	Mean	SD	Mean	SD	Mean	SD
INSECT	Mental Set	66.94	23.53	89.31	10.31	95.69	8.43
	No Mental Set	66.25	20.32	76.53	12.09	91.94	10.02
ANIMAL	Mental Set	66.21	14.44	78.99	11.78	88.73	8.36
	No Mental Set	54.84	16.82	66.91	9.49	74.33	11.95

TABLE 6

RESULTS OF THE REGRESSION ANALYSIS: THE EFFECTS OF AGE AND MENTAL SET ON THE TOTAL MEAN PERCENTAGE SCORES OF THE ABILITY TO GENERALIZE THE CONCEPT INSECT

	Dependent Variable--Ability to Generalize the Concept Insect				
	1	2	3	4	5
Independent Variables	Unstandardized Beta Coefficient B	Standardized Beta β	Standard Error Beta	F	p
Age	0.41883	0.57271	0.04952	71.525	0.001
Mental Set	5.72911	0.15055	2.57697	4.943	0.001
Constant	35.77259				
R^2 (age)	0.3290				
R^2 (mental set)	0.0220				
R^2	0.3510				

The Effect of Age on the Ability to Generalize the Concept Animal

Age also had a significant effect on the ability to generalize the concept *Animal*. The F value obtained for age was 61.083; this was significant at the $p = 0.001$ level. The standardized beta (β) value for age was 0.50. This was interpreted to mean that a one standard deviation-unit change in the age variable produced a 0.50 standard deviation-unit change in the ability to generalize the concept *Animal*. Table 7 summarizes the results of the regression analysis. The value of R^2 for age (*i.e.*, when all other variables are held constant) was 0.25. This indicated that the age variable accounted for 25.9% of the variance in the dependent variable.

Mental Set and the Ability to Generalize the Concept Insect

No studies have examined the effects of instruction on ability to generalize; however, a few experimental studies have examined the effects of instruction on the ability of children to attain concepts. In each case instruction or mental set has been found to significantly affect the child's ability to attain concepts (Osler & Weiss, 1962; Gollin, 1960). In this study the results (Table 6) show that mental set significantly affected the ability to generalize the concept *Insect*. The F value for mental set was 4.943 and this was significant at $p = .001$ level. The standardized beta coefficient (β) for mental set was 0.15. This meant that compared to age ($\beta = 0.57$) mental set was

TABLE 7

RESULTS OF THE REGRESSION ANALYSIS: THE EFFECTS OF AGE AND MENTAL SET ON THE TOTAL MEAN PERCENTAGE SCORES OF THE ABILITY TO GENERALIZE THE CONCEPT ANIMAL

	Dependent Variable--Ability to Generalize the Concept *Animal*				
	1	2	3	4	5
Independent Variables	Unstandardized Beta Coefficient B	Standardized Beta β	Standard Error Beta	F	p
Age	0.317340	0.50854	0.04060	61.803	.001
Mental Set	12.60369	0.38814	2.11106	35.645	.001
Constant	38.42692				
R^2 (age)	0.2597				
R^2 (mental set)	0.1507				
R^2	0.4104				

very much less effective in influencing the ability to generalize the concept Insect. The R^2 value for mental set, with age in the equation, was 0.022. This meant that mental set explained only 2.2% of the variation in the dependent variable, compared to the 32.9% of variation explained by age. Thus, the two variables age and mental set, simultaneously explained ($R^2 = 0.351$) 35.1% of the variation in the scores of the ability to generalize the concept Insect. Figure 3 gives a pictorial representation of the amount of variance accounted for in the dependent variable by age and mental set.

Mental Set and the Ability to Generalize the Concept Animal

A regression analysis carried out on the data for the concept Animal and reported in Table 7 shows that the F value for mental set was 35.645. This was significant at the $p = .001$ level. The standardized beta coefficient (β) for mental set was 0.38. This value was only slightly lower than the value of 0.50 for age. This indicated that although mental set was significant in influencing the ability to generalize the concept Animal, its influence was slightly less than that of age.

The value of R^2 for mental set, when the other variables were held constant, showed that it was 0.1507. This indicated that 15% of the variance in the dependent variable was accounted for by the mental set, compared to

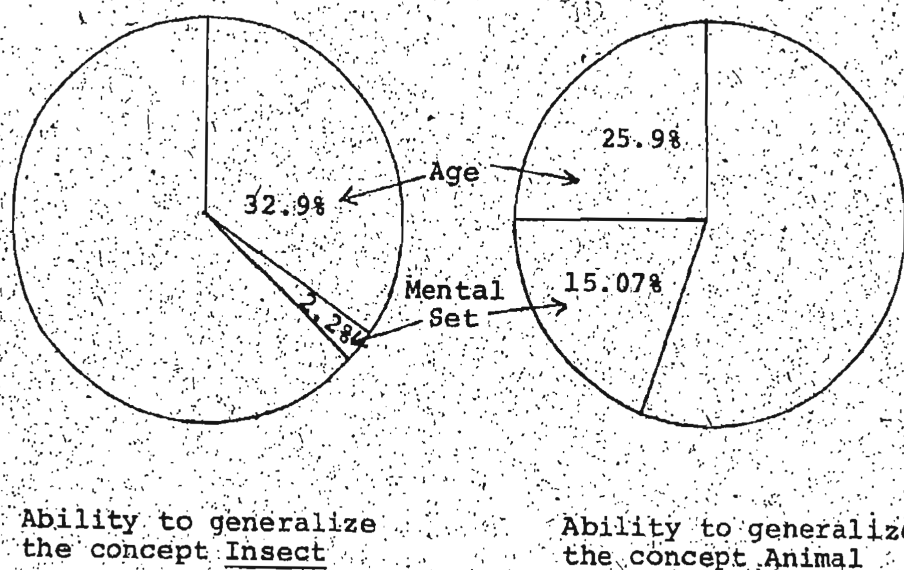

FIGURE 3. AMOUNT OF VARIANCE EXPLAINED BY AGE AND MENTAL SET IN THE SCORES OF THE ABILITY TO GENERALIZE

the 25.9% accounted for by age. Thus both age and mental set simultaneously accounted for ($R^2 = 0.4104$) 41% of the variance in the scores of the ability to generalize the concept Animal. Figure 3 also presents a pictorial representation of the amount of variance accounted for in the dependent variable by age and mental set.

Determination of the Specific Significant Effects of Age and Mental Set

The results of the regression analyses showed that age and mental set were significant in their effect on the ability to generalize the concepts Insect and Animal. However, as stated earlier, regression analysis tells only if there is a significant difference. Scheffe tests ($p < .05$) making multiple comparisons of the total mean percentage scores on the tests of the ability to generalize the concepts Insect and Animal were computed for a) subjects not given a mental set (i.e., the control group) and b) subjects given a mental set (i.e., the experimental group). These tests indicated which of the children in the above groups differed in their ability to generalize the concepts as a consequence of age. T-tests were computed comparing the means of the control and the experimental group of subjects for each concept. These tests revealed which subjects were affected by the mental set. Table 8 gives the results of the t-tests.

TABLE 8

RESULTS OF T-TESTS COMPARING THE TOTAL MEAN PERCENTAGE SCORES OF CONTROL AND EXPERIMENTAL GROUPS ON THE ABILITY TO GENERALIZE THE CONCEPTS INSECT AND ANIMAL

Concept		difference*	df	t	Prob.
INSECT	Kindergarten	0.69	46	-0.11	0.913
	Grade 3	12.78	46	-3.94	0.000
	Grade 5	3.75	46	-1.40	0.167
ANIMAL	Kindergarten	11.37	46	-2.51	0.016
	Grade 3	12.08	46	-3.91	0.000
	Grade 5	14.40	46	-4.84	0.000

*Difference = mean % score of experimental group--mean % score of control group.
Number of subjects per group = 48.

The Specific Effect of Age on the Ability to Generalize the Concept Insect for the Control Group of Subjects

The total mean percentage score on the test of the ability to generalize the concept Insect was 66.2 for the kindergarten subjects. The corresponding scores of the third graders and the fifth graders were 76.5 and 91.9, respectively. Table 5 gives a summary of these scores. Scheffe's tests of multiple comparisons revealed that the kindergarteners' and the third graders' scores did not differ significantly ($p < .05$). Only the fifth graders' score was significantly different from that of the kindergarten and grade three subjects.

This suggests that without a mental set, the kindergarten and grade three subjects did not differ in their ability to generalize the concept Insect. The fifth graders on the other hand showed that they had a greater ability to generalize the concept Insect compared to the kindergarten and grade three subjects.

The Specific Effect of Age on the Ability to Generalize the Concept Insect for the Experimental Group of Subjects

The total mean percentage score obtained by kindergarteners on the test of the ability to generalize the concept Insect was 66.9. The corresponding scores of the third graders and the fifth graders was 89.3 and 95.7, respectively. Table 5 summarizes the above results. The results of Scheffe tests comparing the above means showed that the scores of the third grade and fifth grade subjects did not differ significantly. These scores, however, differed significantly ($p < .05$) from that of the kindergarten subjects. This suggests that the kindergarten subjects had a lesser ability to generalize the concept Insect compared to the third and fifth grade subjects. The third and fifth grade subjects who had been given a mental set did not differ in their ability to generalize the concept Insect.

The Specific Effect of Age on the Ability to Generalize the Concept Animal for the Control Group of Subjects

The kindergarten subjects obtained a total mean percentage score of 54.8 on the test of the ability to generalize the concept Animal. The grade three and grade five subjects obtained scores of 66.9 and 74.3, respectively. Scheffe tests comparing these means revealed that there was no significant difference between the means of the grade three and grade five subjects. However, these means were significantly different from that of the kindergarten subjects. This suggested that of the children who were not given a mental set, the kindergarten subjects had a lesser ability to generalize the concept Animal compared to the third and fifth grade subjects, who did not differ in this respect.

The Specific Effect of Age on the Ability to Generalize the Concept Animal for the Experimental Group of Subjects

The kindergarten subjects obtained a total mean percentage score of 66.2 on the test of the ability to generalize the concept Animal. The grade three subjects had a score of 78.9 while the fifth graders obtained a score of 88.7. Table 5 summarizes the above results. A Scheffe test of multiple comparisons of the above means revealed that these scores were significantly different ($p < .05$) from each other.

This suggested that of the subjects who were given a mental set, kindergarten subjects had the lowest ability to generalize the concept Animal. The fifth graders had the highest ability and the third graders had an ability to generalize this concept which was between that of the kindergarten and grade five subjects. In other words, for subjects given a mental set the ability to generalize the concept Animal was a function of age.

The Specific Effect of Mental Set on the Ability to Generalize the Concepts Insect and Animal

The results of two separate regression analyses reported in Tables 6 and 7 showed that mental set significantly affected the ability to generalize the concepts Insect and Animal. In an effort to determine which group of subjects were significantly affected by the mental sets, *t*-tests (Nie et al., 1975) were computed comparing the means of subjects who were given a mental set and those who were not given one for each concept, at each grade level.

The Specific Effect of a Mental Set on the Ability to Generalize the Concept Insect

The *t*-tests revealed that there was no significant difference between the total mean percentage scores on the test of the ability to generalize the concept Insect of kindergarten subjects who had been given a mental set and those who were not given one. Both groups of subjects had comparatively low total mean percentage scores of 66.9 and 66.2, respectively.

This result suggested that the mental set had no effect on the ability of kindergarten children to generalize the concept Insect. In other words, these kindergarten children were unable to benefit from instruction. This could be due to three reasons. One, that the instances presented in the mental set for the concept Insect were limiting in nature and therefore narrow in scope for the children to benefit; two, the children preferred not to make use of the mental set; and three, the children did not possess the ability to make use of the mental set.

Grade three children who had been given a mental set differed significantly ($p < .0001$) from their peers who had not been given a mental set. Their respective total mean percentage scores on the test of the ability to generalize the concept Insect were 89.3 and 76.5. This suggests that the mental set significantly affected the ability of these children to generalize the concept Insect. In other words, these children, unlike the kindergarteners, were able to make use of the mental set to improve their ability to generalize this concept. This they did by including more instances of the concept Insect than their peers who were not given a mental set.

There was, however, no significant difference between the total mean percentage scores of grade five subjects who were given a mental set and those who were not given one. Their respective scores were 95.7 and 91.4.

These are comparatively high scores resulting in a ceiling effect. This suggests that the instances were easy for the fifth graders and the mental set made no difference to their ability to generalize the concept Insect.

The Specific Effect of a Mental Set on the Ability to Generalize the Concept Animal

It was earlier shown that mental set had a significant effect on the ability to generalize the concept Animal. In order to determine which groups of children benefitted from the mental set, t-tests were carried out on the data comparing the total mean percentage scores of subjects who were given a mental set and those who were not given one. The results of the t-tests are reported in Table 8.

The total mean percentage scores on the test of the ability to generalize the concept Animal of kindergarten subjects who were given a mental set and those who were not given one were 66.2 and 54.8, respectively. These scores were significantly different at the $p < 0.05$ level. This suggests that the mental set significantly affected the ability of these children to generalize the concept Animal. In other words, the kindergarten subjects were able to make use of the mental set to include more instances of the concept Animal and thus improve their ability to generalize the concept.

