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RELATIONSHIPS BETWEEN CONTENT EXPERIENCE AND THE
DEVELOPMENT OF SERIATION SKILLS IN
FIRST GRADE CHILDREN

by
Lewis Alfred Bonney

A Dissertation Submitted to the Faculty of the
DEPARTMENT OF EDUCATIONAL PSYCHOLOGY
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1970
I hereby recommend that this dissertation prepared under my direction by Lewis Alfred Bonney entitled Relationships between Content Experience and the Development of Seriation Skills in First Grade Children be accepted as fulfilling the dissertation requirement of the degree of Doctor of Philosophy.

Dissertation Director Date

After inspection of the final copy of the dissertation, the following members of the Final Examination Committee concur in its approval and recommend its acceptance:

Henry E. Butler Jr. 4/8/70

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ABSTRACT

The study investigated the relationships between content experiences and the development of ability patterns. It focused on the role of experience with concrete, quantitative, interpersonal, and verbal content in stimulating the development of skill in seriating or sequencing these types of content.

Two questions were raised: (1) Do seriation skills generalize across content categories and (2) will a brief training period with materials representative of the content categories alter the extent to which seriation skills generalize across content categories?

Seriation skills were measured with a specially constructed Seriation Skills Test. There were four subtests which yielded scores reflecting a subject's skill in performing the task of seriation with each type of content.

Data were collected from 65 first grade children in Amphitheater School District in Tucson, Arizona. These children's seriation skills were assessed with the Seriation Skills Test. The records of the children's scores on each subtest of the Seriation Skills Test were the basis for computing correlation coefficients reflecting the relationship between the ability of children to seriate different types of content. The six correlation coefficients representing the relationship between the ability to seriate (1) concrete and quantitative content, (2) concrete and interpersonal content, (3) concrete and verbal content, (4) quantitative and interpersonal content, (5) quantitative and interpersonal content, (6) quantitative and verbal content, (7) quantitative and verbal content, (8) quantitative and quantitative content, (9) quantitative and quantitative content.
and verbal content, and (6) interpersonal and verbal content were considered indices of the extent to which seriation skills generalize across content categories.

Following an assessment of initial intercorrelations among seriation abilities, an effort was made to experimentally produce changes in ability patterns. An independent variable of instruction with materials representative of each content category was manipulated and effects were observed in the dependent variables of correlation between seriation abilities. The effect of content experience on ability patterns was assessed by comparing the pretest correlation coefficients among seriation abilities with the post test correlation coefficients among seriation abilities.

Analyses of the data revealed predominantly low pretest correlations among abilities for seriating the four types of content. Four of the six intercorrelations were initially less than .20.

Instructional intervention significantly altered two of the six intercorrelations. Content-relevant instruction increased the correlation between abilities for seriating (a) concrete and verbal content, from $r = -.11$ to $r = .37$, and (b) quantitative and verbal content, from $r = .14$ to $r = .36$.

These results were limited by a small sample, a brief instructional period and a test ceiling effect.

The results were interpreted within these limitations as suggesting (1) that seriation skills do not tend to generalize across content categories; i.e., a well-developed ability for seriating one
type of content does not necessarily imply an equally well-developed capacity for seriating other types of content, and (2) that content relevant instruction can, in some instances, alter the extent to which seriation abilities generalize across content categories.

The results were related to Piaget's concept of accommodation and to Guilford's Structure of Intellect.
CHAPTER I

INTRODUCTION TO THE STUDY

This chapter describes children's ability patterns, identifies some experiential correlates of ability patterns, and proposes a procedure for intervening in the development of abilities. A research problem is formally stated and hypotheses are derived for directing an experimental study.

The Nature of Ability Patterns

Young children commonly demonstrate an uneven pattern of abilities. Some may demonstrate a high level of skill in solving mechanical problems but have poor interpersonal skills. Others may excel in manipulating their peers but have limited skill in manipulating numbers. Still others may have a well-developed capacity for formulating verbal concepts but a less well-developed capacity for grasping quantitative or mechanical concepts. According to Cornbach (1963), individual's verbal and arithmetical abilities tend to correlate about .40. Lesser, Fifer, and Clark (1965) report a correlation of .32 between spatial and numerical abilities in six-year-olds. Stevenson et al. (1968) report that student scores on discrimination learning of line drawings correlate only .27 with discrimination learning of geometrical forms. These moderate to low correlations reflect uneven ability patterns and suggest that some factors are operating in a manner to differentially affect the development of abilities.
Experiential Correlates of Uneven Ability Patterns

The role of experience in stimulating the development of abilities has been the subject of numerous studies (Riesen 1958, Thompson and Heron 1954, Rheingold and Bayley 1959, Lesser et al. 1965). Most recently, Bruner (1966) has demonstrated that the nature of one's experience is related to the pattern of one's abilities. He has shown that the abilities of children from a variety of cultures tend to develop in response to cultural demands. While children of rural and urban cultures initially group objects on the basis of concrete, immediately perceivable characteristics, urban children soon respond to the content of their more complex environment by beginning to group objects on the basis of symbolic, abstract characteristics. Rural children whose adaptational problems remain more concrete continue to group objects on the basis of concrete characteristics. A similar comparison was made between schooled and unschooled children. Schooled children respond to the highly verbal "telling out of context" environment of school by developing skills in thinking with abstract, symbolic content. Un schooled children, who learn in the context of doing, develop abilities for thinking with concrete content. It seems that an individual's ability patterns can be related to the content of his experience.

Compensation for Uneven Ability Patterns

The present study is concerned with investigating the role of content experiences in influencing the development of abilities. It may be that experience with a given type of content is necessary for
development of a capacity for processing or problem solving with that type of content. If experience with a given type of content is related to the development of abilities for handling that type of content, it should be possible to accelerate the development of deficient abilities by the provision of suitable, content-oriented experiences.

This would be consistent with Jean Piaget's (Piaget and Inhelder 1964, Flavell 1963) conception of cognitive development. He views cognitive development as proceeding through a series of qualitative changes in intellectual structures. The structures change in response to experiences of the organism. The content of an organism's past experiences influences the types of material which intellectual structures can organize and process. Structures are changed by accommodating or modifying their organizational properties in accordance with initially incongruent sensory inputs. Structures may be developed for performing a given operation, for example, classification, on a given type of content, such as concrete or figural. These structures would not, however, be able to classify verbal content until some verbal experiences had been accumulated. Experience with a given type of content is regarded as prerequisite to developing structures for processing that type of content.

On the basis of Piaget's theory, it seems reasonable to speculate that training experiences with an appropriate type of content might alter ability patterns. Abilities which were initially slow in development might be accelerated by provision of appropriate content-oriented experiences. For example, an individual observed to have a
well-developed ability for classifying concrete content but a poorly
developed ability for classifying verbal content might demonstrate a
more even pattern of abilities following exposure to verbal experi-
ences. In this instance, verbal experiences would be conceived as ac-
celerating verbal classification ability to a level commensurate with
that of concrete classification ability. The observed result would be
an increased correlation between concrete classification ability and
verbal classification ability. The present study was designed to test
these theoretical speculations by using content-oriented training ex-
periences to produce changes in mental organization.

The role of content experiences in stimulating the development
of content-oriented abilities can be initially investigated by observing
the extent to which an ability for processing one type of content trans-
fers to other types of content. This requires a measuring instrument
in which task is held constant and content varied.

Seriation is a task applicable to many types of content. Seri-
ation is the ability required for ordering or sequencing objects or
events in place or time. It is possible to perform the operation of
seriation on concrete, quantitative, interpersonal, and verbal content.

Statement of the Problem

This study is concerned with the manner in which experience in-
fluences the development of ability patterns. It focuses on the role
of experience with concrete, quantitative, interpersonal, and verbal
content in stimulating the development of abilities for handling these
types of content. It is particularly concerned with the relationships
among first grade children's abilities to seriate or sequence each type of content.

The study investigates the following questions:

1. Do seriation skills generalize across content categories? If so, there should be statistically significant intercorrelations among children's abilities to seriate concrete, quantitative, interpersonal, and verbal content.

2. Will a brief training period with materials representative of the content categories alter the extent to which seriation skills generalize across the content categories? If so, there should be significantly increased intercorrelations among seriation abilities following training.

Hypotheses

1a. There will be no significant relationship between the ability of children to seriate concrete materials and the ability of children to seriate quantitative materials prior to training.

1b. There will be no significant relationship between the ability of children to seriate concrete materials and the ability of children to seriate interpersonal materials prior to training.

1c. There will be no significant relationship between the ability of children to seriate concrete materials and the ability of children to seriate verbal materials prior to training.

1d. There will be no significant relationship between the ability of children to seriate quantitative materials and the ability of children to seriate interpersonal materials prior to training.
1f. There will be no significant relationship between the ability of children to seriate verbal materials and the ability of children to seriate interpersonal materials prior to training.

Hypotheses related to the second question are:

2a. Following training experiences with materials representative of the content categories, there will be a significant increase in the relationship between the ability of children to seriate concrete materials and the ability of children to seriate quantitative materials.

2b. Following training experiences with materials representative of the content categories, there will be a significant increase in the relationship between the ability of children to seriate concrete materials and the ability of children to seriate interpersonal materials.

2c. Following training experiences with materials representative of the content categories, there will be a significant increase in the relationship between the ability of children to seriate concrete materials and the ability of children to seriate verbal materials.

2d. Following training experiences with materials representative of the content categories, there will be a significant increase in the relationship between the ability of children to seriate quantitative materials and the ability of children to seriate verbal materials.

2e. Following training experiences with materials representative of the content categories, there will be a significant increase in the relationship between the ability of children to seriate quantitative materials and the ability of children to seriate interpersonal materials.
Following training experiences with materials representative of the content categories, there will be a significant increase in the relationship between the ability of children to seriate interpersonal materials and the ability of children to seriate verbal materials.

**Definition of Terms**

The study employs the following special definitions of terms:

**Ability** is a well-developed strategy or set for performing an intellectual operation on a specific type of content. The empirical referent is performing a structured task with a specified set of materials.

**Seriation** is the ability required for imposing hierarchial order on the environment. It is observed when an individual performs the task of sequencing a group of materials.

**Content** is a culturally relevant system of categories used to describe information about the environment. The categories of content are: concrete, quantitative, interpersonal, and verbal.

The category of content labeled **concrete** includes information about physical dimensions of objects, such as size, color, and shape.

The category of content labeled **quantitative** includes information about the aggregate amount of objects or frequency of events.

The category of content labeled **interpersonal** includes information about affectional relationships between people.

The category of content labeled **verbal** includes information about linguistic descriptions of objects or events.
Assumptions and Limitations

The study assumes that in growing up a young child accumulates a different amount of experience with concrete, quantitative, interpersonal and verbal content.

The study is limited by the reliability and validity of testing instruments, and findings are restricted to populations similar to the populations from which the experimental sample was drawn.