Grade three subjects who were given a mental set and those who were not given one obtained scores of 78.9 and 66.9 on the test of the ability to generalize the concept Animal. These scores were significantly different at the $p < .001$ level. This again suggested that the mental set significantly affected these children's ability to generalize the concept Animal. The grade three subjects thus improved their ability to generalize as a result of the mental set.

The results show that the fifth graders who had been given a mental set obtained a total mean percentage score of 88.7. This score was significantly greater ($p < .001$) than that obtained by grade five subjects (74.3) who were not given a mental set. Thus the mental set also affected the ability of these children to generalize the concept Animal. They were able to improve their ability to generalize this concept as a result of the mental set. The mental set was therefore effective in enabling all the children to improve upon their ability to generalize the concept Animal.

The Ability to Generalize the Concepts Insect and Animal as a Function of the Degrees of Complexity

The total mean percentage number of correct instances of a given concept selected by a subject was taken as a gross index of the ability to generalize that concept. A comparison of this score for two subjects only tells if there is a difference in their ability to generalize the given concept. It does not tell in which particular sets of instances of the three degrees of complexity the two subjects differed in their selections. To determine where the actual differences lay, a detailed analysis of the scores obtained by each subject for each degree of complexity was computed for each of the two concepts. Table 9 gives the mean number of instances of each degree of complexity selected by subjects for the concept Insect and the concept Animal.

Ability to Generalize the Concept Insect as a Function of Mental Set and Degrees of Complexity

T-tests comparing the mean percentage numbers of instances of each degree of complexity of the concept Insect selected by control and experimental groups of subjects in each grade were computed. The results of the *t*-tests are summarized in Table 10. It was found that there were no significant differences between the means of each of the three degrees of complexity of kindergarten subjects with or without a mental set. The results of this analysis further support the earlier result that there was no significant difference in the ability of kindergarten children to generalize the concept Insect, with or without a mental set.

In the case of grade three children, a similar series of *t*-tests computed on the mean percentage scores of these children revealed that the subjects who were given a mental set selected a significantly greater ($p < .001$)

TABLE 9

MEAN SCORES OF EACH DEGREE OF COMPLEXITY FOR THE CONCEPTS INSECT AND ANIMAL BY GRADE AND EXPERIMENTAL TREATMENT

Concept	Degree of Complexity	Group*	GRADE Kindergarten Mean	Kindergarten SD	Three Mean	Three SD	Five Mean	Five SD
INSECT	1	1	8.33 (83.3)**	2.35	9.88 (98.8)	0.34	9.92 (99.2)	1.84
		2	8.21 (82.1)	2.11	9.79 (97.9)	0.42	10.0 (100)	0
	2	1	3.79 (75.8)	1.32	4.79 (95.8)	0.51	4.96 (99.2)	0.20
		2	3.88 (77.5)	1.33	4.63 (92.5)	0.58	5.0 (100)	0
	3	1	2.08 (41.7)	1.41	3.67 (73.3)	1.27	4.63 (92.5)	0.88
		2	1.96 (39.2)	1.37	1.96 (39.2)	1.60	3.79 (75.8)	1.50

(cont'd.)

Table 9 (cont'd.)

			GRADE					
			Kindergarten		Three		Five	
Concept	Degree of Complexity	Group*	Mean	SD	Mean	SD	Mean	SD
ANIMAL	1	1	20.92 (87.2)	4.23	22.46 (93.6)	0.98	22.67 (94.4)	0.70
		2	20.08 (83.7)	4.01	21.83 (90.9)	1.17	21.21 (88.4)	2.13
	2	1	14.67 (81.5)	2.96	16.96 (94.2)	1.12	17.04 (94.7)	1.30
		2	11.63 (64.6)	5.40	15.33 (85.2)	1.71	15.83 (88.0)	1.95
	3	1	3.0 (30)	1.69	4.92 (49.2)	3.05	7.71 (77.1)	2.20
		2	1.63 (16.3)	1.38	2.46 (24.6)	2.0	4.67 (46.7)	2.35

*Group: 1 = Experimental group
2 = Control group
**( ) = mean percentage/group

TABLE 10

RESULTS OF T-TESTS COMPARING THE MEAN SCORES OF EACH DEGREE OF COMPLEXITY OF CONTROL AND EXPERIMENTAL GROUPS FOR THE CONCEPTS INSECT AND ANIMAL

Concept	Degree of Complexity	Grade	Difference*	df	t	Probability
INSECT	1	Kindergarten	1.2	46	-0.19	0.847
	2	Kindergarten	-1.7	46	0.22	0.828
	3	Kindergarten	2.5	46	-0.31	0.757
	1	Three	0.9	46	-0.76	0.449
	2	Three	3.3	46	-1.06	0.294
	3	Three	34.1	46	-4.09	0.000
	1	Five	-4.6	46	1.22	0.229
	2	Five	-0.8	46	1.00	0.323
	3	Five	16.7	36.99	-2.35	0.023
ANIMAL	1	Kindergarten	3.5	46	-0.70	0.487
	2	Kindergarten	16.9	35.68	-2.42	0.021
	3	Kindergarten	13.7	46	-3.09	0.003
	1	Three	2.7	46	-2.01	0.05
	2	Three	9.0	39.7	-3.89	0.000
	3	Three	14.6	39.69	-3.30	0.002
	1	Five	6.0	27.96	-3.19	0.003
	2	Five	6.7	46	-2.53	0.015
	3	Five	30.4	46	-4.63	0.000

*Difference = mean percentage score of experimental group--mean percentage score of control group.

number of instances of the Third Degree of Complexity than subjects not given a mental set. Their respective scores were 73.3% and 39.2%. There were no differences detected between the scores of these children on the First and Second Degrees of Complexity. This result meant that the improved performance of the grade three subjects as a result of the mental set was primarily due to their selecting a greater number of instances of the Third Degree of Complexity. It was reasoned earlier (Chapter III) that a subject able to generalize a concept from more of its instances which implicitly suggested the attributes of that concept (i.e., instances of the Third Degree of Complexity) would have a better developed concept than a subject generalizing from a lesser number of such instances. This suggests that not only did the third graders improve their ability to generalize as a result of the mental set, their concept of Insect was better developed as a consequence of the mental set.

A similar series of t-tests computed on the mean percentage scores of the fifth graders revealed that those who were given a mental set selected a significantly greater ($p < .05$) number of instances of the Third Degree of Complexity than those who were not given a mental set. Their respective scores were 92.5% and 75.8%. Again, no differences were detected between the scores of these children on the First and Second Degrees of Complexity. Earlier it was found that there was no difference in the ability of grade five subjects to generalize the concept Insect with or without a mental set. It should, however, be borne in mind that the total mean percentage score used as an index of the ability to generalize was a crude measure as such. A more detailed analysis revealed that the mental set was indeed having an effect as these subjects were including a significantly greater number of instances of the Third Degree of Complexity. This suggests that the fifth graders' concept of Insect was better developed as a result of the mental set.

Ability to Generalize the Concept Animal as a Function of Mental Set and Degrees of Complexity

T-tests were computed comparing the mean percentage number of instances of each degree of complexity selected by control and experimental groups of subjects in each grade. The results of the *t*-tests are summarized in Table 10.

Table 9 shows that the mean percentage number of instances of the Second Degree of Complexity selected by kindergarten subjects with and without a mental set were 81.5 and 64.6. The difference was significant at the $p < .05$ level. These kindergarteners who were given a mental set selected a significantly ($p < .01$) greater percentage of instances of the Third Degree of Complexity than their peers who were not given a mental set. Their respective scores were 30 and 16.3. No difference was detected between their scores on the First Degree of Complexity.

These results indicate that the greater ability of kindergarteners to generalize the concept Animal as a result of a mental set was due to their selecting a significantly greater number of instances of the Second and Third Degrees of Complexity than their peers who were not given a mental set. It also meant their concept of Animal was better developed as a consequence of the mental set.

The t-tests show that the third graders included a significantly ($p < .01$) greater number of instances of all the three degrees of complexity as a result of a mental set. Their respective scores with and without a mental set are as follows: First Degree of Complexity 93.6% and 90.9%; Second Degree of Complexity 94.2% and 85.2%; Third Degree of Complexity 49.2% and 24.6%. It was earlier found that the third graders improved their ability to generalize the concept Animal as a result of a mental set. The present analysis revealed that this improvement to generalize was due to their selecting a significantly greater number of instances of each of the three degrees of complexity than their peers who were not given a mental set. It also indicated that their concept of Animal was better developed as a consequence of the mental set.

A similar finding was obtained for the fifth graders. They too selected a significantly greater ($p < .05$) mean percentage number of instances of each of the three degrees of complexity as a result of a mental set. Their respective scores with and without a mental set were as follows: First Degree of Complexity 94.4% and 88.4%; Second Degree of Complexity 94.7% and 88.0%; Third Degree of Complexity 77.1% and 46.7%.

Again, it was found earlier that the fifth graders improved their ability to generalize as a result of being given a mental set of the concept Animal. This analysis revealed that this improvement in performance was due to selecting a significantly greater number of instances of each degree of complexity than their peers who were not given a mental set. In addition, their concept of Animal was also better developed as a result of the mental set.

The Ability to Generalize the Concept Insect as a Function of Age and Degrees of Complexity

Control group:

It was shown earlier that in the case of subjects not given a mental set, grade five subjects showed a greater ability to generalize the concept Insect than grade three and kindergarten subjects. Scheffe tests ($p < .05$) comparing the mean percentage number of instances of each degree of complexity selected by subjects not given a mental set at each grade level, revealed the following results. There was no difference between the mean number of instances of the First Degree of Complexity selected by grade three (97.9%) and grade five (100%) subjects. These scores, however, differed significantly from that of the kindergarteners (82.1%).

In the case of the instances of the Second Degree of Complexity, again the scores of the third graders (92.5%) and the fifth graders (100%) did not differ. These scores, however, differed significantly ($p < .05$) from that of the kindergarteners (77.5%).

In the case of the instances of the Third Degree of Complexity, fifth graders selected a significantly greater number (75.8%) of instances than the grade three (39.2%) and kindergarten subjects (39.2%).

This suggests that the fifth graders' greater ability to generalize the concept Insect was mainly due to their selecting a significantly greater number of instances of the Third Degree of Complexity than the grade three and kindergarten subjects. It also indicated that the fifth graders' concept of Insect was better developed than that of the younger children.

Experimental group:

Earlier the results showed that of subjects who were given a mental set, the grade three and five subjects did not differ in their ability to generalize the concept Insect. However, their ability to generalize the concept Insect was significantly greater ($p < .05$) than that of the kindergarteners.

A Scheffe test of multiple comparisons ($p < .05$) of the mean percentage number of instances of each degree of complexity of the concept Insect selected by these subjects at each grade revealed these results. There were slight differences between the mean percentage number of instances of the First Degree of Complexity selected by subjects in each grade who had been given a mental set. Kindergarteners selected a mean of 83.3% of instances, grade three subjects selected 98.7% and grade five subjects selected 95.4% of these instances.

On the other hand, grade three (95.8%) and grade five subjects (99.2%) selected a significantly greater ($p < .05$) mean percentage number of instances of the Second Degree of Complexity than kindergarteners (75.8%).

In the case of the instances of the Third Degree of Complexity, the mean percentage number of instances selected by the grade five subjects (92.5%) was significantly greater ($p < .05$) than that of the third graders (73.3%) whose score was in turn significantly greater ($p < .05$) than that of the kindergarteners (41.7%).

These results suggest that the greater ability of grade three and grade five subjects to generalize the concept Insect compared to the kindergarteners was mainly a function of the instances of the Second and Third Degrees of Complexity. Since the fifth graders selected a greater number of instances of the Third Degree of Complexity than the third graders who in turn selected more than the kindergarteners, this suggested that as a result of the mental set the fifth graders' concept of Insect was better developed than that of the third graders whose concept in turn was more developed than that of the kindergarteners.

The Ability to Generalize the Concept Animal as a Function of Age and Degrees of Complexity

Control group:

The results of an earlier analysis showed that of subjects not given a mental set of the concept Animal, grade three and five subjects did not differ in their ability to generalize. Their ability, however, was significantly greater ($p < .05$) than that of the kindergarteners.

Scheffe tests comparing the mean percentage number of instances of each degree of complexity selected by these subjects gave the following results. There were no differences in the mean number of instances of the First Degree of Complexity selected by kindergarteners (83.0%), grade three (90.9%) and grade five (88.4%) subjects. Grade three (85.2%) and grade five (88.8%) subjects selected a significantly greater ($p < .05$) mean number of instances of the Second Degree of Complexity than the kindergarten subjects (64.6%). However, the mean number of instances of the Third Degree of Complexity selected by the grade five subjects (46.7%) was significantly greater than that selected by grade three (24.6%) and kindergarten subjects (16.3%).

These results suggest that the greater ability of the grade three and grade five subjects to generalize the concept Animal in this instance was mainly a function of the Second and Third Degrees of Complexity. Since the fifth graders selected a greater number of instances of the Third Degree of Complexity than the other children, this result suggests that their concept of Animal was better developed than that of the other children. Thus, although the third and fifth grade subjects had a greater ability to generalize than the kindergarten subjects, the fifth graders' concept of Animal was better developed than that of the third graders.