Justification

The study investigates the validity of Piaget's concept of accommodation. Piaget's theoretical formulations imply that a person who can seriate concrete material has the potential for seriating quantitative, verbal, and interpersonal content but may not be able to process these latter types of content with equal facility due to lack of appropriate experiences. The provision of meaningful training experiences should stimulate accommodation and result in a more even development of seriation abilities across content categories. This would be observed as higher correlations among seriation abilities following training.

The study attempts a new perspective on the observation familiar to curriculum designers, that abilities vary across content categories. In other studies (Guilford 1967) tasks have been developed to measure abilities which were subsequently factor analyzed to determine content factors. The usual practice of selecting a battery of tests and factor analyzing student scores to determine how the tests cluster regarding content tends to cloud the relationship between test and content
because no effort is made to observe how one test or task can be applied across content categories. While evidence is provided regarding the common factor content of a group of tests, no information is offered regarding the application of specific intellectual processes to different types of content. The present study holds task constant and varies content in an effort to discover the relative levels of development of an intellectual process, seriation, as applied to four content categories. Information regarding the relative levels of development of abilities for dealing with the four types of content can provide the basis for a more meaningful individualization of instruction.

Information regarding the role of content experiences in fostering the development of abilities useful in academic settings could be of value in designing home intervention programs and preschool curriculum to meet the needs of children unprepared experientially to benefit from the school academic environment. If experience with concrete, quantitative, interpersonal, and verbal materials is an important variable in the development of well-balanced abilities patterns, a compensatory curriculum should be directed to these content areas.

The study will be of interest to school systems implementing process-oriented curriculum. The intent of these curriculum is to develop intellectual processes or abilities applicable in all of the subject matter areas. For example, processes such as observation, classification, hypothesis formulation, and data interpretation are applicable to the materials and phenomena studied in science, social studies, and mathematics. Process curriculum use a variety of
materials to foster transfer of intellectual processes from one content area to another; however, there is little evidence that the materials used are representative of psychologically meaningful content categories or that intellectual processes do generalize across content categories.

The present study investigates the extent to which one intellectual process, seriation, generalizes across content categories. The results will hold implications for the extent to which other intellectual processes should be expected to generalize across content categories. Also, the study will collect evidence bearing on the following question: Can a brief instructional experience with materials representative of concrete, quantitative, interpersonal, and verbal content categories increase the intercorrelations among abilities for seriating the four types of content? This evidence will reflect on the effectiveness of brief practice with unfamiliar materials for prompting transfer of intellectual processes to new materials.
CHAPTER II

REVIEW OF LITERATURE

This chapter discusses historical views of intellect, theoretical models of intellectual development, experiential factors in the development of intellect, the role of content factors in the development of abilities, and the nature of six-year-old intelligence.

Historical Views of Intellect

In the past century, intellect has been variously regarded as involving "judgment," "a general fund of mental energy," "multiple independent abilities," and most recently "constructed models of reality." This section provides a review of each major conception of intellect.

In 1916 Binet and Simon (p. 42) referred to intelligence by stating, "To judge well, understand well, reason well--these are the essentials of intelligence." They found that, by measuring a child's judgment, practical sense and initiative, it was possible to predict school performance. The success of their test led to intelligence being considered an inherently fixed, measurable quantity which largely determined a child's possibility of success in school. This was not, however, Binet's and Simon's intent. They expressed their opposition to the view that the intelligence of an individual is a fixed quantity. According to Deutsch (in Jensen and Deutsch 1968), Binet was instrumental in developing special instructional programs to strengthen intellectual functions.
Spearman (1904) proposed a two-factor theory of intelligence. There was a general factor described as a general fund of mental energy which was conceived as contributing to all intellectual activity. There was also a specific capacity for a particular type of work. The existence of a general factor implied that all intellectual activity is a function of one factor. This notion has not been supported in subsequent studies (Guilford 1967).

Thorndike (1913, p. 366) offered an alternative explanation of intellect, suggesting that intelligence involved multiple mental abilities. He stated that "the mind must be regarded not as a functional unity, nor even as a collection of a few general facilities which work irrespective of particular material, but rather as a multiple of functions each of which involves content as well as form, and so is related closely to only a few of its fellows, to the others with greater and greater degrees of remoteness."

Thorndike was apparently the first person to draw attention to the role of content as well as process in intellectual functioning. He was suggesting that intellectual capacities vary with both tasks and materials. A person who can perform a given task, for example, classification, with one type of material may not be able to perform the same task with other types of materials.

Thurstone (1938) used the centroid method of factor analysis to identify a number of primary mental abilities. The intercorrelations among 57 tests designed to measure general intelligence yielded the following factors: spatial, perceptual, numerical, verbal relations,
memory, word fluency, induction. These findings imply that people possess seven independent types of abilities. A person's score on tests measuring one of the abilities should show little relation to his score on tests measuring other abilities.

Guilford (1967) has organized ability factors into a three-dimensional "Structure of Intellect" model. The three dimensions of the cube are operations, contents, and products. An ability is defined by its operation (cognition, memory, divergent production, convergent production or evaluation); its content (figural, symbolic, semantic, or behavioral); and its product (units, classes, relations, systems, transformations, or implications). For example, the ability involved in perceptual speed tasks is defined by the operation of cognition being applied to figural content to yield a unit product. The ability is referred to as cognition of figural units (CFU). As another example, the ability involved in seriation tasks is the operation of convergent production being applied to various types of content to yield hierarchical systems. The ability involved in seriating sticks of various lengths (figural content) would be referred to as convergent production of figural systems (NFS). The ability involved in seriating alphabetical characters (symbolic content) would be referred to as convergent production of symbolic systems (NSS). These two seriation abilities are considered independent because they involve two different types of content. According to the Structure of Intellect model, there should be no correlation between the ability to seriate sticks (NFS) and the ability to seriate letters (NSS).
Guilford's Structure of Intellect model identifies 120 independent abilities. The notion of independence implies that there is no relation between a person's standing on one ability and his standing on any of the other abilities. The intercorrelations among the 120 independent abilities should all be insignificant. A significant correlation between any two of the abilities would cast doubt on the validity of the model.

Jerome Bruner (1967) has suggested that intellectual organization changes during the course of development. He is concerned with the manner in which growing human beings represent their experience of the world. He has indicated that our knowledge of the world is based on constructed models of reality.

According to Bruner, there are striking changes in the manner in which organisms represent reality. He says (p. 1), "At first the child's world is known to him principally by the habitual actions he uses in coping with it. In time there is added a technique of representation through imagery that is relatively free of action. Gradually there are added new and powerful methods of translating action and image into language, still a third system of representation." These three levels of representing reality are referred to respectively as the enactive, the ikonic, and the symbolic level. Intellectual growth proceeds from an almost stimulus-response-type interaction through concrete thoughts to abstract thought.

Jean Piaget (in Flavell 1963) conceives of intelligence as involving content, structure, and function. Content, in Piaget's sense,
is observable stimuli and responses. Structures are the organizational properties of intelligence, analogous to Bruner's representational modes. Functions are the processes by which sensory input is filed or placed within the organizational structures. The function called assimilation refers to the fitting of information within existing structures. For example, structures might be organized for processing concrete information. Incoming information of this nature is assimilated or categorized within the existing organizational framework. The other function, accommodation, refers to the changes in organization structures prompted by incongruent input. Unfamiliar experiences generate incongruent information which leads to changes in intellectual structures. For example, structures might be well organized for categorizing concrete information but be poorly organized for categorizing symbolic information. Some accommodations are required for efficient categorization of symbolic information. These accommodations or changes in the organizational properties of intellectual structure occur following several encounters with symbolic information.

Piaget (in Flavell 1963) identifies a characteristic invariant sequence of changes in cognitive structures. He describes a sensorimotor period in which the infant grapples with problems of manipulating his body and his environment. At this stage, intelligence involves imitations and instrumental responses. This is followed by the concrete operations period in which the child develops the capacity to classify and order objects and events. His intelligence is characterized by the capacity for manipulating symbols that represent the environment. He
is capable of multiple classification and conservation. In dealing with problems of volume he can recognize that a change in height can be compensated for by a change in width. A formal operations period follows in which the young adult's intelligence is characterized by the capacity for propositional thought in dealing with hypothetical situations. According to these formulations, intelligence refers to the relative level of sophistication of intellectual structures.

### Theoretical Models of Intellectual Development

Several models of intellectual development can be identified in the literature. Intellectual development has been variously conceived as (1) being predetermined, (2) an elaboration of S-R connections, (3) an elaboration of mediating responses, (4) involving changes in structural properties, or (5) an accumulation of learning strategies.

According to Hunt (1961), the idea of fixed or predetermined intelligence has its root in Darwin's theory of natural selection. The attention focused on chance genetic mutations in evolutionary history led people to misinterpret the importance of inherited characteristics in human development.

Galton (1869), for example, observed that men of distinction in Great Briton tended to come from a small group of families and concluded that intelligence was inherited. He failed to recognize that these men were products of a highly enriched environment.

In his study of the Kalliak family, Goddard (1912) similarly failed to appreciate the role of environmental factors. It was
observed that the illegitimate children of the barmaid included far more feebleminded individuals than the legitimate children of a respectable New England woman. This evidence was interpreted as supporting the notion that intelligence is inherited.

The notion of predetermined development was also supported by Arnold Gesell (1945, p. 335). He stated, "Infancy is the period in which the individual realizes his racial inheritance. This inheritance is the end product of evolutionary processes which trace back to an extremely remote antiquity." He further stated (p. 53) that the "basic configurations, correlations, and successions of behavior patterns are determined by the innate processes of growth called maturation." According to this view, mental and behavioral organizations unfold more or less automatically.

Arnold Jensen's (Jensen and Deutsch 1968) re-examination of the nature-nurture issue has provided some new insights regarding the determinants of intelligence. He has studied the relative contributions of genetic and nongenetic factors to individual differences in measured intelligence. He states (p. 9):

The largest and methodologically most adequate studies conducted in England and the United States have yielded heritability estimates for intelligence in the range from 0.70 to 0.90. This means that in the various populations studied, between 70 and 90 percent of the variability in measured intelligence is attributable to genetic factors and between 5 and 25 percent to environmental factors . . ." In other words, 70 to 90 percent of the variance among phenotypes is attributable to variance among genotypes. This leaves little room for experiential factors to influence intellectual development.
The connectionist viewpoint was initially articulated by Edward L. Thorndike (1911) in his classic monograph, *Animal Intelligence*. Following careful observation of animal learning, Thorndike concluded that learning involved a gradual "stamping in" of stimulus response connections. If a stimulus led to a response, followed by a satisfying state of affairs, a bond was forged making the S-R connection available in subsequent situations. Intellectual development was conceived as essentially an incremental process.

Skinner (in Hill 1963) has distinguished two types of stimulus-response learning. The first involves reflexes and classical conditioning. The second involves instrumental learning of which responses lead to reinforcement in a given situation. In both of these instances learning consists of accruing a repertoire of S-R and R-S connections. This repertoire is developed through selective reinforcement.

Hull (in Hilgard 1956) postulated the existence of mediating responses to account for the development of flexible insightful behavior. Rather than relying entirely on external stimulation to account for behavior, Hull suggested that some responses produced internal stimuli to guide behavior. These stimuli are not directly observable, but can be inferred from observation of flexible behavior not immediately under control of the external stimulus situation. An example is the fractional antedating goal responses. These are anticipatory responses which occur on first sight of the goals and produce stimuli to guide the animal to the goal. Using these stimulus guides the animal can approach the goal by unfamiliar routes thus acquiring flexibility of behavior.
The concept of mediating responses has been used by several other theorists to account for the development of flexible, insightful behavior. Guthrie (in Hill 1963) employs the term movement-produced-stimuli to account for flexibility in behavior. Miller (in Hill 1963) notes that an individual's emotional responses can produce stimuli to guide behavior. Tolman's (in Hill 1963) sign gestalt learning involves reacting to signs that food is near. These signs in Tolman's system are clearly internal reactions to previous experience in a goal situation. The signs are organized into cognitive maps which guide behavior around obstacles and provide for maximum flexibility in reaching goals. In each instance the mediating responses are acquired through experience or practice in a specific situation. Experience in a situation is considered prerequisite to developing flexible behavior patterns in that situation.

There are two kinds of mediating responses. The first, discussed above, was conceived as involving response-produced stimuli. The second is an observing response. This is a response that changes the external stimulation one receives. Examples are seen in dogs pricking up their ears or in persons focusing their attention on relevant aspects of a situation.

Observing responses are a type of mediating response that guide attention to pertinent cues. These responses can be used to explain the learning involved in acquired distinctiveness of cues. For example, in reading, children must learn to respond to the shape rather than the size of letters. Following experience in reading situations, mediating
responses develop for guiding attention to the relevant cues. Initial difficulty in dealing with unfamiliar situations or materials can be attributed to lack of distinctiveness of cues. Given some experience with the situation or materials, mediating responses are elaborated for focusing attention on relevant cues and guiding behavior toward problem solution. Intellectual development in this framework involves the elaboration of an increasingly refined, and widely applicable, system of mediating responses.

Learning sets are another example of mediating responses. Harlow (1949) demonstrated that monkeys acquire sets for learning discrimination problems. In a series of problems in which several objects are presented and one object repeatedly rewarded regardless of position, the monkeys soon develop a systematic approach. They vary their behavior until they discover the critical objects and then repeatedly respond to that object. In another series of problems, several objects are presented and the one in a particular position is always rewarded regardless of shape. The monkeys soon learn to vary their choice until they discover which position is critical and then repeatedly respond to that position regardless of which object occupies the position. In these situations, monkeys learn how to solve a particular type of problem. They learn from experience which cues are important and respond by focusing their attention on these cues. It should be noted that acquired distinctiveness of cues in these situations requires some experience with the situations and/or materials to be used in subsequent learning problems. If the animals were unfamiliar with the situation
or materials, they would have no basis or rationale for directing their attention.

Ausubel (1960) has experimentally demonstrated the importance of mediating responses or advance organizers in human learning. He found that the advance introduction of mediating concepts in the form of substantive materials of a highly conceptual nature facilitated the learning of unfamiliar but meaningful verbal material. Experience with mediating concepts relevant to unfamiliar material enhanced both initial learning and retention. This indicates that intellectual development can be fostered by the deliberate introduction of appropriate content specific mediating concepts.

Robert Gagne (1968) conceives of intellectual development as involving the accumulation of learning strategies. In order to apply the job description--task analysis approach to learning problems, one asks "what do individuals have to be able to do to perform successfully in a task?" This leads to the identification of a hierarchy of learning strategies or sets involved in mastering the task. Intellectual development is viewed as the progressive mastery of learning strategies ranging from stimulus-response associations through multiple discriminations to concept formation and problem solving.

The notion that intellectual development involves accumulation of learning strategies has led to process-oriented curricula. In commenting upon Science--A Process Approach, Gagne (in Jensen and Deutsch 1968, p. 50) says,
The new science aims at a progressive growth in such skills as inferring, predicting, observing, graphing and hypothesizing. . . . The most striking characteristic of these materials is that they are intended to teach children the processes of science rather than what may be called science content. The performances in which these skills are applied involve objects and events of the natural world; the children do, therefore, acquire information from various sciences as they proceed. The goal, however, is not an accumulation of knowledge about any particular domain, such as physics, biology, or chemistry, but competence in the use of the processes that are basic to all science.

The implication is that processes developed for one type of materials will generalize to other types of materials; however, this inference has not been empirically investigated.

Bruner (1966), as already mentioned, has drawn attention to developmental changes in the manner in which organisms represent reality. He considers the individual to be inherently capable of representing the world according to three modes; however, the modes actually employed by individuals depend upon the types of problems they encounter in adapting to their ecological niches. A person existing in a rural subsistence culture will tend to interact with his environment on a concrete level. His modes of representing reality may not develop past the imagery stage. This is in part due to the fact that his adaptational problems are stated in concrete terms and also that his culture probably doesn't include highly abstract conceptualization of agricultural knowledge. On the other hand, an individual existing in a technical culture will be faced with more abstract problems, such as the equivalence of money to time and will be more inclined to develop abstract modes of thought. The development of abstract modes of thought
by persons in technical cultures will be fostered by the probable presence of abstract linguistic concepts within the culture.

This viewpoint serves to identify the content of one's cultural experiences as an important variable in cognitive development. It implies that an individual who has not been exposed to a given type of content, such as abstract concepts, will not have developed capacities for handling that type of content. He would, however, be viewed as possessing the capacity for abstract thought and would be expected to develop conceptual abilities given experiences utilizing abstract concepts.

Bruner's (1966) notion that a person's modes of representing reality change during development has led to a spiral curriculum. Bruner (1965, p. 45) has organized materials in a manner approximately commensurate with the individual mode of representing reality. As Bruner says,

Any domain of knowledge can be represented in three ways: by a set of actions appropriate for achieving a certain result (enactive representation), by a set of summary images or graphics that stand for a concept without defining it fully (ikonic representation); and by a set of logical propositions drawn from a symbolic system that is governed by rules or laws for forming and transforming propositions (symbolic representation).

In a spiral curriculum, facts and ideas are successively presented at higher levels of abstraction. Children are encouraged to utilize intellectual processes at or just beyond their development level in organizing and applying curriculum content. As intellectual processes at one level of development (e.g., ikonic) prove lacking in power for
handling ideas and abstractions, the child is prompted to differentiate the intellectual processes of the next level of development.

According to Piaget (in Flavell 1963), intellectual development involves changes in the organizational properties of intellectual structures. Changes in organizational structures are prompted by interactions with the environment. Interactions may stimulate the development of a structure for organizing and performing operations on concrete content, but fail to stimulate structures for performing similar operations on other types of content.

Piaget uses the concept of horizontal decalage to describe the situation which occurs when structures organized for processing one type of content are inapplicable to other types of content. An example is the observation (Piaget and Inhelder 1964) that concepts related to the invariance of mass are typically achieved a year or two earlier than concepts related to invariance of weight. Operations accomplished with mass cannot be accomplished with weight. Stevenson et al. (1968) reports a similar discrepancy in the development of discrimination learning abilities. They report that the discrimination learning of one type of content, line drawings, correlates only .27 with the same operation, discrimination learning, as applied to geometrical forms. In both examples, intellectual operations performed on one type of content are not performed equally well on other types of content.

The concept of accommodation implies that horizontal decalage is related to lack of experience with specific kinds of content. In the two examples above, it would be consistent with the theory to state
that structures failed to develop for handling invariance of weight or discrimination learning with geometrical forms due to lack of experience with these types of content.

In Piaget's system, as with others mentioned above (Hull in Hilgard 1956, Tolman in Hill 1963, Harlow 1949, Ausubel 1960, Bruner 1966), experience with a given type of content is considered influential in developing intellectual abilities applicable to that type of content.

Experiential Factors in the Development of Intelligence

Animal Studies

Riesen (1947, 1958) has carried out a series of experiments designed to demonstrate the influence of experiential factors in the development of intelligent behavior in animals. He found that infant chimpanzees reared in darkness for 16 months were retarded in visual competence and discrimination learning. After 48 days in lighted environments their visual responses were restored to a normal level. In a later study Riesen (1958) demonstrated that the speed with which particular classes of visual inputs can gain control over behavior depends upon the degree of prior exposure to that class of inputs. He compared chimpanzees raised for seven months in conditions (1) allowing no light experience, (2) allowing 1½ hours per day of diffuse unpatterned light, and (3) allowing 1½ hours per day of patterned light. He found that the amount of deprivation was directly related to the time required to learn eye blink responses, visual pursuit, and visual fixation. The
greater the amount of deprivation, the greater the retardation in learning speed. Limited exposure to visual stimuli makes learning with that type of stimuli extremely difficult. Experience with visual stimuli was clearly related to the development of abilities for dealing with visual stimuli.

Thompson and Heron (1954) found that restriction of early experience had long-term effects on learning skills. They raised Scottish terriers from weaning to eight months of age in three degrees of deprivation: (1) complete isolation, (2) in normal cages with sides covered to restrict external stimulation, and (3) normal laboratory conditions. The dogs in each condition had pet reared controls. After eight months, the investigator arranged for all of the dogs to share ten months of normal laboratory life. At eighteen months of age there were significant differences in the experimental and control groups. The cage-reared dogs made significantly lower scores on orientation and barrier tests. The cage-reared dogs also made significantly lower scores on all 18 problems of the Hebb Williams Intelligence Test. These findings suggest that the effects of early deprivation on problem solving skills may be irreversible.

Rosenzweig, Bennett, and Diamond 1967) have demonstrated that environmental deprivation and enrichment has observable anatomical and physiological effects. They compared rats raised in an enriched environment with rats raised in a deprived environment. The enriched environment included 10 to 12 rats in a large cage with ladders, wheels, boxes, and platforms. The impoverished environment involved rats
individually housed in dimly lighted, solid-walled cages. The rats raised in the enriched environment showed significantly greater brain weight, capillary diameter, and enzyme activity. The rats from the enriched environment also demonstrated higher scores on reversal problems. The environment variables significantly affected both physiological and intellectual development.

**Human Studies**

In 1938 Beth Wellman published findings indicating that preschool attendance can lead to marked changes in children's I.Q. While her findings were derisively criticized by Goodenough (1939), she and her colleagues at Iowa persisted in the belief that the environment can be manipulated to produce changes in intelligence. In 1940 Wellman matched a group of 34 nursery school children with 34 control children who did not attend nursery school. After a year in nursery school, the schooled children gained an average of 7.0 points in I.Q. while the unschooled children lost an average of 3.9 points. This difference was statistically significant and supported her contention that the environment can enhance intelligence.