Experimental group:

An earlier analysis for subjects given a mental set showed that the ability to generalize the concept Animal was a function of age. That is, grade five subjects were able to generalize the concept Animal to a greater extent than the third graders who in turn generalized to a greater extent than the kindergarteners.

Scheffe tests of multiple comparisons of the mean percentage number of instances of each of the three degrees of complexity selected by these subjects revealed these results. Kindergarten (87.2%), grade three (93.6%), and grade five subjects (94.4%) did not differ in the mean number of instances that they selected of the First Degree of Complexity.

There was no difference in the mean scores of the grade three (94.2%) and grade five subjects (94.7%) on the Second Degree of Complexity. However, their scores were significantly greater ($p < .05$) than that of the kindergarteners (81.5%). As expected, the grade five subjects' (77.1%) mean number of instances of the Third Degree of Complexity was significantly greater than that of the grade three (49.2%) subjects whose mean score was in turn significantly greater than that of the kindergarteners (30%).

These results indicate that the greater ability of the fifth graders to generalize the concept Animal was primarily due to their selecting a significantly greater number of instances of the Third Degree of Complexity than the other subjects. However, the third graders greater ability to generalize compared to the kindergarteners was mainly due to their selecting a significantly greater number of instances of the Second and Third Degrees of Complexity as a result of the mental set. The results further indicate that the fifth graders' concept of Animal was much better developed than that of the third graders who in turn had a better developed concept than that of the kindergarten subjects.

A Comparison of the Abilities to Generalize the Concepts Insect and Animal

It is an accepted fact that the concept Animal is at a higher level of generality and therefore more inclusive than the concept Insect. This suggests that the concept Animal would be more difficult to generalize than the concept Insect. To test this assumption, correlated t-tests (Nie et al., 1975) were computed comparing the total mean percentage scores of the ability to generalize the concepts Insect and Animal of subjects in each grade. Table 11 gives the total mean percentage scores of subjects on the tests of the ability to generalize the concepts Insect and Animal by grade level. Table 12 summarizes the results of the correlated t-tests.

Kindergarten Subjects

Control group:

The total mean percentage scores obtained by kindergarten subjects on the ability to generalize the concepts Insect and Animal were 66.24 and 54.84, respectively. These scores were significantly different at the $p < .05$ level. This suggests that for these children the concept Insect was more generalizable than the concept Animal.

Experimental group:

The t-tests revealed that the kindergarten children who were given a mental set did not differ in their scores

TABLE 11

COMPARISON OF THE ABILITY TO GENERALIZE THE CONCEPTS INSECT AND ANIMAL BY GRADE AND EXPERIMENTAL TREATMENT

		GRADE					
		Kindergarten		Three		Five	
Group	Concept	Mean	SD	Mean	SD	Mean	SD
CONTROL	Insect	66.25	20.32	76.53	12.09	91.94	10.09
	Animal	54.84	16.82	66.91	9.49	74.33	11.95
EXPERIMENTAL	Insect	66.94	23.53	89.31	10.31	95.69	8.43
	Animal	66.21	14.44	78.99	11.78	88.73	8.36

TABLE 12

RESULTS OF CORRELATED T-TESTS COMPARING THE TOTAL MEAN PERCENTAGE SCORES OF THE ABILITY TO GENERALIZE THE CONCEPTS INSECT AND ANIMAL BY GRADE LEVEL AND EXPERIMENTAL TREATMENT

	Grade	Difference*	df	t	Probability
Kindergarten	1	0.7	23	0.18	0.861
	2	11.41	23	2.21	0.037
Grade 3	1	10.83	23	4.27	0.000
	2	9.61	23	3.23	0.004
Grade 5	1	6.96	23	4.47	0.000
	2	17.61	23	5.46	0.000

Group 1--Experimental; Group 2--Control

*Difference = Total mean percentage score of ability to generalize the concept Insect--total mean percentage score of ability to generalize the concept Animal.

on the ability to generalize the concepts Insect and Animal. Their respective scores were 66.94 and 66.21. This suggests that these children were generalizing the two concepts to the same extent.

Earlier it was shown that the mental set of the concept Insect had no significant effect on the ability of kindergarten children to generalize. Their score of 66.94 obtained as a result of the mental set was not significantly different from a score of 66.25 which was obtained by subjects not given a mental set. However, a mental set of the concept Animal enabled the kindergarten subjects to improve their ability to generalize the concept Animal. Kindergarten subjects given a mental set of the concept Animal obtained a score of 66.21, whereas those not given a mental set obtained a score of 54.84. Clearly then, the mental set of the concept Animal was understood better than the mental set of the concept Insect, in that these children were able to make use of one and not the other. This issue will be taken up further in the discussion. The results therefore suggest that the mental set of the concept Animal enabled the kindergarten subjects to generalize the concept Animal to the same extent as the concept Insect whereas the children were unable to benefit from the mental set of the concept Insect to improve their generalizability, presumably because it was too difficult for them to comprehend.

Grade Three Subjects

In the case of the grade three subjects it was found that, irrespective of a mental set, the concept Insect was more generalizable than the concept Animal. The scores of these children on the instruments measuring the ability to generalize the concepts Insect and Animal (without a mental set) were 76.53 and 66.91, respectively. The corresponding scores of subjects given mental sets were 89.31 and 78.99, respectively. Both sets of scores were significantly different at the $p < .01$ level.

Grade Five Subjects

For these subjects, with or without a mental set, the total mean percentage scores on the instrument measuring the ability to generalize the concept Insect were significantly higher ($p < .01$) than their scores for the concept Animal. The scores of subjects not given a mental set for the concepts Insect and Animal were 91.94 and 74.33, respectively. The corresponding scores of subjects who were given mental sets were 95.69 and 88.73, respectively. This suggests that like the grade three subjects, the fifth graders' concept of Insect was more generalizable than the concept Animal.

The results of a correlated *t*-test comparing the total mean percentage scores on the tests of the ability to generalize the concepts Insect and Animal of all subjects, irrespective of mental set, revealed that the concept Insect was more generalizable than the concept Animal by the children in this study. The total mean percentage score of all children on the test of the ability to generalize the concept Insect was 81.11. The corresponding score of these children for the concept Animal was 71.67. The difference was significant at $p < .001$ level. Table 13 summarizes the results.

TABLE 13

RESULTS OF A CORRELATED T-TEST COMPARING THE ABILITY OF ALL SUBJECTS TO GENERALIZE THE CONCEPTS INSECT AND ANIMAL

Concept	No. of Cases	Mean	SD	T-value	df	Prob.
INSECT		81.1106	19.096			
	144			6.53	143	0.0001
ANIMAL		71.6682				

Undergeneralization and Overgeneralization of the Concepts Insect and Animal

Researchers dealing with undergeneralization and overgeneralization of children's concepts based on the sorting technique generally use pictures displaying the whole object. Subjects are given a concept label and asked to select pictures which they think are instances of the given concept. So as to facilitate comparisons of results with other studies, the number of pictures displaying the whole object (in this case instances of the First Degree of Complexity) selected by each subject will be analyzed to assess undergeneralization and overgeneralization of the children's concepts.

Undergeneralization of the Concept Insect

There were 10 instances of the First Degree of Complexity of the concept Insect, that is, there were 10 pictures of insects. A subject who did not include any of these pictures would have an error score of 10 indicating that he undergeneralized the most. Undergeneralization is defined here as the non-inclusion of an instance when it was in fact an exemplar of a given concept. Table 14 gives the mean number of 'errors' made by subjects for the concept Insect by grade level and experimental treatment.

It is clear from Table 14 that the number of instances undergeneralized by subjects in this study is very small. A Scheffe test of multiple comparisons revealed that of the control group, the kindergarten subjects made a significantly greater ($p < .05$) number of 'errors' than either grade three or grade five subjects. This suggests that the kindergarten subjects undergeneralized more instances of the concept Insect than the older children. A similar result was obtained for the experimental group. The younger children undergeneralized a significantly greater number of instances

TABLE 14

MEAN NUMBER OF 'ERRORS' (INSTANCES UNDERGENERALIZED) FOR THE CONCEPTS INSECT AND ANIMAL BY GRADE AND EXPERIMENTAL TREATMENT

		GRADE					
		Kindergarten		Three		Five	
Concept		Mean	SD	Mean	SD	Mean	SD
INSECT	Control	1.79 (17.9%)	2.11	0.21 (2.1%)	0.41	0.0 (0%)	0.0
	Experimental	1.67 (16.7%)	2.35	0.125 (1.25%)	0.34	0.08 (0.8%)	1.84
ANIMAL	Control	3.92 (16.3%)	4.01	2.17 (9.0%)	1.17	2.79 (11.6%)	2.13
	Experimental	3.08 (12.8%)	4.23	1.54 (6.4%)	0.98	1.33 (5.5%)	0.70

than the older children. T-tests comparing the scores of control and experimental subjects of each grade revealed no differences between these children. Since the older children were rarely undergeneralizing even without a mental set, the result is not surprising. The younger children on the other hand did not benefit from the mental set. Their results reveal that they were undergeneralizing to the same extent with or without a mental set. The results of the t-tests are reported in Table 15.

Overgeneralization of the Concept *Insect*

Overgeneralization has been operationally defined as the inclusion of a non-instance as an exemplar of a given concept. Two types of non-instances or distractors of the concept *Insect* were used in this study. The first type of which there were five, consisted of inaminate objects perceptually similar in general appearance to instances of the concept *Insect*. The second type of non-instances consisted of pictures of animals that were not insects. There were 15 such non-instances.

Overgeneralization of the Concept *Insect* Due to Selection of Non-Instances Perceptually Similar in General Appearance to Instances of the Concept *Insect*

Table 16 gives the mean number of the above non-instances selected by subjects by grade level and experimental treatment. A Scheffe test comparing the means of the control

TABLE 15

RESULTS OF T-TESTS COMPARING THE MEAN NUMBER OF ERRORS (INSTANCES UNDERGENERALIZED) FOR THE CONCEPTS INSECT AND ANIMAL BY GRADE LEVEL

Concept	Grade	Difference*	df	t	Prob.
	Kindergarten	-.12	46	-0.19	0.847
INSECT	Three	-.08	46	-0.76	0.449
	Five	0.08	46	1.22	0.229
	Kindergarten	-.84	46	-0.70	0.487
ANIMAL	Three	-0.63	46	-2.01	0.050
	Five	-1.46	27.96	-3.19	0.003

*Difference is the mean of experimental group--mean of control group

group of subjects revealed that there were no significant differences between these kindergarten, grade three and grade five subjects. This suggests that the control group was overgeneralizing to the same extent.

In comparing the means of the experimental group, a Scheffe test showed that only the kindergarten children differed significantly ($p < .05$) from the fifth graders. The third graders' scores were not different from those of the kindergarten or grade five subjects. This suggested that only the fifth graders benefitted from the mental set.

TABLE 16

MEAN NUMBER OF OVERGENERALIZATIONS FOR THE CONCEPTS INSECT AND ANIMAL DUE TO INCLUSION OF NON-INSTANCES PERCEPTUALLY SIMILAR IN GENERAL APPEARANCE TO INSTANCES OF THE CONCEPTS

		GRADE					
		Kindergarten		Three		Five	
Concept	Group	Mean	SD	Mean	SD	Mean	SD
INSECT	Control	2.08 (41.6%)	0.83	2.08 (41.6%)	0.65	1.62 (32.5%)	0.92
	Experimental	1.87 (37.6%)	1.03	1.67 (33.4%)	0.87	1.08 (21.6%)	0.88
ANIMAL	Control	8.25 (48.5%)	4.91	6.04 (35.5%)	5.13	0.50 (2.94%)	1.53
	Experimental	6.58 (38.7%)	4.69	2.58 (15.2%)	3.45	0.0 (0%)	0.0

This assumption was shown to be true by the results of <u>t</u>-tests comparing the means of the control and experimental groups at each grade. It was found that the fifth graders who were given a mental set included a significantly lesser ($p < .05$) number of non-instances than their peers who were not given a mental set. No other differences were detected. This suggests that only the fifth graders were able to benefit from the mental set and as a consequence overgeneralized to a lesser extent. Table 17 displays the results of the <u>t</u>-test.

<u>Overgeneralization of the Concept Insect due to Selection of Animals that were Non-Instances of the Concept</u>

The results of a Scheffe's test of multiple comparisons carried out on the mean scores of the control group showed that the kindergarten subjects (56.7%) selected a significantly greater ($p < .05$) number of the above non-instances than grade three (36.4%) and grade five (28.1%) subjects. No other differences were detected. This suggests that the younger children's concept of <u>Insect</u> is more overgeneralized than that of the older children. It also indicates that the older children have a better notion of the criterial attributes of insects than the younger children. Table 18 displays the above results.

When the mean scores of the experimental group were analysed by means of a Scheffe test, it was found that the kindergarten subjects selected a significantly greater

TABLE 17

RESULTS OF T-TESTS COMPARING THE MEAN OVERGENERALIZATIONS* OF CONTROL AND EXPERIMENTAL GROUPS FOR THE CONCEPT INSECT AND THE CONCEPT ANIMAL

Concept	Group	Difference*	df	t	Prob.
INSECT	Kindergarten	-0.20	46	-0.77	0.446
	Three	-0.41	46	-1.88	0.067
	Five	-0.54	46	-2.08	0.043
ANIMAL	Kindergarten	-1.67	46	-1.20	0.236
	Three	-3.46	46	-2.74	0.009
	Five	-0.09	46	-0.16	0.874

*Overgeneralization due to inclusion of non-instances perceptually similar in general appearance to instances of the concepts.

**Difference is the mean score of the experimental group--mean score of control group.

($p < .05$) number of non-instances than the fifth graders. No other differences were detected. This suggests that the kindergarten subjects' concepts of Insect is more overgeneralized than that of the fifth graders' with or without a mental set. Furthermore, t-tests comparing the means of the control and experimental groups revealed that there were no significant differences between the scores of these subjects at each grade level. This suggests that no subjects

TABLE 18

MEAN NUMBER OF OVERGENERALIZATIONS OF THE CONCEPT INSECT DUE TO INCLUSION OF ANIMALS THAT ARE NOT INSECTS BY GRADE AND EXPERIMENTAL TREATMENT

		GRADE					
		Kindergarten		Three		Five	
Concept	Group	Mean	SD	Mean	SD	Mean	SD
INSECT	Control	8.50 (56.7%)	3.01	5.46 (36.4%)	1.64	4.21 (28.1%)	1.53
	Experimental	7.54 (50.3%)	4.57	6.29 (41.9%)	1.54	4.29 (28.6%)	1.43

benefitted from the mental set to select fewer non-instances of the concept Insect. The results of the t-tests are displayed in Table 19.

Undergeneralization of the Concept Animal

The children in this study were presented with 24 instances of the First Degree of Complexity of the concept Animal. That is, they were shown 24 pictures of a variety of animals. These pictures displayed the whole animal. Hence, if a subject did not include all the above pictures in his selections, he would have an error score of 24, which would suggest that his concept of Animal was most undergeneralized. Table 14 gives the mean number of 'errors' made by subjects for the concept Animal by grade level and experimental treatment. A Scheffe's test computed on the data of the control group revealed that there was no difference between the mean percentage number of 'errors' made by kindergarten (16.3), grade three (9.0) and grade five subjects (11.6). This suggests that the concept Animal was undergeneralized to the same extent by the three groups of children, although as the percentages indicate, only a small number of instances were undergeneralized.

The results of t-tests comparing the mean 'error' scores of the control and experimental groups at each grade level are reported in Table 15. The results show that the kindergarten subjects did not differ in the number of 'errors'

TABLE 19

RESULTS OF T-TESTS COMPARING THE MEAN OVERGENERALIZATIONS* OF CONTROL AND EXPERIMENTAL GROUPS FOR THE CONCEPT INSECT

Concept	Grade	Difference**	df	t	Prob.
INSECT	Kindergarten	-0.96	46	-0.86	0.396
	Three	0.83	46	1.88	0.077
	Five	0.08	46	0.19	0.846

*Overgeneralization due to inclusion of animals not insects as instances of the concept Insect.

**Difference = mean score of control group--mean score of experimental group.

made with or without a mental set. On the other hand, it was found that the grade three and grade five subjects made a significantly lesser number of 'errors' ($p = .05$ and $p < .01$, respectively) as a result of the mental set. This suggests that unlike the younger children, the older subjects were able to benefit from the mental set.

However, a Scheffe's tests comparing the mean 'error' scores of the experimental group of subjects revealed that there were no significant differences between the scores of the kindergarten (12.8), grade three (6.4), and grade five subjects (5.5). The results suggest that all the children were able to benefit from the mental set. However, only in the case of the older children was this significant.

The result suggesting that in each case (i.e., with or without a mental set) all the children in the study under-generalized the concept Animal to the same small extent.

Overgeneralization of the Concept Animal

There were altogether 52 non-instances of the concept Animal used in this study. Of these, 17 consisted of inanimate objects perceptually similar in general appearance to instances of the concept Animal. There were 17 pictures of a variety of plants and 18 pictures of inanimate objects which were obviously not instances within the limits of the definition of Animal used in this study. These non-instances included pictures of a sewing machine, a light bulb and the like. Table 16 gives the mean number of overgeneralizations made by subjects as a result of including perceptually similar non-instances, by grade level and experimental treatment. No subject included a plant or an inanimate object obviously not an instance of the concept Animal in their selections. This suggests that the children had some idea as to what constituted an animal.

Overgeneralization of the Concept Animal due to Inclusion of Inanimate Objects Perceptually Similar in General Appearance to Instances of the Concept

It is clear from Table 16 that the grade five subjects selected fewer non-instances than the other children. The results of a Scheffe's test comparing the mean scores of the control group of subjects supported this assumption. The grade five subjects (2.9) selected a significantly lesser ($p < .05$) mean percentage number of non-instances than grade three (35.5) and kindergarten (48.5) subjects. No other differences were detected. This suggests that the grade three and kindergarten subjects concept of Animal was more overgeneralized than that of the fifth graders.

The results of a Scheffe's test computed for the data of the experimental group revealed that the mean percentage scores of the grade five (0.0) and grade three (15.2) differed significantly ($p < .05$) from that of the kindergarten subjects. This suggested that the grade three subjects benefitted from the mental set and selected fewer non-instances. The results of *t*-tests comparing the mean scores of control and experimental groups at each grade level supported this finding. The *t*-tests are reported in Table 17. The results show that grade three subjects, unlike the kindergarteners, selected a significantly lesser ($p < .01$) number of non-instances as a result of the mental set. This suggests that the grade three subjects benefitted from the mental set, whereas the kindergarten subjects did not. The grade five subjects overgeneralized only a few instances with or without a mental set. The results therefore suggest that as a consequence of the mental set, the older children's concept of Animal was less overgeneralized than that of the younger children.

SUMMARY

A Guttman Scale analysis computed for the two instruments used to measure the ability to generalize the concepts Insect and Animal yielded results which indicated that the instruments had valid scale types. These results supported the use of the total mean percentage score as an index of the ability to generalize the respective concepts. Regression analyses revealed that of the independent variables tested (age, IQ, sex and mental set) only age and mental set had a significant effect on the ability to generalize the concepts Insect and Animal.

Further analysis revealed that of subjects not given a mental set for the concept Insect, the fifth grade subjects had a greater ability to generalize than the other children. Their concept of Insect was also better developed than that of the other children. This was due to their selecting a greater number of instances of the Third Degree of Complexity than the other subjects. The instances of the Third Degree of Complexity only implicitly suggested attributes of instances of a concept. As such, a subject able to generalize a given concept from more of such instances was considered to have a relatively better developed concept than subjects generalizing from a lesser number of these instances.

The mental set for the concept Insect enabled the third graders (unlike the kindergarten subjects) to improve their ability to generalize and perform at the same level as the fifth grade subjects. However, the third graders selected fewer instances of the Third Degree of Complexity than the fifth graders. This suggested that although these two groups were performing at the same level, the fifth graded subjects' concept was better developed than that of the third grade subjects, who in turn had a more developed concept than that of the kindergarten subjects.

It was also found that of subjects not given a mental set for the concept Animal, the two older groups showed a greater ability to generalize this concept than the younger subjects. The older subjects selected a greater number of instances of the Second and especially the Third Degree of Complexity, which suggests that their concept of Animal was more developed than that of the younger subjects. Subjects in each of the three grades improved their performance as a result of the mental set. This improved performance was a result of a differential use of the mental set due to age. Thus of subjects given a mental set, the fifth graders not only were able to generalize the concept Animal to a greater extent than the third grade and kindergarten subjects, their concept was better developed as well. This was due to their selecting a significantly greater number of instances of the Third Degree of Complexity than the other subjects. The third grade subjects had the next greatest ability to generalize. Since they included more instances of the Third Degree of Complexity than the kindergarten subjects, their concept was relatively more developed. The kindergarten subjects then, had the least developed concept of Animal and the lowest ability to generalize it. It was also shown that of the two concepts, the children in this study had a more generalizable concept of Insect than of Animal.

It was also shown that the children's concepts of Insect and Animal were both undergeneralized and overgeneralized to varying extents. The children's concept of Insect was undergeneralized to a small extent with or without a mental set. The younger children's concept was more undergeneralized than that of the older children. The control group's concept of Insect was overgeneralized to the same extent. There were no differences in the number of non-instances selected by these subjects, which were perceptually similar in general appearance to instances of the concept Insect. Only the fifth graders were able to benefit from the mental set to include a significantly lesser number of such non-instances. Hence their concept was less overgeneralized than that of the other children. Furthermore, of the control group, the kindergarten subjects included a significantly greater number of animals that are not insects as instances of the concept Insect than the older children. This suggested that the older subjects had a better idea of the criterial attributes of insects than the younger children. It also indicated that the younger children's concept was more overgeneralized. The mental set was ineffective in enabling the children to overgeneralize to a lesser extent. The result was that the kindergarten subjects still overgeneralized more than the older children.

The control group's concept of Animal was undergeneralized to a small extent. Although subjects in each of the three grades made fewer undergeneralizations as a result of the mental set, only the error scores of the third and fifth grade subjects were significantly different. In spite of this, a Scheffe's test revealed that the experimental group's concept of Animal was still undergeneralized to the same extent by subjects in each of the three grades. No subject included any plants or inanimate objects which were obviously not instances of the concept Animal in their selections. This suggests that these children have some idea as to what an animal is. In the control groups, the kindergarten and grade three subjects' concept of Animal was more overgeneralized than that of the fifth graders. The fifth graders rarely overgeneralized. Unlike the kindergarten subjects, the grade three subjects benefitted from the mental set for the concept Animal to include a significantly lesser number of non-instances which were perceptually similar in general appearance to instances of the concept Animal. The result was that the younger children's concept of Animal was more overgeneralized than that of the older children.

CHAPTER V

DISCUSSION

Introduction

The findings to be discussed in this chapter are based on the results obtained from the analysis of data reported in Chapter IV. These results were obtained from the responses of 144 children on two instruments which used a novel format to test the ability of these children to generalize the concept Insect and the concept Animal, respectively. The development of these instruments comprised a significant part of this thesis. The stimuli used in these instruments consisted of three sets of instances each set displaying a progressively reduced number of attributes of a given concept. These sets of instances were referred to as the First, Second and Third Degrees of Complexity respectively, each successive set being more difficult and at a higher level of conceptualization than the other. The extent to which a subject could generalize a given concept from these sets of instances was taken as a measure of his ability to generalize the concept.

The discussion will be reported with reference to the hypotheses that were tested in this study. It will also include some findings on the nature of the concepts

Insect and Animal used by the children in this study, that is, to what extent these concepts are undergeneralized or overgeneralized.

Hypothesis I

Age will have no effect on the ability of children to generalize the concept Insect.

The results of the regression analysis carried out on the data revealed that age significantly ($p = .001$) affected the ability of children to generalize the concept Insect. The null hypothesis was thus rejected.

To determine the extent to which age specifically influenced the ability to generalize this concept, Scheffe's tests of multiple comparisons were computed for the data on a) subjects who were not given a mental set, that is, the control group, and b) subjects who were given a mental set, that is, the experimental group.

Control Group

The subjects in this group were able to generalize the concept Insect to varying extents. The results of a Scheffe's test of multiple comparisons computed for the data revealed that as expected, grade five subjects had a greater ability ($p < .05$) to generalize the concept Insect than either grade three or kindergarten subjects who did not differ in this respect. A detailed analysis of the subject's specific responses on the test indicated that grade five subjects selected a significantly greater ($p < .05$) percentage of instances of the Third Degree of Complexity than the other children (i.e., including in their responses items such as a cocoon, a wasp's nest and a bee's hive). These representations only implicitly suggested attributes of instances of the concept Insect and thus were considered abstract in nature. The very fact that the older children were spontaneously selecting a larger number of these instances indicated that for these children such items were a part of the images and meanings they held of the concept Insect. This suggested that their concept was better developed than that of the younger groups of children.

Experimental Group

In the case of subjects given a mental set, the results of a Scheffe's test comparing the total mean percentage scores of these subjects on the test of the ability to generalize the concept Insect showed that the kindergarten subjects' performance was significantly different ($p < .05$) from that of the grade three and grade five subjects. No difference was detected between the grade three and grade five subjects. This indicated that the older children had a greater ability to generalize than the kindergarten subjects. A detailed analysis of items selected on the test revealed that the third and fifth grade subjects selected a significantly greater number of instances of the Second and Third Degrees of Complexity than the kindergarten subjects. However, the fifth grade subjects selected a greater number of instances of the Third Degree of Complexity than the third grade subjects. This suggests that the fifth grade subjects' concept was more developed than that of the third grade subjects whose concept was more developed than that of the kindergarten subjects. What is important here is that the third grade subjects were able to benefit from instruction (i.e., the mental set) and achieve at the same level as the fifth grade subjects while the kindergarten subjects were unable to do so. This point will be discussed later in this section.

Hypothesis 2

Age will have no effect on the ability of children to generalize the concept Animal.

A regression analysis performed on the data for the concept Animal indicated that age was significant ($p =$ .001) in influencing the performance on the test of the ability to generalize the concept Animal. The null hypothesis was therefore rejected. The results are discussed in terms of the control and experimental groups of children.