Spitz (1946a,1946b) published a series of studies which served to convince many persons of the modificability of intelligence. He compared infants in a foundling home where attention and stimulation were minimal with children from the nursery of a penal institution. Infants in the foundling home received little variety in their environment and no maternal contact, whereas infants in the nursery were cared for and played with by their mothers every day for the first year of
of their lives. At the beginning of the study the mean Developmental
Quotient of the foundling home children was 131 and the D.Q. of the
nursery children was 97. After eight months in the foundling home, the
deprieved children's mean dropped to 72. During the same period, the
D.Q. of the nursery children rose to 100. Although no statistical data
were reported, it appears that the impoverished experience of the
foundling home had a retarding effect on intellectual development.
Spitz attributed the retarding effects of the foundling home to "lack
of mothering." In any event, the study was an impressive demonstration
of the role of experiential factors in intellectual development.

Dennis (1960) has studied the locomotor development of chil-
dren from the impoverished environment of an orphanage in Teheran. He
observed that only 15% of the children were walking at four years of
age. Some of the children had, however, developed an alternate form
of locomotion referred to as "scooting." He concluded that these facts
indicated that experience affected not only the ages at which motor
patterns appear but also their form.

Kirk (1958) demonstrated that special instruction can signifi-
cantly increase intelligence. His experimental subjects were institu-
tionalized children about four and one-half years old. At the start of
the study, the children had I.Q.'s between 45 and 80. The control sub-
jects were institutionalized children of comparable age and intelli-
gence. The experimental children were enrolled in a preschool for six
hours per day until entering the first grade. The school provided
group experience, opportunities to tell stories, and individual tutoring
in abilities that seemed weak. The control children had no preschool experience. The experimental and control children were compared at the end of the first grade. The institutional children with preschool gained 10.2 points in I.Q., while the institutional children without preschool lost 6.5 points.

Preschool experience had a relatively permanent positive effect on I.Q. It is particularly impressive that the I.Q.'s of all of the experimental children were raised above initial levels. None of the control children made similar gains. This suggests that, given appropriate individualized instruction, it is possible to significantly intervene in the development of intelligence.

The Role of Content Factors in the Development of Intellect

Cornbach (1963, p. 242) has stated, "Consistent opportunities to use a type of reasoning or discrimination, with appropriate reward, enhance that activity." The notion that experience with a given type of content enhances abilities for handling that type of content has been supported by a variety of studies.

Ford (1957) observed that Samoans have an uncanny ability to score highly on the Navy test of aptitude for learning radio codes, which calls for memory of rhythmic patterns.¹ He explained this exceptional ability on the basis of the Samoan's experience in singing and

¹ The reader may be interested to know that the Navy presently employs only Samoans on its Honolulu to Pago Pago radio circuits because other persons are unable to transmit and receive at a sufficiently rapid pace.
dancing to highly complex rhythmic patterns produced by percussion instruments. In this instance experiences with a given sort of content, rhythmic beats, led to highly developed abilities for dealing with rhythmic patterns.

Birch (1945) presented some observations suggesting that for chimpanzees, experiences with a given type of material may be prerequisite to solving problems with the particular type of content. He observed that the only one of the six chimpanzees that succeeded in securing food with a hoe-like tool was the animal which had been observed to use sticks regularly in the spontaneous play.

Lesser et al. (1965) have collected evidence indicating that the contrasting cultural milieu presented by different ethnic groups fosters distinctly different ability patterns. They studied ability patterns of Chinese, Negro, Jewish, and Puerto Rican ethnic groups. Members of low and middle class socioeconomic levels were included in each ethnic sample. The abilities studied were: verbal ability, reasoning, number facility, and space conceptualization. Their results revealed (1) significant differences between the two social class groups in level of score on each mental ability, (2) significant differences among the four ethnic groups in level of score for each mental ability, (3) significant interaction between social class and ethnicity in determining the level of scores for each mental ability, and (4) significant differences among the four ethnic groups in pattern of scores on the four mental ability scales. They stated (p. 83):
Ethnic group affiliation strongly affects the pattern or organization of mental abilities, but once the pattern specific to the ethnic group emerges, social class differences within the ethnic group do not alter this basic organization.

They concluded by stating that "mediators associated with ethnicity provide differentiated impacts upon the development of mental abilities." The study indicates that the content of one's experiences influences the patterns of one's abilities.

Whiteman and Deutsch (in Jensen and Deutsch 1968) have identified some experiential correlates of abilities and reading achievement. They studied 165 first and fifth grade children from varying SES levels in New York City. Their data indicate that quality of housing, scholastic aspiration, dinner conversation, cultural activities and kindergarten are all significantly associated with abilities as measured by the Lorge Thorndike I.Q. Test, the vocabulary subtest of the WISC, and a special orientation test. The background factors most closely associated with reading achievement were interaction activities with parents, mealtime conversations, and visits to zoos and museums. Whiteman and Deutsch (in Jensen and Deutsch 1968, p. 97) comment that

... the correlations between the abilities and the achievement variable, reading, are higher than between environmental conditions and reading. The median correlation between abilities and reading is .64 as compared to a median correlation of .27 between environmental conditions and reading. This suggests that these abilities may be exerting a more direct influence on reading than the more distant background variable. There is consistency here with the notion that environmental conditions exert their influence on underlying skills which in turn more directly influence the development of reading skills.

This emphasizes the importance of studying environmental factors as related to intellectual processes. It may be that the focus of
experiential factors is on basic intellectual processes, such as clas-
sification and seriation, rather than on more complex performances such
as reading.

A different line of evidence indicating that abilities are con-
tent specific is provided by factor analytic studies. G. M. Smith
(1933) selected tests so that an analysis could cluster the tests either
in terms of similar content (spatial, number, verbal) or according to
formats with similar types of items. The items clustered according to
content suggesting that this was an important dimension of test per-
formance. In subsequent studies, Guilford (1967) has distinguished in-
dependent factors for figural, symbolic, semantic, and behavioral con-
tent. Thus content becomes a dimension of his Structure of Intellect.
The implication is that in order to describe and distinguish adequately
one must specify the content to which it is being applied.

Bloom, Davis, and Hess (1965) report a study suggesting that
exposure to unfamiliar materials may accelerate the development of abil-
ities for processing these materials. The study investigated visual
perceptual ability in Kindergarten children. On a visual discrimina-
tion test, in which children matched an abstract form to the same form
in a cluster of three forms, upper socioeconomic status children scored
significantly higher than lower SES children. The interesting finding
was that, following "instruction" in which the children merely looked
at the forms projected on a screen, the low SES children made greater
gains than the upper SES children on the discrimination task. The
final scores of the two SES groups were approximately the same. The
study illustrates that (1) lower SES children may have poorly developed
perceptual discrimination abilities and that (2) content relevant experiences can accelerate the development of low SES children's perceptual discrimination abilities to a level commensurate with their high SES peers.

An early study by Anastasi (1936) found that content specific instruction can produce changes in mental organization. She developed a group of tests utilizing verbal, numerical, and spatial content. She attempted to minimize the overlap of content between these tests. The scores of preadolescent children produced a pattern of intercorrelations shown in Table 1.

<table>
<thead>
<tr>
<th>Table 1. Intercorrelations Among Test Scores for Preadolescent Children.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
</tr>
<tr>
<td>1. Vocabulary</td>
</tr>
<tr>
<td>2. Digit span</td>
</tr>
<tr>
<td>3. Pattern analysis</td>
</tr>
<tr>
<td>4. Verbal reasoning</td>
</tr>
<tr>
<td>5. Code manipulation</td>
</tr>
</tbody>
</table>

It should be noted that tests differing in content produced (with two exceptions) uniformly low correlations.

Following instruction specific to each ability, Anastasi found changes in ability patterns. She found an increase in correlation between (1) the abilities for pattern analysis and verbal reasoning (from
Her results indicate that content relevant instruction can alter the degree of association among content specific abilities.

**The Nature of Six-year-old Intelligence**

The nature of six-year-old intelligence can be described in terms of structure or ability factors.

The structural viewpoint, as articulated by Jean Piaget (in Flavell 1963) considers the six-year-old child to be in a transitional period between the pre-operational subperiod and the concrete operations subperiod. The child has acquired the capacity to use signs and symbols in representing the environment. The child can think about objects both with images and with symbols. He is conceived as developing the capacity to perform multiple classifications and consider two dimensions of an object simultaneously. He may not yet have acquired the capacity to conserve or report that mass or volume can remain constant through proportional changes in dimensions. Focusing on seriation skills, the six-year-old child is described by Piaget (Piaget and Szeminska 1952) as being able to categorize sticks by length. He is considered to be in the process of developing the capacity to order the sticks in a staircase effect in which the bottoms are even and the tops of increasing length. The child is conceived as developing the appreciation that each item in a series is both greater than the preceding item and smaller than the one which is to follow.
An alternative perspective on six-year-old intelligence is provided by factorial research. Meyers and Orpet (1962) have distinguished four separate abilities in six-year-olds: hand-eye coordination, perceptual speed, linguistic, and spatial reasoning. Children can be characterized by their status on each of these abilities. In a later study Meyers and Orpet (1966) identified four independent structures of intellect abilities in six-year-olds: Auditory memory for symbolic units (MSU), convergent semantic production (NM), divergent production of semantic units (DMS), and evaluation of figural units (EFU).

Lesser et al. (1965) found low positive correlations among abilities in six-year-olds. As shown in Table 2, only reasoning and number abilities correlate above .50. It is interesting that those abilities dealing with different content (verbal x number, verbal x space, space x number) show the lowest intercorrelations. This suggests that some factors were operating to differentially affect the development of content-oriented abilities in six-year-old children.

Table 2. Correlation Among Abilities in Six-year-olds.

<table>
<thead>
<tr>
<th></th>
<th>Reasoning</th>
<th>Number</th>
<th>Space</th>
</tr>
</thead>
<tbody>
<tr>
<td>Verbal</td>
<td>.46</td>
<td>.37</td>
<td>.32</td>
</tr>
<tr>
<td>Reasoning</td>
<td></td>
<td>.61</td>
<td>.47</td>
</tr>
<tr>
<td>Number</td>
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<td></td>
<td>.35</td>
</tr>
</tbody>
</table>
Summary

This chapter has reviewed literature related to historical views of intellect, theoretical models of intellectual development, experiential factors in the development of intellect, the role of content factors in the development of abilities, and the nature of six-year-old intelligence.

The review indicated that abilities develop in response to experiential variables, such as content, and that content specific instruction may experimentally produce changes in the ability patterns of six-year-old children.
CHAPTER III

PROCEDURES FOR COLLECTING AND ANALYZING THE DATA

This chapter (1) discusses the pilot studies used to develop and refine testing and curriculum materials, (2) identifies the experimental population, (3) describes the final revision of testing and curriculum materials, (4) outlines the experimental design, and (5) details the statistical tests used to assess the experimental hypotheses.