Control Group

It was found that these children were able to generalize the concept Animal. The results of a Scheffe's test for contrasting pairs of means showed that the kindergarten subjects had a lesser ability to generalize the concept Animal than the older children. The older children selected a significantly greater number of instances of the Second Degree of Complexity ($p < .05$) than the kindergarten subjects. However, the fifth graders selected a significantly greater ($p < .05$) number of instances of the Third Degree of Complexity than the other children. This suggested that although the older children had a greater ability to generalize than the kindergarten subjects, the fifth graders concept of Animal was more developed than that of the other children. The fifth graders were again spontaneously including a significantly greater number ($p < .05$) of instances of the Third Degree of Complexity such as a bird's nest, a bird's egg, a spider's web, a hornet's nest and a moulted skin of a snake, than the other children. This again suggested that for these children such items were part and parcel of the store of images and meanings they held of the concept Animal.

Experimental Group

This group of subjects were also able to generalize the concept Animal. The results of a Scheffe's test carried out on the data for these children show that the kindergarten, grade three and grade five subjects differ significantly ($p < .05$) from each other. This suggests that the fifth graders have a greater ability to generalize the concept Animal than the other children and the third graders' ability to generalize was relatively greater than that of the kindergarten subjects, who therefore had the lowest ability to generalize this concept. An analysis of the mean number of instances selected by these subjects for each degree of complexity revealed that the older children included a significantly greater number of instances of the Second Degree of Complexity than the kindergarten subjects. In the case of instances of the Third Degree of Complexity, there were significant differences ($p > .05$) between the means of the three groups of children. This suggests that the fifth graders' concept of Animal was more developed than that of the third grade subjects who in turn had a relatively better developed concept than that of the kindergarteners. What is interesting here is that the kindergarten subjects were able to make use of a mental set of the concept Animal to improve their performance, as did the third and fifth graders. However, as stated earlier, the improved performance of the fifth graders was greater than that of the third graders who in turn performed relatively better than the kindergarten subjects. This indicated that subjects in each grade were capable of making differential use of the mental set to improve their performance. In other words, ability to use information is a function of age for these children.

Research in the field of concept development indicates that, in general, the ability to generalize and attain concepts is a function of age. The results of the present study give further evidence supporting this finding. In addition, empirical evidence for the progressive development of the concepts was obtained. Instances of the First, Second and Third Degrees of Complexity demanded increasingly higher levels of conceptualization for generalization to take place. Since in general, the grade five subjects invariably selected more instances of the Third Degree of Complexity than the third graders who in turn selected more of such instances than the kindergarteners, this suggests that the ability to conceptualize increases with age. In addition, the ability to make use of information is also in general a function of age for these children.

In a study replicating the research of Saltz et al. (1972), Neimark (1974) attempted to determine the extent to which four concepts were developed by children. These concepts were Food, Things to Eat, Clothing and Things to Wear. She found that for the concept Things to Eat, there was no difference between the number of instances selected by the second and third grade children. However, for the concept Clothing there was a significant difference between the performance of these two groups of children. What is alluded to here is that for certain concepts children in different grades are able to perform at the same level whereas for other concepts they perform differently. A similar result was obtained in the present study. Thus, for the concept Insect in the control group, the kindergarten and grade three subjects generalized to the same extent. However, for the concept Animal these same children performed differently. The grade three subjects generalized to a significantly greater extent than the kindergarten subjects. This result suggests that the ability to generalize is not only affected by age, it is also dependent on the type of concept that is studied.

Hypothesis 3

IQ will have no effect on the ability of children to generalize the concept Insect.

Hypothesis 4

IQ will have no effect on the ability of children to generalize the concept Animal.

The results of regression analyses carried out separately for the data on the concept Insect and the concept Animal indicated that IQ was not significant in influencing the ability to generalize the concepts Insect and Animal. The null hypotheses were accepted.

Research studies in the field of concept formation and concept attainment using IQ as an independent variable have reported inconsistent results. In studies where there is no differentiation between concept formation and concept attainment, IQ seems to have a variable effect, in that, it may or may not be significant (Osler & Trautman, 1961; Wolffe, 1967; Osler & Shapiro, 1964; Osler & Fivel, 1961; Gollin, 1960). Where concept formation is the only task involved, IQ is significant in its effect (Katz, 1968). Where concept attainment is only involved, that is, information or hints are given to the subject on how to form a concept, IQ does not seem to be significant (Osler & Weiss, 1962). In this context, the present study falls in a category which is closely related to the latter study i.e., concept attainment. In the present study subjects did not have to form the concepts Insect and Animal. They were already aware of these concepts; in fact, subjects were only included in the study if they had some notion of the above two concepts. What was determined was the extent to which these children could generalize a concept from the instances, with and without a mental set. It is concluded that since the study was experimental, no IQ effects were observed.

Hypothesis 5

Sex will have no effect on the ability of children to generalize the concept Insect.

Hypothesis 6

Sex will have no effect on the ability of children to generalize the concept Animal.

Separate regression analyses carried out on the data for each concept showed that sex was not significant. The null hypotheses were thus accepted.

Sex has been invariably found to be not significant as an independent variable in studies of concept attainment in children (Clark, 1971). Its inclusion as an independent variable in this study was chiefly due to the fact that the present study dealt with insects and animals. And, it is a popular belief that girls are more averse to insects in particular and animals in general than boys. However, as the results indicate sex was not significant. Thus, in both control and experimental groups sex did not have a significant effect on the ability of children to generalize the concepts Insect and Animal.

Hypothesis 7

Mental set will have no effect on the ability of children to generalize the concept Insect.

A regression analysis computed on the data for this concept showed that mental set had a significant effect ($p = .001$) on the ability of children to generalize the concept Insect. The null hypothesis is thus rejected. The results of t-tests comparing the total mean percentage scores of control and experimental groups at each grade level revealed that only the third grade subjects were significantly affected ($p < .01$) by the mental set. That is, they were able to make use of the information given in the mental set to improve their performance in generalizing the concept Insect. This improved performance was found to be due to their selecting a greater number of instances of the Third Degree of Complexity than their peers who were not given a mental set. This suggests that not only was their concept capable of being modified, their notion of the concept Insect was also more developed as a result of the mental set.

In the case of the kindergarten children the control and experimental groups did not differ in their scores on the ability to generalize the concept Insect. This indicated that those children's concept of Insect was not capable of being modified given the limits of this study. Both groups of fifth graders (i.e., control and experimental) obtained relatively high scores, 91.94 and 95.69, respectively, which suggested that the instances presented were easy for these subjects, resulting in a ceiling effect. The mental set, therefore, made no difference to these children in their ability to generalize the concept Insect. However, further analysis revealed that the fifth graders did select a greater number of instances of the Third Degree of Complexity as a result of the mental set. This indicated that the total mean percentage score being a rough index of the ability to generalize was not sensitive enough to detect a significant effect of the mental set. This result suggests that although the fifth graders did not improve in their ability to generalize, they were able to modify their concept of Insect as a result of the mental set, by selecting a greater number of instances of the Third Degree of Complexity, which also suggests that their concept was more developed.

Hypothesis 8

Mental set will have no effect on the ability of children to generalize the concept Animal.

The results of a regression analysis showed that mental set had a significant effect ($p = .001$) on the ability to generalize the concept Animal. The null hypothesis is thus rejected. The results of *t*-tests comparing the total mean percentage scores of control and experimental subjects revealed that at each grade, the experimental group scored significantly ($p < .05$) higher than the control group of subjects. This suggests that in this instance, the mental set was effective in every case. Further analysis revealed the kindergarten subjects' improved performance was due to their selecting a significantly greater number of instances of the Second and Third Degrees of Complexity than their peers who were not given a mental set. On the other hand, the older children's better performance as a result of the mental set was due to their selecting a significantly greater number of instances of all the three degrees of complexity than their respective peers. These results indicate that children in each of the three grades were able to modify their concept of Animal as a consequence of the mental set. These children (including the kindergarten subjects) were able to make use of the information given in the mental set for the concept Animal and improve their performance. The result being that not only did the subjects in each grade improve their ability to generalize, their concept was more developed than that of their peers as a consequence of the mental set.

Inability to Make Use of a Mental Set

The kindergarten subjects' inability to make use of the mental set for the concept Insect may be accounted for in three ways. 1) the mental set was too limiting in nature; 2) they preferred not to make use of it, and 3) they did not have the ability to make use of it. The fact that they were able to make use of the mental set for the concept Animal suggests that the former reasons may provide the more valid explanation.

An examination of the number and types of positive and negative instances used in each of the two mental sets revealed that there were in fact fewer pictures of each type of instances and non-instances used in the mental set of the concept Insect. Thus there were six pictures of insects (two each of the three degrees of complexity) and five pictures of non-instances (three of the perceptually similar type and two of animals that were not insects) presented in the mental set of the concept Insect. On the other hand there were nine pictures of instances (three of each of the three degrees of complexity) and nine pictures of non-instances (three of the perceptually similar type, three of plants and three of inanimate objects not animals). These differences in the mental set could be part of the reason why the kindergarten children were able to make use of the mental set of the concept Animal and not that of the concept Insect. This reasoning, however, does not explain why the grade three children were able to make use of the mental set of the concept Insect while the kindergarten subjects were not able to do so. It could perhaps be that the kindergarten children were not willing to give up their preferred but non-defining attributes of the concept Insect even when faced with the fact that these were 'noisy' or useless.

In a review of studies on concept attainment, Clark (1971) reports that seven out of eight studies reported significant effects of instruction on concept attainment. In a study carried out by Osler and Weiss (1962) they found that six-year-olds' attainment of the concept Bird was significantly affected by instruction. The instruction involved the explicit definition of the nature of the task. Gollin (1960) reports a significant effect of training on the recognition of some common objects by children aged 3½ to 5 years, from representations of these objects having a reduced number of cues. His subjects were in fact generalizing from representations of reduced number of attributes to the object in question. In the present study, the instruction that was given to subjects involved the presentation of instances and non-instances of the concept under study together with verbal cues pointing these out as such. This was done to establish a mental set for the children and also to ensure the children understood the nature of the task.

The findings of the present study give further support to the growing body of evidence that instruction has a significant effect on the ability of children to generalize and attain concepts. The results also show that instruction in the form of a mental set, when limited to only a few positive and negative instances of a concept, for example <u>Insect</u>, may not be effective in enabling the younger subjects to improve their ability to generalize. This suggests that in teaching a concept a wide variety of instances and non-instances be presented for concept attainment, especially in the case of younger children.

<u>Hypothesis 9</u>

There will be no difference in the ability of children to generalize the concept <u>Insect</u> and the concept <u>Animal</u>.

Control Group

A significant difference ($p < .05$) was found between the scores of kindergarten subjects on the tests of the ability to generalize the concepts Insect and Animal. The results indicate that these kindergarten children were more able to generalize the concept Insect than the concept Animal. The same pattern of results is seen in the case of the grade three and grade five subjects, both showing a significantly greater ability to generalize the concept Insect than the concept Animal.

Experimental Group

Correlated *t*-tests comparing the scores of kindergarten subjects revealed no differences between their scores on the tests of the ability to generalize the concepts Insect and Animal. This may be explained by the fact that these children were unable to benefit from a mental set of the concept Insect which was considered to be too limited or 'narrow' in nature for these children. However, they were able to benefit from a mental set of the concept Animal which resulted in their performing in this concept at the same level as that for the concept Insect.

In the case of the grade three and grade five children who were given a mental set, the results show that their ability to generalize the concept Insect was significantly greater ($p < .001$) than their ability to generalize the concept Animal. The results of a correlated t-test computed on the scores of all the children (control and experimental) on the tests of the ability to generalize the concepts Insect and Animal showed that on the whole, the children's concept of Insect was more generalizable than the concept Animal. The null hypothesis was rejected.

The concept Animal not only includes a greater variety and types of instances, it also is at a higher level of generality and therefore more inclusive than the concept Animal. It is, however, a term that has been more frequently used by children in their every-day lives (Anglin, 1977), than the term insect. According to Rinsland (1945) the frequency with which children (grade one) used words which referred to instances of the concept Animal is very high. The term insect was not given in his list of words most frequently used by these children. Based on these facts it was assumed that children would have a more generalizable concept of Animal than of Insect. The results of this study have shown this not to be the case.

Generally the children in this study (control and experimental groups) had a more generalizable concept of Insect than of Animal. One reason for this finding could be due to the fact that the concept Insect was more specific than the concept Animal. Being more specific, the concept Insect contained instances which were more perceptually homogeneous in nature than say a more general concept like

Animal which contained more perceptually diverse instances. Consequently, if a child correctly generalized one instance of a less general concept, he probably was able to generalize other instances since they would be perceptually similar in nature. Thus, although the instances of the concept Animal were frequently verbalized by children, the perceptual diversity of its instances assured no guarantee that if a subject correctly generalized one instance, he would be able to generalize other instances of that concept.

Anglin (1977) working with children aged 2-6 years has shown that these children usually tend to attain intermediate concepts first before they attain more specific or more general concepts. Thus he found that such children will attain an intermediate concept such as Dog before learning the more specific term Collie or the more general term Animal. In this context, the concept Insect may be said to be of intermediate generality between a more specific term such as a Beetle and a more general one such as Animal. The results of this study by showing that children aged 5-13 years have a more generalizable concept of Insect than of Animal, offer supporting evidence to Anglin's finding that children tend to attain intermediate or less general concepts before they attain more general ones.