Pilot Studies

The testing materials were developed and standardized in a series of informal pilot studies conducted in the late spring of 1969. Subjects for the pilot were eighteen first grade children enrolled in a parochial day school. While vital statistics were not available for the school population, it should be noted that approximately two-thirds of the student body were from middle socioeconomic level homes, while the remaining third were scholarship students from minority groups.

An effort was made to develop test items representative of each content category, attractive to children, and capable of generating a normal distribution of correct answers. The author approached these objectives by individually administering various revisions of the test to the children. Instructions were revised in a manner designed to enhance children's understanding of the task. Scoring was adjusted to

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yield a maximum subtest score of 25 for each type of content and a total score of 100. The interest level and difficulty level of items within each content category were manipulated in accordance with the author's observation of the children's performance.

It was observed that children in the pilot tended to score highly on the test. Their scores were considered a reflection of their seven to eight months of schooling. As the test was intended for use with beginning first grade children, it was assumed that the relative naivety of younger, less experienced children would tend to normalize the distribution.

The curriculum materials were developed in a pilot study conducted during the summer of 1969. Subjects for the curriculum pilot were five-year-old Head Start children. The author instructed the children in a small group. He encouraged the children to (1) pick up, hold, and manipulate the materials; and (2) verbally label similarities and differences between materials such as bigger, smaller, longer, shorter, before, and after.

The children were exposed to a variety of materials representative of each content category. The author's impression of the children's interest in manipulating and labeling the materials was the criterion for inclusion in the final curriculum units.

It was observed that the Head Start children scored very low (1, 2, 3 points per subtest) on pretesting with the Seriation Skills Test and that their scores improved following instruction.
The Sample

Data to test the hypotheses were collected from a sample of 65 first grade children residing in a predominantly white, middle socio-economic level district of a large southwestern city. The children attended a neighborhood elementary school with 430 students enrolled in six grades. They were homogeneously grouped in three first grade classrooms on the basis of scores on the Metropolitan Readiness Tests. The median I.Q. was 106 with a range of 73 to 131 as measured by the Primary Mental Abilities Test.

Measurement

The Seriation Skills Test, developed and standardized in pilot studies, was used to assess children's seriation abilities. The test required the subjects to perform the same task with each of the four types of content.

While the task remained constant, the content of items was selected to correspond with the content categories. Concrete items involved ordering seven balsa wood sticks of varying lengths to form "staircase" patterns. For example, the examiner would order the three shortest sticks from the shortest to the longest, give the subject the remaining four sticks and say, "Now you put these sticks in order to finish the staircase." Quantitative items required subjects to place relatively greater and greater numbers of marbles in a series of seven empty cups. For example, the examiner would place one marble in the first cup, two marbles in the second cup, three marbles in the third cup, give the subject a bin of marbles, and say, "Now you put the right
number of marbles in the rest of the cups." Interpersonal items re-
quired the subject to order a group of separately mounted pictures in
a manner "to tell a story." For example, the examiner would present
three pictures to the subject and say, "These pictures tell a story,
but they're in the wrong order. You put them in order so they's tell a
story." Verbal items required that the subject choose one of four pic-
tures and tell a story about the picture. For example, the examiner
would present a picture to the subject and say, "I want you to tell me
a story about this picture." "Remember that a story has a beginning, a
middle and an end. Tell me what happened at the beginning of the story
before the picture, what happened at the middle of the story, as shown
by the picture, and what happened at the end of the story, after the
picture." It was possible to acquire a maximum of twenty-five points
in each content area for a maximum total score of one hundred. A de-
tailed description of each item of the Seriation Skills Test was pro-
vided by the manual for administration and is included in Appendix A.

The Seriation Skills Test was individually administered to sub-
jects by either a female graduate student in Rehabilitation Counseling
or a female graduate student in School Psychology. Testing time var-
ied with the number of correct responses. The actual range was ten
minutes to thirty-five minutes. Test/re-test reliability for one
month was .80 for a sample of ten first grade children.

Curriculum Materials

There was a curriculum unit corresponding to each content cate-
gory. Concrete materials were Cuisenaire rods. These brightly colored
wooden rods of varying lengths could be arranged in ascending and descending patterns. Also, two small rods could be fitted together to make a combination exactly equal to a longer rod or one unit shorter or longer. Quantitative materials were poker chips. The chips could be ordered according to the number of chips in stacks of varying height. The difference between stacks could be varied by one or two or three chips. Interpersonal materials were independently mounted series of pictures cut out of elementary workbooks. There were four different sets of pictures which could be ordered to tell logical, sequential stories. Verbal materials were brightly colored pictures of spacemen and ferocious animals. The pictures readily prompted verbalization from the children. The verbalization could be structured into sequential stories.

**Teaching Methods**

The rationale underlying instructional techniques was based on the theoretical formulations of Jerome Bruner (1966) and Jean Piaget (as described in Sigel and Hooper 1968). The most salient characteristics were: (1) active physical manipulation of materials by students, (2) verbal labeling, and (3) small heterogeneous group instruction.

The children were removed from their regular classroom and instructed in groups of five by experienced, certificated elementary teachers. Instruction periods lasted for thirty minutes and occurred twice per week for four successive weeks. Instruction was held in the school library.
The teachers' anecdotal records of instructional sessions are summarized in Appendix B.

Experimental Design

The study relied upon a Solomon Four Group Design (Campbell and Stanley 1963) to insure internal validity. The design, graphically illustrated in Figure 1, provided for (1) an assessment of treatment effects, (2) an assessment of possible relationships between pretest and treatment, and (3) an assessment of possible relationships between pretest and post test.

The disproportionately large distribution of subjects to group I stems from practical limitations on the number of subjects involved in the study. A restricted budget dictated that only three first grade classrooms (n = 61) could be included in the study. As subjects in groups II, III, and IV were being used to control the internal validity of the experiment and not to directly test the hypotheses, it was decided to minimize the n in the control groups and maximize the n in the experimental groups.

The process of assigning subjects to groups was based on traditional randomization procedures. There were twenty-seven children in classroom 1, so it was possible to distribute ten children to treatment condition I, five children to treatment condition II, six children to treatment condition III, and five children to treatment condition IV. There were twenty-three children in classroom 2, so ten children were distributed to treatment condition I, five children to condition II,
<table>
<thead>
<tr>
<th>R</th>
<th>I</th>
<th>0₁</th>
<th>X</th>
<th>0₂</th>
<th>n = 23</th>
</tr>
</thead>
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<tr>
<td>R</td>
<td>II</td>
<td></td>
<td>X</td>
<td>0₃</td>
<td>n = 14</td>
</tr>
<tr>
<td>R</td>
<td>III</td>
<td>0₄</td>
<td></td>
<td>0₅</td>
<td>n = 13</td>
</tr>
<tr>
<td>R</td>
<td>IV</td>
<td></td>
<td></td>
<td>0₆</td>
<td>n = 11</td>
</tr>
</tbody>
</table>

**Figure 1**

**SOLOMON FOUR GROUP DESIGN**

Roman numerals = 4 treatment groups or experimental conditions.
- R = subjects randomly assigned to the groups.
- 0 = observations or administrations of the test battery.
- X = treatments or, in the case of the present study, training designed to provide experiences with each type of content.
- n = number of subjects per group.
four children to condition III, and four children to condition IV. There were sixteen children in classroom 3, so five children were distributed to condition I, five children to condition II, four children to condition III, and two children to condition IV. The total number of children in each treatment condition is seen in Figure 1.

It should be recalled that on both pretesting and post testing subjects received a score on each of four types of content and a total score. The Seriation Skills Test included subtest scores for concrete, quantitative, interpersonal, and verbal content and a total score.

The effect of training on both content scores and total scores was assessed by performing planned comparisons (Hays 1963) on the mean of subject's scores as observed in $0_2$, $0_3$, $0_5$, and $0_6$ (see Figure 1).

Specific sources of variance were investigated by making the following comparisons:

1. Treatment variance was assessed by comparing the pooled average of means observed in groups which had the treatment (Groups I and II, $0_2$ and $0_3$) with the pooled average of means observed in groups which did not have the treatment (Groups III and IV, $0_5$ and $0_6$).

2. The interaction of pretest and treatment was assessed by comparing the mean of the group which had pretest and treatment (Group I, $0_2$) with the mean of the group which had no pretest but did receive the treatment (Group II, $0_3$).

3. The interaction of pretest and post test was assessed by comparing the mean of the group which had pretest and post test (Group III, $0_5$) with the mean of the group which had only the post test (Group IV, $0_6$).
The initial comparisons were based on raw scores. Subsequently following discovery of violated assumptions (Hays 1963) in the planned comparisons, the same comparisons were computed for square root and logarithmic transformations of the raw data.

The possibility of a test ceiling effect was investigated by computing a correlation coefficient between subtest mean scores and variances.

The discovery of a test ceiling effect limiting the amount of gain students could make in high scores led to a different perspective on treatment effects. In an effort to compensate for test ceiling effects, percentage gain scores were computed for subjects in Group I who received the treatment and subjects in Group III who did not receive the treatment. The significance of the difference between mean percentage gain in Group I and mean percentage gain in Group III was assessed with a t test.

Following these explorations of the internal validity of the experiment, the hypotheses were tested by focusing on subjects in Group I.

Hypotheses 1a to 1f were assessed by computing the six correlation coefficients representing the pretest relationships between seriation skills for the four types of content. The six correlation coefficients reflected the relationships between the ability to seriate (1) concrete and quantitative content, (2) concrete and interpersonal content, (3) concrete and verbal content, (4) quantitative and interpersonal content, (5) quantitative and verbal content, and
(6) interpersonal and verbal content. These coefficients were based on the data obtained for Group I in O₁ (see Figure 1).

In assessing the significance of the correlation coefficients, it was recalled that the experiment was designed to identify any existing relationships among abilities. Accordingly, the alpha levels of significance tests were adjusted inward, beyond the traditional levels. This increased the power of tests to detect any coefficients departing from chance expectations at the expense of increasing the risk of falsely concluding that an observed departure was significant. The alpha levels were established at the .50 level.

To test the null hypotheses that \( p \), the population correlation, was equal to zero, the following formula (Edwards 1967, p. 246) was utilized:

\[
t = \frac{r}{\sqrt{1 - r^2}} \sqrt{n - 2}
\]

The \( t \) is a ratio whose sampling distribution depends only on the size of \( n \). The \( r \) is the correlation coefficient reflecting the relationship between two variables, in the present case, scores on subtests of the Seriation Skills. It was determined from tabled values (Edwards 1967, p. 425) that correlation coefficients greater than .16 (\( t = .69, \text{df} = 22 \)) were statistically significant at the .50 level for two-tailed tests.