Nature of the Concepts

Research in concept development has shown that the child's concepts do not refer to exactly the same sets of objects and meanings as those denoted by adults (Vygotsky, 1962). On one hand there are those proponents, for example the Gibsons (1955) and Clark (1973) who suggest that young children systematically overgeneralize their concepts, while there are others who believe that older children overgeneralize their concepts (Salt et al., 1972) and still others who suggest that children both overgeneralize and undergeneralize their concepts (Anglin, 1977). Overgeneralization was operationally defined in this study as the inclusion of a non-instance as an exemplar of a concept. Thus a child who refers to all four-legged animals as 'dog' is said to overgeneralize the concept Dog. Undergeneralization was operationally defined as the non-inclusion of an instance when it was in fact an exemplar of a concept. Thus when a child does not include a butterfly or a praying mantis as an instance of the concept Animal he is said to have undergeneralized the concept Animal (Anglin, 1977).

Undergeneralization of the Concept Insect

It was found that with or without a mental set the concept Insect was undergeneralized to a small extent. In the control group, the kindergarten subjects' concept of Insect was undergeneralized more than that of the older children. This was found to be due to the kindergarten subjects making, in general, a greater number of undergeneralized responses to more instances of the concept

Insect than the other subjects. A katydid produced 37% of undergeneralized responses, 29% undergeneralized a caterpillar and 17% undergeneralized a praying mantis and a water-skater. Twenty percent of the third grade subjects undergeneralized a katydid. The fifth grade students did not undergeneralize. The mental set was ineffective in preventing the kindergarten children from undergeneralizing. The reason may be that these children preferred not to make use of the information given in the mental set or that they did not have the ability to do so. This result gives further support to the finding that the younger children's concept of Insect is least developed.

The four most commonly verbalized insects by these kindergarten children in response to the question, "Tell me what insects you know," were butterfly, bee, lady bug and dragonfly, in that order. These instances evoked spontaneously in response to the above question may thus be considered to be central to or typical of the concept Insect for these children, whereas instances such as a katydid caterpillar, praying mantis etc. do not appear to be typical insects for some of these children. They may be said to be atypical or peripheral instances of the concept Insect (Anglin, 1972). Hence it may be said that the younger children's concept of Insect was more undergeneralized than that of the older children and the instances mostly not included being considered to be peripheral instances of the concept. This result supports the earlier finding that the older children have a better developed concept of Insect than the younger children. Table 20 gives the frequency with which each instance of the concept Insect was undergeneralized.

Overgeneralization of the Concept Insect

It was found that the control groups' concept of Insect was overgeneralized to the same extent by subjects in each of the grades kindergarten, three and five. There were no differences in the mean number of non-instances perceptually similar in general appearance to instances of the concept Insect selected by these children. A paper beetle and a paper dragonfly were selected by 63% or more of the subjects in each of the three grades and 17% or more of these subjects selected a metal butterfly as instances of the concept Insect. Table 21 gives the frequency with which these non-instances were overgeneralized.

The mental set was found to be effective only in the case of the fifth graders who as a result selected fewer such non-instances. The other children were overgeneralizing to the same extent. Thus the fifth grade subjects' concept of Insect was less overgeneralized than that of the other children. The inference here is that the children in this study are dependent on perceptual attributes; the younger children more so than the older. A look at the nature of

TABLE 20

FREQUENCY OF UNDERGENERALIZED RESPONSES (OUT OF A POSSIBLE 24) FOR THE CONCEPT INSECT BY GRADE AND MENTAL SET

		Subjects not given mental set			Subjects given mental set		
		GRADE			GRADE		
Item	Instance	Kindergarten	Three	Five	Kindergarten	Three	Five
13	Praying mantice	4	0	0	3	0	0
30	Katydid	9	5	0	8	2	1
6	Mosquito larva	4	0	0	5	0	0
5	Caterpillar	7	0	0	4	0	0
26	Mosquito	3	1	0	4	0	0
39	Housefly	2	0	0	5	0	0
37	Grasshopper	4	0	0	3	0	0
22	Water skater	4	0	0	5	0	0
28	Ant	3	0	0	4	0	0
8	Butterfly	0	0	0	0	0	1

TABLE 21

FREQUENCY OF OVERGENERALIZED RESPONSES (OUT OF A POSSIBLE 24) FOR THE CONCEPT <u>INSECT</u> BY GRADE AND MENTAL SET

Item	Inanimate objects perceptually similar to instances of concept <u>Insect</u>	Subjects not given a mental set			Subjects given a mental test		
		GRADE			GRADE		
		Kindergarten	Three	Five	Kindergarten	Three	Five
4	Kermit (muppet)	1	0	0	1	0	0
7	Paper beetle	16	20	20	14	16	12
17	Metal butterfly	12	8	4	11	2	1
19	Paper dragonfly	22	23	15	21	22	15
25	Car painted like Insect	0	0	0	0	0	0

the non-instances mostly selected, supports this line of reasoning. The most number of overgeneralized responses made by the younger children were for a picture of a dragonfly and a bettle made out of paper; the next most selected was a picture of a metal butterfly. Since these objects look like insects the children selected these as instances.

However, on being given a mental set which included the presentation of instances and non-instances (which included two inanimate objects perceptually similar in appearance to insects) the older subjects understood the facts better. They were able to overcome the pull of perceptual attractiveness that these non-instances held for them and select fewer non-instances. The younger children were unable to overcome this physical attraction and thus selected just as many non-instances in spite of the mental set. They were therefore more perceptually bound than the older children.

If the children had not noticed that the dragonfly and beetle were made of paper or the butterfly made of metal then their overgeneralization was perceptual in nature. If they had noticed that these non-instances were in fact ornaments and yet selected these as instances, then their problem was conceptual. The children were given a mental set in which there were two perceptually similar non-instances (a metal butterfly with differently shaped wings from the one given in the test, and a plastic toy in the shape of a caterpillar) of the concept Insect. These were pointed out to the subjects as non-instances and in most cases the writer is of the opinion that these children noticed that the non-instances were an ornament and a toy. This opinion is based upon the comments of the individual subjects. When it was pointed out that a metal butterfly or a plastic caterpillar did not 'go' with the word Insect, the usual response from the younger subjects especially was "I know, that's a toy," or "That's made of something, that's not real." Since the children did notice that the non-instances in the test were made out of paper or metal this suggests that their overgeneralizations were conceptual in nature.

The results show that in the control group the kindergarten subjects included more non-instances of the type 'animals that are not insects,' as instances of the concept Insect than the older children. This suggests that the younger children's concept of Insect was more overgeneralized than that of the older children. The mental set did not enable any group of subjects to improve their performance, i.e., to overgeneralize less. The result being that the younger children's concept was still more overgeneralized than that of the older children. A look at Table 22 which gives the frequency of overgeneralization responses produced for each animal non-instance of the concept Insect proves to be interesting. It can be seen that for the following non-instances, a seahorse, a mouse,

TABLE 22

THE FREQUENCY OF OVERGENERALIZED RESPONSES (OUT OF A POSSIBLE 24) FOR THE CONCEPT INSECT BY GRADE AND MENTAL SET

Item	Animals that are not insects	Subjects not given a mental set GRADE Kindergarten	Three	Five	Subjects given a mental set GRADE Kindergarten	Three	Five
1	Seahorse	15	10	1	12	5	0
3	Slug	16	24	20	13	22	19
9	Mouse	12	2	0	9	3	0
10	Spider	18	23	22	19	23	23
11	Fish	5	0	0	5	0	0
14	Crocodile	12	1	0	12	3	0
15	Beaver	13	0	0	12	3	0
21	Scorpion	20	20	18	17	23	21
24	Snake	17	3	0	12	1	0
27	Nautins	18	10	7	11	13	7
29	Worm	18	23	20	17	23	15
33	Seal	14	3	0	12	1	0
34	Bird	5	0	0	4	0	0
35	fish-fly	11	17	14	11	16	16
40	bat	16	6	2	13	7	0

a fish, a snake, a beaver, a bird, a crocodile, a seal and a bat the kindergarten subjects, with or without a mental set produced more overgeneralized responses than the older children. The following non-instances were mostly overgeneralized by both the younger and the older subjects. These were a slug, a spider, a scorpion and a worm.

A spider and a scorpion although not insects are closely related to the class Insect. A slug and a worm may be said to belong to classes of animals closely related to the class Insect. However, the other animals such as a beaver, mouse, etc. which were mainly included by the younger subjects are quite unrelated to the class Insect. Generally then, the older children may be said to have a better idea of the criterial attributes of insects than the younger children. This again supports the notion that the older children's concept is better developed. However, since none of the subjects could make use of the mental set to select fewer non-instances it is concluded that the subjects in this study were generally unable to abstract the criterial attitudes of insects from the instances and non-instances presented in the mental set. It is, however, acknowledged that the mental set was limiting in nature as only two instances (a bee and a dragonfly) and two non-instances (a squid and an iguana) were presented. As such this limitation may have contributed to the inability of these children to abstract the characteristics of insects. As such the children may have been merely relying on their semantic memory in selecting instances of the concept Insect.

Undergeneralization of the concept Animal

It was found that the concept Animal was undergeneralized to the same extent by the control group in each of the three grades. However, they undergeneralized to a very small extent. An examination of the instances mostly undergeneralized (summarized in Table 23) revealed that no children included a picture of a woman as an instance of the concept Animal. When asked why they did not select the picture of a woman the usual answer was "A woman don't go with animal," or "A woman is a human not animal." Anglin (1977) reports a similar finding in his study of the children's concept of Animal. None of his subjects (aged 2-6 years) would include a picture of a woman as an instance of the concept Animal. However, in this study even older children (5-12 years) do not consider a woman to be an animal.

The instances of the concept Animal which evoked the most number of undergeneralized responses from the kindergarten subjects were as follows: jellyfish (42%), frog (25%), cobra (25%), goldfish (21%), tadpole (21%) and a deep-sea fish (21%). A jellyfish (37%), beetle (29%) and spider (21%) were not included by the grade three subjects. The grade five subjects on the other hand made the most under-

TABLE 23

THE FREQUENCY OF UNDERGENERALIZED RESPONSES (OUT OF A POSSIBLE 24) FOR THE CONCEPT ANIMAL BY GRADE AND MENTAL SET

		Subjects not given mental set			Subjects given mental set		
		GRADE			GRADE		
Item	Instances	Kindergarten	Three	Five	Kindergarten	Three	Five
6	Frog	6	1	0	1	0	0
8	Toad	3	1	0	2	1	0
13	Krait	4	0	1	2	0	0
19	Cobra	6	0	1	2	0	0
31	Eagle	2	0	0	2	1	0
35	Horse	1	1	1	0	0	0
41	Spider	3	5	8	1	1	2
50	Goldfish	5	0	1	2	0	0
70	Snail	2	3	7	4	1	1
74	Owl	2	0	0	3	0	0
82	Catfish	4	0	1	4	0	0
85	Cat	1	0	0	1	0	0
9	Jellyfish	10	9	3	3	3	1
11	Tadpole	5	4	5	2	0	1

(cont'd.)

Table 23 (cont'd.)

		Subjects not given mental set			Subjects given mental set		
		GRADE			GRADE		
Item	Instances	Kindergarten	Three	Five	Kindergarten	Three	Five
25	Penguin	3	0	0	2	0	0
29	Chick	2	0	0	2	0	0
36	Newt	4	0	1	2	2	0
54	Agamid Lizard	3	0	1	2	0	0
56	Iguana	3	0	1	1	0	1
65	Armadillo	2	0	0	3	1	1
76	Seahorse	3	0	1	2	0	0
93	Woman	24	24	24	24	24	23
100	Beetle	2	7	13	1	2	3
103	Deep Sea Fish	5	0	1	2	0	0

generalized responses for a beetle (54%), a spider (33%), a snail (29%) and tadpole (21%). It will be noted that the animals that were mostly undergeneralized are not mammals. Smith, Shoben and Rips (1973) have shown that for young children a mammal is the typical animal. Rosch (1973) has argued that natural concepts have an 'internal structure', that is, they are instantiated by different exemplars to varying degrees. Thus more children would include a dog as an instance of the concept Animal than a praying mantice (Anglin, 1977). Thus a dog would be considered to be a central instance and a praying mantice a peripheral instance of the concept Animal. In the light of these findings the instances mostly undergeneralized by the children in this study such as a jellyfish, bettle, etc. may well be considered as peripheral instances of the concept Animal. As such the children in this study may be said to have made undergeneralized responses to peripheral instances of the concept Animal, a result which supports Anglin's (1977) findings. He too found that children undergeneralized peripheral instances of the concept Animal.

It may be noted that the fifth grade subjects made more undergeneralized responses to three instances than the other children. These were a beetle, a spider and a snail. When asked (after the response had been made) why these three instances were not selected, the answer was always the same. "That's not an animal, that's an insect." When these subjects were asked to identify the instances, they did so correctly (i.e., a spider was identified as spider, etc.). These children were wrongly classifying a spider and a snail as insects. Only the bettle is an insect. To these children, the groups insects and animals were mutually exclusive. Since they were able to identify the above instances, their under-generalization was not due to perceptual confusion but was conceptual in nature and as such suggests a poorly developed concept of Insect and Animal.

Although all the subjects undergeneralized to a lesser extent as a result of a mental set, the difference however, was only significant in the case of the older children. Even so, it was however, found that the experimental group in each grade undergeneralized the concept Animal to the same extent.