Hypotheses 2a to 2f were tested by (1) computing the six correlation coefficients representing the six post test relationships among
the four seriation skills, and (2) assessing the statistical significance of the change in correlation between pretest and post test. The significance of the difference between pretest coefficients and post test coefficients was assessed by transforming the correlation coefficients to Fisher Z' scores (in Edwards 1967, p. 248). Fisher has shown that the distribution of Z' is approximately normal. Since Z' is approximately normally distributed, differences between Z' scores were expressed as Z scores by dividing by the standard error of the difference. The significance of the Z indicating the amount of the difference between pretest and post test correlation coefficients was determined by reference to the standard normal table.

In the present exploratory study, it was considered important to detect evidence indicating a change in relationships among abilities. The limitations on correlation coefficients imposed by a relatively homogeneous sample and a restricted range of scores at upper levels indicated that small observed changes in coefficients should be considered significant under the limiting circumstances. Accordingly, an effort was made to increase the power of statistical tests to detect small changes in relationship by setting the alpha levels for rejection of the null hypotheses at the .15 level. It was recognized that this criterion for accepting hypotheses increased the chances of falsely concluding that an observed difference was significant when in fact there was no relationship in the population parameters. The investigator was willing to risk making a few mistakes in the interest of discovering any true relationships. As the hypotheses were directional, a
one-tailed test with the alpha level set at .15 was used in testing the hypotheses.

**Calendar for Collection of Data**

The following steps were taken in collecting the data: (1) individually pretest subjects in treatment conditions I and III (n = 39), October 6 to 17, (2) instruct subjects in treatment conditions I and II (n = 40, 5 subjects per group) for four weeks, October 20 to November 14, 1969; and (3) individually post test all subjects (n = 65), November 17 to December 12, 1969.

**Summary**

This chapter has (1) identified the experimental sample; (2) described the measuring instrument, curriculum materials, and teaching methods; (3) presented the experimental design and statistical analyses used in assessing the hypotheses; and (4) outlined a calendar of events for collecting the data.
CHAPTER IV

ANALYSIS OF RESULTS

This chapter presents some considerations related to the internal validity of the experiment, translates the hypotheses into operational and symbolic form, tests the hypotheses, and analyzes the results.

Internal Validity of the Experiment

The Solomon Four Group Design was employed to scrutinize the treatment effect (instruction) and possible interactions between pretest treatment and pretest/post test. The design, shown in Table 3, rendered the data amenable to a planned comparisons statistical analysis.

Table 3. Experimental Design.

<table>
<thead>
<tr>
<th>Group</th>
<th>n</th>
<th>Experimental condition</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>23</td>
<td>Obs. Instruct Obs.</td>
</tr>
<tr>
<td>II</td>
<td>13</td>
<td>Instruct Obs.</td>
</tr>
<tr>
<td>III</td>
<td>14</td>
<td>Obs.</td>
</tr>
<tr>
<td>IV</td>
<td>11</td>
<td>Obs.</td>
</tr>
</tbody>
</table>

Comparison 1 assessed the significance of the treatment effect by comparing the pooled average of the post test scores from Group I
and Group II with the pooled average of post test scores for Groups III and IV.

Comparison 2 assessed the significance of the interaction between the pretest treatment by comparing the mean of post test scores for subjects in Group I with the mean of post test scores for subjects in Group II.

Comparison 3 assessed the significance of the interaction between pretest/post test by comparing the mean of post test scores for subjects in Group III with the mean of post test scores for subjects in Group IV.

These three comparisons are orthogonal. As the planned comparisons techniques required equal n's in each group, it was necessary to randomly choose eleven subjects from Groups I, II, and III for purposes of planned comparison analysis. This served to equalize the number of subjects in each treatment condition. The comparisons were computed with raw scores. The results of the planned comparisons are shown in Table 4.

Table 4. Planned Comparisons Analysis of Raw Scores.

<table>
<thead>
<tr>
<th>Source</th>
<th>SS</th>
<th>df</th>
<th>MS</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Between</td>
<td>266</td>
<td>3</td>
<td>88</td>
<td></td>
</tr>
<tr>
<td>Comparison:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>136</td>
<td>1</td>
<td>136</td>
<td>Not sig.</td>
</tr>
<tr>
<td>2</td>
<td>89</td>
<td>1</td>
<td>89</td>
<td>Not sig.</td>
</tr>
<tr>
<td>3</td>
<td>50</td>
<td>1</td>
<td>50</td>
<td>Not sig.</td>
</tr>
<tr>
<td>Error</td>
<td>10631</td>
<td>40</td>
<td>265</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>10879</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
The planned comparisons analysis of raw scores failed to reveal a significant treatment effect or any significant interaction effects. This cast doubt on the validity of the data for assessing the hypotheses.

A closer examination of the data revealed that one of the assumptions underlying analysis of variance was questionable. The assumption related to independent population means and variances was not well supported by the data. A correlation coefficient of -.38 was observed between sample means and variances. Although this coefficient is not statistically significant, it seemed worthwhile to re-analyze the data in a manner designed to compensate for a relationship between population means and variables.

In the case where cell variances tend to be functions of cell means, Winer (1962) recommends a square root transformation of the data to make the variances more homogeneous. Accordingly, a square root transformation was carried out with the present data and planned comparisons were recomputed for the transformed scores.

The results of the planned comparisons computed for the transformed scores are shown in Table 5.

Although the square root transformation diminished the relationship between means and variances ($r = -.27$), the planned comparisons still failed to reveal a significant treatment effect or significant interaction effects.

The validity of the planned comparisons was further questioned by the possible introduction of unequal sampling errors. The procedure
### Table 5. Planned Comparisons for Transformed Scores.

<table>
<thead>
<tr>
<th>Source</th>
<th>SS</th>
<th>df</th>
<th>MS</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Between</td>
<td>1.34</td>
<td>3</td>
<td>.45</td>
<td></td>
</tr>
<tr>
<td>Comparison:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>.22</td>
<td>1</td>
<td>.22</td>
<td>Not sig.</td>
</tr>
<tr>
<td>2</td>
<td>.53</td>
<td>1</td>
<td>.53</td>
<td>Not sig.</td>
</tr>
<tr>
<td>3</td>
<td>.67</td>
<td>1</td>
<td>.67</td>
<td>Not sig.</td>
</tr>
<tr>
<td>Error</td>
<td>47.69</td>
<td>40</td>
<td>1.19</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>49.03</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

by which eleven subjects were randomly sampled from Groups I, II, and III in order to equalize the n's for planned comparisons analysis could have resulted in substantially more sampling error for treatment population I than for Groups II, III, and IV. Only one-half of the observations from Group I was used in the planned comparisons so there was room for substantial sampling error. On the other hand, almost all or all of the observations from Groups II, III, and IV were used in the analysis. Utilization of large proportions of the available observations left less room for sampling error. The results for Group I could be affected by sampling error while results from Groups II, III, and IV would be much less influenced by sampling errors. In short, the unequal distribution of sampling errors limits the validity of the planned comparisons.

Additional analysis of the data revealed a test ceiling effect. A correlation coefficient of -.69 was observed between subtest mean
scores and variances. This indicated that high scores tended to be associated with low variance. In other words, high scores were varying within a relatively small interval. The range of the interval was restricted by the maximum score on the test.

Test ceiling effects can be compensated for by computing percentage gain scores. Percentage gain scores are computed by dividing a subject's observed pretest to post test gain by the amount of possible gain. In this manner subjects who initially score high on tests and have little room for improvement are equated with subjects who initially score low and have ample room for improvement.

A new perspective on the treatment effects was gained by assessing the difference between percentage gain scores for subjects in Group I and subjects in Group III.

The subjects in Group I who received instruction made significantly greater percentage gain scores than subjects in Group III who did not receive instruction. A t test of the difference between the mean percentage gain scores for subjects in Group I and the mean percentage gain scores of subjects in Group III yielded a t value of 4.94 which was significant beyond the .01 level. This indicated that instruction had a significant effect on test scores.

The evidence from percentage gain scores indicated that the instruction was influencing student abilities as measured by the Seriation Skills Test. It was concluded that the experiment had sufficient internal validity to warrant using the data to test the hypotheses.
Testing the Hypotheses

This section presents data relevant to the two questions identified in the Statement of Problem:

1. Do seriation skills generalize across content categories?
2. Will a brief training period with materials representative of the content categories alter the extent to which seriation skills generalize across content categories?

The First Question

It will be recalled that the literature review and theoretical rationale predicted moderate to low intercorrelations among children's abilities to seriate different types of content. The acceptance of null hypotheses stating that there will be no significant relationship between seriation skills would be consistent with these predictions.

An observed correlation coefficient that could occur by chance in less than 50 out of 100 samples was considered evidence of a relationship and led to the rejection of the null hypotheses. Correlation coefficients beyond the .50 level of significance were considered sufficiently strong evidence of a population relationship to warrant rejection of the null hypotheses. The null hypotheses were only considered acceptable if the observed correlation between seriation abilities was sufficiently small (less than .16) to suggest the absence of a meaningful relationship.

Data pertinent to the first question, "Do seriation skills generalize across content categories?", are presented in Table 6. The table lists each hypothesis pertinent to question 1, the correlation
Table 6. Intercorrelations Between Seriation Abilities as Measured by the Concrete, Quantitative, Interpersonal, and Verbal Subtests of the Seriation Skills Test.

<table>
<thead>
<tr>
<th>Hypothesis</th>
<th>Abilities</th>
<th>Correlation Coefficient</th>
<th>t Value&lt;sup&gt;a&lt;/sup&gt;</th>
<th>Likelihood of a Chance Relationship</th>
</tr>
</thead>
<tbody>
<tr>
<td>la</td>
<td>conc. x quant.</td>
<td>.43</td>
<td>2.18</td>
<td>5/100</td>
</tr>
<tr>
<td>lb</td>
<td>conc. x interpers.</td>
<td>.05</td>
<td>.05</td>
<td>96/100</td>
</tr>
<tr>
<td>lc</td>
<td>conc. x verbal</td>
<td>-.11</td>
<td>.50</td>
<td>60/100</td>
</tr>
<tr>
<td>ld</td>
<td>quant. x interpers.</td>
<td>.13</td>
<td>.59</td>
<td>50/100</td>
</tr>
<tr>
<td>le</td>
<td>quant. x verbal</td>
<td>.14</td>
<td>.61</td>
<td>50/100</td>
</tr>
<tr>
<td>lf</td>
<td>interpers. x verbal</td>
<td>.30</td>
<td>1.44</td>
<td>20/100</td>
</tr>
</tbody>
</table>

<sup>a</sup>The t values above .69 are statistically significant at the .50 level.

coefficient reflecting the degree of association between the abilities involved in the hypothesis and the significance level of the observed relationship.

The hypotheses related to question 1 are translated and tested in the following manner:

Hypothesis la.