Overgeneralization of the Concept Animal

No subject selected a plant or an inanimate object which was obviously not an instance of the concept Animal (i.e., a sewing machine, light bulb, etc.). It is therefore concluded that the subjects in this study had some idea as to the characteristics of animals. It was found that in the control group the kindergarten and grade three subjects overgeneralized more than the fifth graders by including a greater number of inanimate objects perceptually similar in general appearance to instances of the concept Animal.

The following non-instances were selected by 50% or more of the kindergarten and grade three subjects, a reindeer and a hippopotamus made of peanuts, a glass horse and a metal owl. Table 24 gives the frequency with which each non-instance is overgeneralized. The results suggest that the kindergarten and grade three subjects' concept of Animal is more overgeneralized than that of the fifth grade subjects. The fifth grade subjects rarely overgeneralized.

The mental set made no difference to the fifth graders since they were rarely overgeneralizing without it. However, unlike the kindergarten subjects, the third grade subjects were able to benefit from the mental set to overgeneralize to a lesser extent. This suggests that the third grade subjects unlike the kindergarteners were able to abstract from the instances and non-instances presented in the mental set, attributes which differentiated animals from the non-instances. This resulted in the third graders making fewer overgeneralizations. On the other hand, the younger children selected the same number of non-instances even after being given a mental set. This suggests that these younger children were more perceptually bound than the older children (i.e., that physical appearance was more critical for the younger than the older children).

The appearance of a stuffed animal or an ornament in the shape of an animal was sufficient reason for most of the kindergarten and grade three subjects to select these

TABLE 24

THE FREQUENCY OF OVERGENERALIZED RESPONSES (OUT OF A POSSIBLE 24) FOR THE CONCEPT ANIMAL BY GRADE AND MENTAL SET

Item	Non-instances perceptually similar in appearance to instances of the concept Animal	Subjects not given a mental set			Subjects given a mental set		
		GRADE			GRADE		
		Kindergarten	Three	Five	Kindergarten	Three	Five
1	Muppet bear	12	7	7	7	1	0
15	Clay pot in the shape of an ape	16	9	2	12	4	0
21	Plastic horse	6	5	1	5	0	0
26	Jade turtle	12	7	1	13	3	0
38	Steel pot in the shape of a pig	6	2	0	7	0	0
47	Bugs bunny	13	9	1	8	3	0
48	Plastic dog	12	10	1	5	2	0
53	Girl doll	0	0	0	0	0	0
59	Glass dog	9	10	1	8	3	0

(cont'd.)

Table 24 (cont'd.)

Item	Non-instances perceptually similar in appearance to instances of the concept <u>Animal</u>	Kindergarten	Three	Five	Kindergarten	Three	Five
71	Iron model of a pig	12	11	0	11	7	0
77	Hippopotamus made of peanuts	19	14	1	18	10	0
81	Glass swan	13	11	0	11	5	0
83	Plastic baby doll	0	0	0	0	0	0
90	Reindeer made of peanuts	21	4	2	21	8	0
91	Glass horse	14	16	0	12	7	0
95	Metal owl	14	15	0	13	8	0
101	Wooden horse	9	5	0	6	2	0

as instances of the concept Animal. However, in spite of instruction, the younger children (unlike the older children) were unable to 'decenter' from the pull of perceptual attractiveness that the non-instances held for them. The result was that the younger children's concept of Animal was more overgeneralized than that of the older children. The results suggest that the children in this study both undergeneralize and overgeneralize their concepts. In general, the younger children both undergeneralize and overgeneralize their concepts more than the older children, a result which supports Anglin's (1977) finding.

CHAPTER VI

SUMMARY, CONCLUSIONS AND IMPLICATIONS

SUMMARY

Past research on the ability of children to generalize and attain concepts has resulted in a controversy over a variety of issues. Thompson (1941) suggests that the ability to generalize increases with age. The results of Neimark's (1974) study suggest that for certain concepts children of different age groups do not differ in their ability to generalize their concepts. Vygotsky (1962) and Piaget (1964) believe that young children are unable to attain 'true concepts' until they are at least 12 years of age. That is, they are unable to abstract from their perceptions of objects and events attributes criterial in nature to form generalizations. Vygotsky (1962) has suggested that the young child's generalizations are 'primitive' in nature in the sense that he does not abstract criterial attributes but includes all the attributes of an object in his generalizations. The young child's concepts are therefore 'complexes'. The older child's generalizations are considered to be more 'advanced' in that the child is able to form abstractions and see the hierarchical nature of his concepts which he terms as 'true concepts'. On the other hand, there are those who suggest that young children are able to attain specific as well as general concepts (Povey & Hill, 1975) as well as to form abstract concepts (Pella et al., 1967).

In addition, there are studies (Gibson & Gibson, 1955; Clark, 1973) that suggest the young child systematically overgeneralizes his concepts. With age his concepts become more differentiated. Others believe that the older children's concepts are generally more overgeneralized (Saltz et al., 1972) while still others (Anglin, 1977) believe that young children both undergeneralize and overgeneralize their concepts. Most of these studies were based on a sorting technique (Saltz et al., 1972; Anglin, 1977) making use of a comprehension paradigm. Few if any carried out a truly experimental study where the effect of instruction on the ability to generalize was investigated. Nor has the effect of instruction on the nature of the concepts children used been examined before. In this respect, the present study was unique in its approach to the subject at hand.

This study attempted to determine the extent to which generalization to selected science concepts, viz. Insect and Animal could take place with and without some limited experience with stimulus materials (i.e., the mental set). In addition, the effects of various developmental criteria such as age, IQ, and sex on this ability were studied. It also determined if the nature of these concepts used by children changed as a result of a mental set. The study was heuristic and experimental in nature and is unique in the sense that it used a novel format to determine the extent to which generalization of a concept was achieved. Previous studies used pictures displaying the whole object which children were asked to sort according to some given concept label. The present study employed three sets of pictures: a) pictures of the whole insect or animal, b) pictures of part of an insect's or animal's anatomy, and c) pictures of products of the natural activity of insects or animals. These three sets of pictures displayed a progressively decreasing number of attributes of the concepts Insect and Animal and were considered to be increasingly difficult in order. These three sets of pictures were taken to represent instances of the First, Second, and Third Degrees of Complexity, respectively. Each degree of complexity represents a level of conceptualization. As the degree of complexity increases (becomes more difficult) so does the level of conceptualization. These sets of instances afforded a measure of the child's level of conceptualization of a given concept and an index of his ability to generalize the concept. Thus a major part of the study involved the development of such a novel instrument. In fact, two such instruments were developed, one testing the ability to generalize the concept Insect and the other testing the ability to generalize the concept Animal.

These two instruments were used to determine the ability of 144 children, 72 each from kindergarten, grade three and grade five to generalize the concepts Insect and Animal, with and without instruction in the form of a mental set. The nature of the two concepts used by these children with and without instruction was also determined. Three questions were asked at the outset which led to the formulation of nine hypotheses which were subsequently tested. The data from the study were analyzed using regression analysis. The total mean percentage scores on the tests of the ability to generalize the concepts Insect and Animal were treated as the dependent variables. The multiple regression value of the F test at the 0.05 level of significance was taken as a basis for rejection of the null hypotheses. If the regression analysis showed significance, Scheffe tests and *t*-tests were computed to find the group or groups for which differences were apparent. Correlated *t*-tests were computed to determine which concept was more generalized. For all these tests a probability level of 0.05 was established for significance.

CONCLUSIONS

In this section the three questions asked in Chapter I will be answered. The first question sought to determine the effect of age, IQ, sex and mental set on the ability to generalize the concepts Insect and Animal. It was found that only age and mental set significantly affected the ability to generalize these concepts. The results show that children aged 5-12 years are able to generalize the two concepts to varying extents without a mental set. The kindergarten and grade three subjects did not differ in their ability to generalize the concept Insect. However, their ability to generalize this concept was significantly less than that of the fifth grade subjects. The kindergarten and grade three subjects' performance was, however, significantly different from each other on the test of the ability to generalize the concept Animal. In this instance the grade three subjects performed at the same level as the fifth graders. Neimark (1974) similarly found that grade two and grade six children performed at the same level on one concept (Things to Eat) and performed differently on another concept (Clothing). It is concluded that in general the ability to generalize increases with age but it is also dependent on the type of concept that is studied. This finding is in agreement with the results obtained by Thompson (1941) and Neimark (1974).

The fifth graders invariably select a greater number of instances of the Third Degree of Complexity (i.e., instances which only implicitly imply attributes of a concept and therefore considered abstract) of the concepts Insect and Animal than the other children. The third graders in general select more of such instances than the kindergarten subjects. The instances of the Third Degree of Complexity demand a higher level of conceptualization for generalization to occur than instances of the First and Second Degrees of Complexity. Thus subjects able to generalize from more instances of the Third Degree of Complexity will obviously have a more developed concept than subjects generalizing from fewer of such instances. It is thus concluded that the younger children's concepts of Insect and Animal are the least developed and that with age, these concepts become more developed and more conceptual in nature as Piaget (1964) and Vygotsky (1962) claim.

The results show that unlike the kindergarten subjects, the grade three subjects were able to make use of the information given in the mental set for the concept Insect. This enabled them to improve their ability to generalize and perform at the same level as the fifth graders. The mental set made no difference to the extent to which the fifth grade subjects were generalizing the concept Insect as their scores reflected a ceiling effect. However, the subjects in each of the three grades were able to make use of the information given in the mental set for the concept Animal. Subjects in each grade thus improved their ability to generalize this concept. This improvement, however, was a function of age. It is concluded that in general the ability to use information given in a mental set and generalize a concept is a function of age.

The kindergarten subjects were unable to make use of information given in the mental set for the concept Insect. They were, however, able to benefit from the mental set for the concept Animal. As a consequence, their concept of Animal was more developed than that of their peers who were not given a mental set. The mental set also enabled them to improve their ability to generalize. It was acknowledged that there were fewer examples of instances and non-instances in the mental set for the concept Insect than in the mental set for the concept Animal. This unequal exposure to stimulus materials in the two mental sets may have resulted in the children's improved performance on the concept Animal and not on the concept Insect. This reasoning suggests that for instruction to be effective in enabling young children to generalize a concept, it should include presentation of a great number and variety of instances and non-instances of that concept.

The second question that was addressed in this study was to determine which concept, Insect or Animal, is more generalizable. The results show for all groups the subjects were more able to generalize the concept Insect than the concept Animal. Since children more often use names of animals in their daily lives (Rinsland, 1941) than say names of insects, it was expected that they would be more knowledgeable of and familiar with instances of the concept Animal and therefore generalize it to a greater extent.

The results show this was not so. One reason for these results could be that the concept Animal is more abstract and at a higher level of generality than the concept Insect. As such its instances were more perceptually diverse than those of the concept Insect, which were more perceptually homogeneous in nature. The children possibly found it more difficult to generalize from such perceptually diverse instances than the more homogeneous ones of the concept Insect. This may imply that children acquire a less general concept like Insect before they acquire a more general concept like Animal.

The final question sought to determine the nature of the concepts Insect and Animal used by subjects in this study. That is, to what extent the concepts were undergeneralized and overgeneralized by these children. The results show that children undergeneralized and overgeneralized both concepts. The concept Insect was undergeneralized to only a small extent by the younger subjects who failed to include peripheral instances of the concept. In addition, the mental set did not enable these children to undergeneralize to a lesser extent. They were, therefore, unable to benefit from it. This implies the younger children were unable to abstract criterial attributes of insects from the information given in the mental set.

The concept Insect was overgeneralized to the same moderate extent by the control group in each grade. The overgeneralization was due to the inclusion of perceptually similar non-instances as instances of the concept. The mental set was effective only in the case of the older children enabling them to make fewer overgeneralizations. The conclusion drawn here is that the younger children are more perceptually bound than the older children. Even after being given a mental set, these younger children unlike the older, were unable to overcome the pull of perceptual attractiveness that the non-instances held for them.

The younger kindergarten subjects included more non-instances of the type 'animals that are not insects' than the older children. The same result was obtained when the subjects were given a mental set. No subject, however, benefitted from the mental set. It is concluded that the subjects in this study were unable to abstract criterial attributes of insects from the information given in the mental set and as such were merely relying on semantic memory in selecting insects from amongst the non-instances. The results, however, suggest that the older children have a better notion of some characteristics of insects than the younger children.

The concept Animal was undergeneralized to a small extent by the subjects in this study. The control group in each grade undergeneralized to the same extent by not including peripheral instances of the concept. The older children, it was found, were able to make use of the information given in the mental set and thus undergeneralized to a lesser extent. Although the younger children also undergeneralized to a lesser extent as a consequence of the mental set, the difference was not significant. The conclusion drawn here is that the older children were able to abstract some attributes of animals from the information given in the mental set which enabled them to make a lesser number of undergeneralizations. Since the older children were able to identify the instances that they undergeneralized it is concluded that for these children their undergeneralizations were conceptual in nature.