The operational form is: There will be no significant correlation between the concrete and quantitative abilities of first grade children at Holaway School as measured by subtest scores on the Seriation Skills Test.
The symbolic form is:

\[ H \text{ null} \quad r_{xy} = 0.0 \]

\[ H \text{ directional} \quad r_{xy} \neq 0.0 \]

where \( r_{xy} \) is the correlation coefficient between scores on \( x \) (concrete content) and scores on \( y \) (quantitative content).

Hypothesis la was rejected. The data indicated the presence of a significant relationship between children's abilities to seriate concrete and quantitative content. This relationship would occur by chance only five times out of 100. This suggests that the ability to seriate concrete content is associated with ability to seriate quantitative content. Persons who can readily seriate concrete content tend to be equally proficient in seriating quantitative content.

Hypothesis lb.

The operational form is:

There will be no significant correlation between the concrete and interpersonal abilities of first grade children at Holaway as measured by subtest scores on the Seriation Skills Test.

The symbolic form is:

\[ H \text{ null} \quad r_{xy} = 0.0 \]

\[ H \text{ directional} \quad r_{xy} \neq 0.0 \]

where \( r_{xy} \) is the correlation coefficient between scores on \( x \) (concrete content) and scores on \( y \) (interpersonal content).
Hypothesis 1b was accepted. There was no suggestion of a relationship between the ability to seriate concrete content and the ability to seriate interpersonal content. If a relationship did exist between these two abilities, it would be most unusual to obtain a sample correlation coefficient as small as .05. Apparently the ability to seriate concrete content is unrelated to the ability to seriate interpersonal content.

Hypothesis 1c.

The operational form is:

There will be no significant correlation between the concrete and verbal abilities of first grade children at Holaway as measured by subtest scores on the Seriation Skills Test.

The symbolic form is:

\[ H \text{ null} \quad r_{xy} = 0.0 \]
\[ H \text{ directional} \quad r_{xy} \neq 0.0 \]

where \( r_{xy} \) is the correlation coefficient between scores on \( x \) (concrete content) and \( y \) (verbal content).

Hypothesis 1c was accepted. There was very little evidence to suggest a relationship between the ability to seriate concrete content and the ability to seriate verbal content. An observed correlation coefficient of -.11 reflects the absence of a meaningful relationship in 60 out of 100 cases. The negative value means that in the observed sample there was a slight, insignificant tendency for persons who scored high on concrete content to score relatively lower on verbal
content and vice versa. There was apparently no relationship between the abilities for seriating concrete and verbal content.

Hypothesis 1d.

The operational form is:

There will be no significant correlation between the quantitative and interpersonal abilities of first grade children at Holaway as measured by subtest scores on the Seriation Skills Test.

The symbolic form is:

\[ H_{\text{null}} : r_{xy} = 0.0 \]
\[ H_{\text{directional}} : r_{xy} \neq 0.0 \]

where \( r_{xy} \) is the correlation coefficient between scores on \( x \) (quantitative content) and \( y \) (interpersonal content).

Hypothesis 1d was accepted. There was little evidence of a relationship between the ability to seriate quantitative content and the ability to seriate interpersonal content. A correlation coefficient of .13 reflects a chance relationship of 50 out of 100 cases. The ability to seriate quantitative content can be considered unrelated to the ability to seriate interpersonal content.

Hypothesis 1e.

The operational form is:

There will be no significant correlation between the quantitative and verbal abilities of first grade children at Holaway as measured by subtest scores on the Seriation Skills Test.

The symbolic form is:
where $r_{xy}$ is the correlation coefficient between scores on $x$ (quantitative content) and scores on $y$ (verbal content).

Hypothesis Ie was accepted. There was little reason to suspect a meaningful relationship between the ability to seriate quantitative and verbal content. A correlation coefficient of .14 reflects a chance relationship in at least 50 per cent of possible samples. It seemed reasonable to consider the ability to seriate quantitative content to be unrelated to the ability to seriate interpersonal content.

Hypothesis If.

The operational form is:

There will be no significant correlation between the interpersonal and verbal abilities of first grade children at Holaway as measured by subtest scores on the Seriation Skills Test.

The symbolic form is:

\[
\begin{align*}
H \text{ null} & : r_{xy} = 0.0 \\
H \text{ directional} & : r_{xy} \neq 0.0
\end{align*}
\]

where $r_{xy}$ is the correlation coefficient between scores on $x$ (interpersonal content) and $y$ (verbal content).

Hypothesis If was rejected. The sample data indicated that a relationship probably exists between the ability to seriate interpersonal content and the ability to seriate verbal content. A correlation as high as .30 would occur by chance in only 20 out of 100 cases. It
appeared that the ability to seriate interpersonal content was associated with the ability to seriate verbal content.

In summary, there was little evidence to suggest an association between the abilities to seriate: (1) concrete and interpersonal content, (2) concrete and verbal content, (3) quantitative and interpersonal content, (4) quantitative and verbal content. It appeared that in many cases, the ability to seriate one type of content is not related to the ability to seriate another type of content. It appeared that seriation skills do not tend to generalize across content categories.

The Second Question

"Will a brief training period with materials representative of the content categories alter the extent to which seriation skills generalize across content categories?" This question was investigated by (1) determining the effect of instruction on the level of ability for seriating each type of content, and (2) determining the extent to which instruction altered the correlation between abilities as measured by the subtests of the Seriation Skills Test.

Table 7 presents data related to the effect of instruction on the level of ability for seriating each type of content. These data indicate that instruction had a significant effect on the level of the student's ability for seriating concrete quantitative and interpersonal content. Following instruction, there were highly significant improvements in scores on the concrete, quantitative and interpersonal subtests of the Seriation Skills Test. The high pretest mean of scores on the
Table 7. The Effects of Instructional Intervention as Reflected by the Difference Between Students' Pretest and Post Test Scores on the Four Subtests of the Seriation Skills Test.

<table>
<thead>
<tr>
<th>Subtest</th>
<th>Pre $\bar{X}$</th>
<th>s.d.</th>
<th>Post $\bar{X}$</th>
<th>s.d.</th>
<th>$\bar{D}$</th>
<th>s.d.</th>
<th>$t$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Concrete</td>
<td>13.9</td>
<td>6.4</td>
<td>19.3</td>
<td>4.8</td>
<td>5.13</td>
<td>1.58</td>
<td>3.25*</td>
</tr>
<tr>
<td>Quantitative</td>
<td>8.2</td>
<td>6.7</td>
<td>14.8</td>
<td>5.7</td>
<td>6.61</td>
<td>1.61</td>
<td>4.12*</td>
</tr>
<tr>
<td>Interpersonal</td>
<td>12.6</td>
<td>6.2</td>
<td>19.8</td>
<td>3.8</td>
<td>7.17</td>
<td>1.32</td>
<td>5.43*</td>
</tr>
<tr>
<td>Verbal</td>
<td>18.4</td>
<td>6.7</td>
<td>20.0</td>
<td>6.0</td>
<td>0.52</td>
<td>1.96</td>
<td>1.96</td>
</tr>
</tbody>
</table>

* (P < .01).

Verbal subtest left little room for improvement in verbal skills. It appeared that instruction was effective in modifying the level of the student's ability to seriate concrete, quantitative, and interpersonal content.

The literature review suggested that content-related instruction might increase the relationships between seriation skills as applied to various types of content. In the interests of discovering any relationships which were altered following instruction, the investigator
Table 8. The Effects of Intervention on the Relationships Among Seriation Abilities for Six-year-old Children as Measured by Subtests of the Seriation Skills Test.

<table>
<thead>
<tr>
<th>Hypothesis</th>
<th>Pretest $r$</th>
<th>Pretest $z'$</th>
<th>Post Test $r$</th>
<th>Post Test $z'$</th>
<th>Difference $Z'<em>{\text{post}}-Z'</em>{\text{pre}}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>2a conc. x quant.</td>
<td>.43</td>
<td>.46</td>
<td>.24</td>
<td>.24</td>
<td>1.0</td>
</tr>
<tr>
<td>2b conc. x interpers.</td>
<td>.05</td>
<td>.05</td>
<td>-.03</td>
<td>-.03</td>
<td>.36</td>
</tr>
<tr>
<td>2c conc. x verbal</td>
<td>-.11</td>
<td>-.11</td>
<td>.37</td>
<td>.38</td>
<td>2.22*</td>
</tr>
<tr>
<td>2d quant. x interpers.</td>
<td>.13</td>
<td>.13</td>
<td>.19</td>
<td>.19</td>
<td>.27</td>
</tr>
<tr>
<td>2e quant. x verbal</td>
<td>.14</td>
<td>.14</td>
<td>.36</td>
<td>.38</td>
<td>1.09*</td>
</tr>
<tr>
<td>2f interpers. x verbal</td>
<td>.30</td>
<td>.31</td>
<td>.33</td>
<td>.34</td>
<td>.16</td>
</tr>
</tbody>
</table>

*(P < .15).*

decided to risk making 15 errors out of 100 observations and set the alpha levels at .15. In the present instance, rejection of the null hypothesis would be consistent with theoretical predictions.

The hypotheses pertinent to question 2 were translated into operational and symbolic form and tested with the following results:

Hypothesis 2a.

The operational form is:

Following four hours of small group instruction equally allotted to units dealing with concrete, quantitative, interpersonal, and verbal content, there will be a significant increase in the correlation between the concrete and quantitative abilities of first grade children at Holaway as measured by subtest scores on the Seriation Skills Test.
The symbolic form is:

\[
\begin{align*}
H & \quad z'_{\text{post}} - z'_{\text{pre}} = 0.0 \\
H \text{ directional} & \quad z'_{\text{post}} - z'_{\text{pre}} > 0.0
\end{align*}
\]

where \( z' \) is a transformed correlation coefficient computed according to the formula \( z' = \frac{1}{2} \log_2 (1 + r) - \log_2 (1 - 4) \) (Edwards 1967, p. 248). \( z'_{\text{post}} \) refers to the correlation coefficient observed between concrete and quantitative scores following training. \( z'_{\text{pre}} \) refers to the correlation coefficient observed between concrete and quantitative scores prior to training.

Hypothesis 2a was accepted. The direction of change in relationship between the abilities to seriate concrete and quantitative content was opposite to that predicted by the theory and specified in the directional hypothesis. Instruction apparently reduced the relationship between the ability to seriate concrete content and the ability to seriate quantitative content. This suggests some individual differences in response to instruction and is an area for further investigation.

Hypothesis 2b.