No subject selected a plant or an inanimate object (e.g., a sewing machine, light bulb) which was not an instance of the concept <u>Animal</u>. It is concluded that the subjects in this study have some idea of the characteristics of animals. The kindergarten and grade three subjects overgeneralized the concept <u>Animal</u> more than the fifth graders, by including more inanimate objects perceptually similar in appearance to instances of the concept. The grade five subjects in fact were rarely overgeneralizing. The grade three subjects unlike the younger subjects were able to benefit from the mental set. They thus included fewer such non-instances as a result of the mental set. It is concluded that the younger children are more perceptually bound than the older children and as stated before are unable to overcome the pull of physical attraction that the non-instances (such as stuffed animals, ornaments shaped like animals) hold for them. The younger children's concept of <u>Animal</u> was, therefore, more overgeneralized than that of the older children. This gives further support to the finding that the younger children have a less developed concept of <u>Animal</u> than the older children.

IMPLICATIONS OF THE STUDY

This study attempted to determine the nature and the extent to which children aged 5-12 years were able to generalize two hierarchically related science concepts, <u>Insect</u> and <u>Animal</u> with and without instruction in the form of a mental set. Specifically, the children's ability to generalize these concepts from instances displaying a progressively reduced number of attributes and immediacy of the concepts was investigated. From the limitations and results of this investigation, a number of implications for curriculum and instruction are suggested.

<u>Implications for Curriculum and Instruction</u>

The finding that even young children are able to improve their ability to generalize concepts like <u>Animal</u> if appropriate instruction is given has important implications for curriculum and instruction. It suggests that children may be able to improve their learning of general concepts, provided a great number and variety of instances and non-instances of the concept are used in the instruction.

Children in this study were more able to generalize a less general concept like Insect than a more general concept like Animal. This may suggest that less general concepts are easier for children to master than more general ones. As such the sequence of concepts in curricular materials should progress from less general to more general and complex concepts especially in the elementary school.

It was also found that the younger children were more perceptually bound than the older children. The younger children were unable to overcome the pull of perceptual attractiveness that the non-instances held for them despite instruction. This resulted in their concepts being overgeneralized and therefore poorly developed. What is important here is that teachers of these children should be aware of the nature of the concepts these children have at their disposal.

Suggestions for Further Research

1. In this study, a rough index of the ability to generalize a concept was obtained by adding the scores a subject received for each degree of complexity. Since instances of each consecutive degree of complexity were more difficult, it is suggested that some form of weighting be considered for scores obtained on each degree of com-

plexity so that a more sensitive index of the ability to generalize is obtained.

2. Unequal numbers of instances and non-instances were used for the mental sets of the concept Insect and the concept Animal. This unequal number may have resulted in the children performing better on one concept than the other, thus making comparisons between their performances on these two concepts open to question. Further research should ensure that the same numbers of such stimuli be used in the mental sets.

3. The experimental aspect of the study was confined to students in kindergarten, grade three and grade five of one school. It is suggested that students from different schools be randomly selected and tested so that generalization of results could be extended to a larger population.

4. It has been suggested that educable mentally retarded children are not merely retarded in mental development but exhibit different cognitive processes than the normal mental age equivalents (Lowell, 1974). If this were true then the normal and retarded children should perform differently on this instrument.

5. One important variable which has been known to be of some importance as a predictor of cognitive behavior is social-economic status (Johnson, 1973). Further research based on the novel format used in this study should include the above variable. This may result in explaining a greater amount of variance.

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APPENDICES

APPENDIX A

STIMULI USED IN THE INSTRUMENT MEASURE OF THE ABILITY TO GENERALIZE THE CONCEPT INSECT

Stimuli Used as Instances of the First Degree of Complexity

Item No.	Stimulus
5	caterpillar
6	mosquito larva
8	butterfly
13	praying mantice
22	water skater
26	mosquito
28	ant
30	katydid
37	grasshopper
39	housefly

Stimuli Used as Instances of the Second Degree of Complexity

Item No.	Stimulus
12	leg of grasshopper
18	head of grasshopper
23	butterfly's wing
32	anterior half of caterpillar
38	posterior half of beetle

Stimuli Used as Instances of the Third Degree of Complexity

Item No.	Stimulus
2	moth cocoon
16	wasp's nest
20	insect moult
31	bee's hive
36	empty cocoon

STIMULI USED AS NON-INSTANCES OF THE CONCEPT INSECT

A. Inanimate Objects Perceptually Similar in General Appearance to Instances of the Concept Insect

Item No.	Stimulus
4	kermit (the muppet)
7	beetle made of paper
17	metal butterfly
19	dragonfly made of paper
25	plastic car painted with eyes, mouth

B. Animals that are not Insects

Item No.	Stimulus
1	sea horse
3	snail
9	mouse
10	spider
11	fish
14	crocodile
15	beaver
21	scorpion
24	snake
27	nautilus
29	earthworm
33	seal
34	bird
35	fish-fry
40	bat

MENTAL SET FOR THE CONCEPT INSECT

A. Stimuli Used as Instances of the Concept Insect

First Degree of Complexity - 1. Dragonfly 2. Bee

Second Degree of Complexity - 1. Saggital half of beetle
2. Anterior half of fly

Third Degree of Complexity - 1. Ant's hill 2. Cocoon

B. Stimuli Used as Non-Instances of the Concept Insect

1. plastic caterpillar
2. metal butterfly
3. plastic car with painted eyes
4. squid
5. iguana

STIMULI USED IN THE INSTRUMENT 'MEASURE OF THE ABILITY TO GENERALIZE THE CONCEPT ANIMAL'

Stimuli Used as Instances of the First Degree of Complexity

Item No.	Stimulus	Item No.	Stimulus
6	frog	54	lizard
8	toad	56	iguana
9	jellyfish	65	armadillo
11	tadpole	70	snail
13	krait	73	sea horse
19	cobra	74	owl
25	penguin	82	fish
29	chick	85	cat
31	eagle	93	woman
35	horse	100	beetle
36	newt	103	deep-sea fish
41	spider		
50	goldfish		

Stimuli Used as Instances of the Second Degree of Complexity

Item No.	Stimulus
5	leg and part of abdomen of lizard
7	hind end of leopard
12	bird's legs
17	middle part of alligator's body
18	bird's beak
23	frog's hind leg
30	part of frog's head
39	feather
46	part of a cat's face
57	posterior part of fly
60	part of a snake's coiled body
63	part of frog's abdomen

Item No.	Stimulus
72	part of a grasshopper's leg
79	caudal fin of fish
84	part of a horse's body and legs
87	part of a fish's head
96	part of wing and legs of insect
97	middle part of a fish's body

Stimuli Used as Instances of the Third Degree of Complexity

Item No.	Stimulus
14	bird's egg
27	hornet's nest
34	human foot print
37	shell
42	insect eggs
51	snake's moult
62	bird's nest
68	beaver's dam
94	silk cocoon
98	spider's web

STIMULI USED AS NON-INSTANCES OF THE CONCEPT ANIMAL

A. Plants

Item No.	Stimulus	Item No.	Stimulus
2	seaweed	49	hazel nut
3	orchid (cultivated)	61	tomato
10	chrysanthemum	73	wild orchid
16	coconut palm	75	mushroom
20	berries	78	hibiscus
33	orange	80	fruits
40	fruits	88	grapes
44	allamanda	92	lemon
		102	flowers

B. Inanimate Objects Obviously Not Animals

Item No.	Stimulus	Item No.	Stimulus
3	light bulb	58	clothes washer
22	helmet	64	dust bin
24	watch	66	spice rack
28	percolator	69	umbrella
32	fan	86	binoculars
42	sewing machine	89	chair
45	clock	99	cannon
52	baby car seat	104	knives
55	lamp		

C. Inanimate Objects Perceptually Similar in General Appearance to Instances of the Concept Animal

Item No.	
1	muppet bear
15	clay model of ape
21	plastic horse
26	jade turtle
38	metal pot shaped like pig
47	bugs bunny
48	plastic dog
53	doll (girl)
59	glass dog
71	sculptured pig
77	hippopotamus made of peanuts
81	glass swan
83	baby doll
90	reindeer made of peanuts
91	glass horse
95	metal owl
101	wooden horse

MENTAL SET FOR THE CONCEPT ANIMAL

A. Stimuli Used as Instances of the Concept Animal

First Degree of Complexity - 1. Ape 2. Hawk 3. Fish

Second Degree of Complexity - 1. Bear's claw 2. Part of fish's body 3. Part of snake's body

Third Degree of Complexity - 1. Ant's hill 2. Cocoon 3. Shell

B. <u>Stimuli Used as Non-Instances of the Concept Animal</u>

1. lilly
2. brocolli
3. dahlias
4. plastic pool
5. bus
6. mirror
7. muppet bear
8. stuffed koala bear
9. stuffed owl

APPENDIX B

Validation of Instrument

You are kindly asked to rate each picture according to how representative you think it is of an example that fits one instance of the appropriate dimensions stated below.

Dimensions

Stimulus complexity. Stimulus complexity is considered here as a continuum of increasing difficulty of instances of the concept in question. Three degrees are posited. The First Degree of Complexity is represented by a complete picture of an instance of the concept being investigated. The symbol used to represent it is 1D.

The Second Degree of Complexity (2D) is represented by a picture of part of an instance of the concept being investigated. For example, a bird's beak or a fish's tail, for concept Animal.

The Third Degree of Complexity (3D) is represented by a picture of a product of an instance of the concept being investigated. For example, a web or a bird's nest for the concept Animal.

Distractors. Three types of distractors have been included. Plant distractors (P) consist of pictures of various examples of the category plant, e.g., flowers, fruits, trees.

Inanimate objects (S) similar in general appearance to instances of the concept being investigated.

Inanimate objects (O) obviously not instances of the concept being investigated.

The scale to be used is given below.

Unrepresentative						Representative
1	2	3	4	5	6	7
Extremely	Very	Quite	Moderately	Quite	Very	Extremely

You are now asked to kindly state your rating for each of the pictures on the rating sheet provided below.

First Degree of Complexity 1D

Second Degree of Complexity 2D

Third Degree of Complexity 3D

Plant distractor .... P

Animal-like distractor .... S

Obvious distractor .... O

RATING SHEET

(for the concept Animal)

Picture	Dimension	Rating	Picture	Dimension	Rating
1	S		23	S	
2	P		24	2D	
3	O		25	S	
4	P		26	O	
5	P		27	P	
6	2D		28	1D	
7	1D		29	2D	
8	O		30	O	
9	2D		31	O	
10	1D		32	S	
11	1D		33	1D	
12	1D		34	3D	
13	3D		35	1D	
14	1D		36	3D	
15	2D		37	2D	
16	P		38	O	
17	P		39	P	
18	1D		40	1D	
19	1D		41	P	
20	P		42	3D	
21	3D		43	3D	
22	2D		44	P	

Picture	Dimension	Rating	Picture	Dimension	Rating
45	3D		70	2D	
46	1D		71	3D	
47	P		72	O	
48	O		73	P	
49	1D		74	P	
50	P		75	3D	
51	O		76	S	
52	S		77	1D	
53	1D		78	1D	
54	P		79	1D	
55	2D		80	P	
56	O		81	P	
57	S		82	1D	
58	O		83	O	
59	1D		84	3D	
60	1D		85	1D	
61	1D		86	S	
62	S		87	2D	
63	P		88	1D	
64	3D		89	1D	
65	3D		90	S	
66	1D		91	O	
67	O		92	S	
68	O		93	S	
69	S		94	P	

Picture	Dimension	Rating	Picture	Dimension	Rating
95	O		120	3D	
96	2D		121	2D	
97	1D		122	O	
98	P		123	3D	
99	1D		124	O	
100	S		125	S	
101	1D		126	S	
102	S		127	2D	
103	2D		128	2D	
104	O		129	1D	
105	S		130	S	
106	2D		131	S	
107	1D		132	S	
108	O		133	1D	
109	1D		134	O	
110	S		135	3D	
111	P		136	2D	
112	1D		137	O	
113	2D		138	S	
114	P				
115	1D				
116	1D				
117	S				
118	O				
119	1D				

For the concept Insect, there are 20 pictures of instances representative of the three degrees of complexity. There are also two types of distractors. The first type consists of animals that are not insects (NI) and the second type consists of pictures of inanimate objects similar in general appearance to instances of the concept Insect (S).

You are kindly asked to similarly rate the following pictures on the rating form given below.

Picture	Dimension	Rating	Picture	Dimension	Rating
1	NI		17	NI	
2	1D		18	2D	
3	3D		19	S	
4	S		20	1D	
5	NI		21	3D	
6	NI		22	NI	
7	S		23	2D	
8	NI		24	NI	
9	1D		25	3D	
10	NI		26	2D	
11	NI		27	1D	
12	1D		28	1D	
13	1D		29	S	
14	S		30	NI	
15	3D		31	1D	
16	NI		32	NI	

Picture	Dimension	Rating	Picture	Dimension	Rating
33	2D		37	1D	
34	NI		38	2D	
35	NI		39	1D	
36	3D		40	NI	

You are kindly asked to rate the following pictures which will be used to give the children a mental set of the task. The children will be shown these pictures and told that they go with the word Animal. In other words, these pictures are instances of the concept Animal.

Picture	Dimension	Rating	Picture	Dimension	Rating
1	2D		12	2D	
2	2D		13	2D	
3	3D		14	1D	
4	2D		15	2D	
5	2D		16	3D	
6	2D		17	1D	
7	3D		18	2D	
8	1D		19	1D	
9	1D		20	1D	
10	2D		21	2D	
11	3D		22	1D	