The operational form is:

Following four hours of small group instruction equally allotted to units dealing with concrete, quantitative, interpersonal, and verbal content, there will be a significant increase in the correlation between the concrete and interpersonal abilities of first grade children at Holaway as measured by subtest scores on the Seriation Skills Test.
The symbolic form is:

\[ H_{null} \quad Z'_{post} - Z'_{pre} = 0.0 \]
\[ H_{directional} \quad Z'_{post} - Z'_{pre} \geq 0.0 \]

where \( Z' \) is a transformed correlation coefficient computed according to the formula listed above; \( Z'_{post} \) refers to the correlation coefficient observed between concrete and interpersonal scores following training. \( Z'_{pre} \) refers to the correlation coefficient observed between concrete and interpersonal scores prior to training.

Hypothesis 2b was accepted. Intervention had no observable effect on the relationship between the ability to seriate concrete content and the ability to seriate interpersonal content. The abilities were unrelated on pretest and remained unrelated on post test. Instruction was considered ineffective in changing the relationship between abilities for seriating concrete and interpersonal content.

Hypothesis 2c.

The operational form is:

Following four hours of small group instruction equally allotted to units dealing with concrete, quantitative, interpersonal, and verbal content, there will be a significant increase in the correlation between the concrete and verbal abilities of first grade children at Holaway as measured by subtest scores on the Seriation Skills Test.

The symbolic form is:

\[ H_{null} \quad Z'_{post} - Z'_{pre} = 0.0 \]
\[ H_{directional} \quad Z'_{post} - Z'_{pre} \geq 0.0 \]
where $Z'$ is a transformed correlation coefficient computed according to the formula listed above; $Z'$ post refers to the correlation coefficient observed between concrete and verbal scores following training. $Z'$ pre refers to the correlation coefficient observed between concrete and verbal scores prior to training.

Hypothesis 2c was rejected. Instruction apparently had a significant effect on the relationship between the ability to seriate concrete content and the ability to seriate verbal content. The pre-test relationship between abilities for seriating concrete and verbal content was slightly negative while the post test relationship was distinctly positive ($r = .37$ is significant beyond the .20 level of confidence). The change in relationship ($Z = 2.22$) is significant beyond the .01 level of confidence on one-tailed tests. Instruction was considered effective in modifying the relationship between abilities for seriating concrete and verbal content.

Hypothesis 2d.

The operational form is:

Following four hours of small group instruction equally allotted to units dealing with concrete, quantitative, interpersonal, and verbal content, there will be a significant increase in the correlation between the quantitative and interpersonal abilities of first grade children at Holaway as measured by subtest scores on the Seriation Skills Test.
The symbolic form is:

\[ H \text{ null} \quad Z' \text{ post} - Z' \text{ pre} = 0.0 \]
\[ H \text{ directional} \quad Z' \text{ post} - Z' \text{ pre} \geq 0.0 \]

where \( Z' \) is a transformed correlation coefficient computed according to the formula listed above; \( Z' \text{ post} \) refers to the correlation coefficient observed between quantitative and verbal scores following training. \( Z' \text{ pre} \) refers to the correlation coefficient observed between quantitative and verbal scores prior to training.

Hypothesis 2d was accepted. The pretest correlation between the ability to seriate quantitative content and the ability to seriate interpersonal content was .13 and the post test correlation was .19. This change in relationship could occur by purely chance fluctuation in 40 samples out of 100. There was no evidence that instruction modified the relationship between abilities for seriating quantitative and interpersonal content.

Hypothesis 2e.

The operational form is:

Following four hours of small group instruction equally allotted to units dealing with concrete, quantitative, interpersonal, and verbal content, there will be a significant increase in the correlation between the quantitative and verbal abilities of first grade children at Holaway as measured by subtest scores on the Seriation Skills Test.

The symbolic form is:

\[ H \text{ null} \quad Z' \text{ post} - Z' \text{ pre} = 0.0 \]
\[ H \text{ directional} \quad Z' \text{ post} - Z' \text{ pre} \geq 0.0 \]
where \( Z' \) is a transformed correlation coefficient computed according to the formula listed above; \( Z'_\text{post} \) refers to the correlation coefficient observed between quantitative and verbal scores following training. \( Z'_\text{pre} \) refers to the correlation coefficient observed between quantitative and verbal scores prior to training.

Hypothesis 2e was rejected. There was evidence to suggest that instruction altered the relationship between the ability to seriate quantitative content and the ability to seriate verbal content. The initial correlation between these abilities was .14, while the post test correlation was .36. This change in degree of association was significant at the .13 level of confidence. Instruction apparently modified the relationship between abilities for seriating quantitative and verbal content.

Hypothesis 2f.

The operational form is:

Following four hours of small group instruction equally allotted to units dealing with concrete, quantitative, interpersonal, and verbal content, there will be a significant increase in the correlation between the interpersonal and verbal abilities of first grade children at Holaway as measured by subtest scores on the Seriation Skills Test.

The symbolic form is:

\[
\begin{align*}
H \text{ null} & \quad Z'_\text{post} - Z'_\text{pre} = 0.0 \\
H \text{ directional} & \quad Z'_\text{post} - Z'_\text{pre} > 0.0
\end{align*}
\]

where \( Z' \) is a transformed correlation coefficient computed according to the formula listed above; \( Z'_\text{post} \) refers to the correlation coefficient
observed between interpersonal and verbal scores following training. 

$Z_{pre}$ refers to the correlation coefficient observed between interpersonal and verbal scores prior to training.

Hypothesis 2f was accepted. These data did not indicate any change in the relationship between abilities for seriating interpersonal and verbal content following training. There was apparently some association between the ability to seriate interpersonal content and the ability to seriate verbal content; however, instruction had no noticeable effect on the relationship.

Instruction had no significant effect on the relationship between abilities to seriate (1) concrete and interpersonal content, (2) quantitative and interpersonal content, (3) interpersonal and verbal content. The post test correlation between these abilities was essentially the same as the pretest correlation. It appeared that instructional experiences with materials representative of the content categories was not effective in altering relationships between these abilities.

There were, however, conflicting results indicating that instruction served to increase the relationship (1) between abilities for seriating concrete and verbal content, and (2) between abilities for seriating quantitative and verbal content. It appeared that instruction was effective in altering the relationships between these abilities.

In summary, content-related instruction did not alter the relationships between abilities for seriating concrete and interpersonal
content, quantitative and interpersonal content, and verbal and interpersonal content, but did alter the relationship between abilities for seriating concrete and verbal content and quantitative and verbal content.

Analysis of Results

In analyzing the results, one should note that a test ceiling effect probably served to restrict the range of correlation coefficients. There was a correlation of -.69 between subtest score means and variances indicating that scores in upper ranges varied through a smaller interval than scores in the lower ranges. Garrett (1966) has commented on the effect of a restricted range upon correlation coefficients: "The size of a correlation coefficient will vary with the heterogenity, i.e., the degree of scatter, in the group; the more restricted the spread of scores, the lower the correlation" (p. 171). The curtailed range for high scores probably resulted in an upper limit on correlation coefficients. This could be reflected in (1) spuriously low coefficients throughout the data, and (2) limitations on the amount of possible change in relationship following instruction. The test ceiling effect could have had a pervasive, limiting effect on the results of the experiment.

The evidence of low intercorrelation among abilities to seriate various types of content is consistent with Guilford's Structure of Intellect. The SI model predicts that there will be no association between similar intellectual operations applied to different types of content. The data of the present study revealed low intercorrelations
between seriation abilities for concrete and interpersonal content, concrete and verbal content, and quantitative and verbal content. Convergent production operations with one type of content demonstrated little relationship with convergent production operations applied to a different type of content. There was evidence of separate and distinct abilities for seriating the several types of content.

The evidence of low intercorrelations among seriation abilities leading to the acceptance of hypotheses lb, lc, ld, and le is also consistent with the theoretical formulations of Jean Piaget (in Flavell 1963) and Jerome Bruner (1966). According to these theorists, a person must have some experience with a given type of content before developing an ability for processing that type of content. Assuming that children accumulate differing amounts of experience with the four types of content, one would expect to find abilities developed to different levels. The low pretest intercorrelation among abilities indicated that the level of development of a given ability was not necessarily associated with the level of development of another ability. In the present case, there was evidence of uneven ability patterns.

It should be noted that the acceptance of hypotheses lb, lc, ld, and le confirmed the findings of several other investigators. Stevenson et al. (1968) previously demonstrated low correlations between discrimination learning ability as applied to different types of content. Similarly, Anastasi (1936) found low intercorrelations among content specific tests. Also, Lesser et al. (1965) discovered low positive correlations among the abilities of six-year-olds. These studies
suggest that human intellect can be described as involving a number of independent abilities.

The evidence of high intercorrelations between abilities leading to the rejection of hypotheses la and lf lends support to the notion that abilities generalize across content categories. It was found that a high level of ability in seriating concrete content was associated with a high level of ability in seriating quantitative content, and that a high level of ability in seriating interpersonal content was associated with a high level of ability in seriating verbal content. The observed generalization of abilities across content categories could be explained in two ways: (1) The present study's distinction between content categories may not be psychologically meaningful. The categories are not exactly parallel to Guilford's factorially distinct content categories. (2) There may be a tendency for persons who accumulate large amounts of experience with concrete content to accumulate large amounts of experience with quantitative content. Similarly, persons who have a good deal of interpersonal experience may concurrently accumulate a good deal of verbal experience. In either case, the result could well be a high association between abilities for seriating two types of content. The latter explanation depends upon the assumption that content experiences do influence the development of abilities. This assumption remains to be investigated.

In summary, the low intercorrelations among seriation abilities leading to the acceptance of hypotheses lb, lc, ld, and le offer evidence of uneven ability patterns. The rejection of hypotheses la and lf on the basis of high intercorrelations among seriation abilities
suggests that in some cases abilities may generalize across content categories.

The next section analyzes data pertinent to the effect of content relevant instruction on (1) level of abilities, and (2) the relationship between abilities.

The concrete, quantitative, interpersonal, and verbal curriculum materials were apparently compatible with students' and teachers' interests. The teachers' anecdotal records, summarized in Appendix B, indicate that students were expressing enthusiasm about the materials and that teachers found the materials easy to use in small group settings.

Content-relevant instruction had the expected effect on level of seriation abilities. Instruction with materials representative of each content category significantly increased student scores on the concrete, quantitative, and interpersonal subtests of the Seriation Skills Test. While it was anticipated that instruction would influence test scores, the central focus of the investigation was on possible differential responses to instruction.

Theoretical models and the literature review suggested that students initially demonstrating poorly developed seriation skills with one type of content and relatively well-developed seriation skills with other types of content would respond to content-relevant instruction by readily developing skills which were initially weak. In other words, students would profit more from instruction in areas of weakness than from instruction in areas of strength. The result of differential
responses to content-relevant instruction would be a closer association between abilities for seriating various types of content.

Content-relevant instruction did increase the association between some seriation abilities. The rejection of hypotheses 2c and 2e indicated that instruction increased the relationship between (1) abilities for seriating concrete and verbal content and (2) abilities for seriating quantitative and verbal content.

The findings that content-relevant instruction can lead to an increase in the relationship between abilities for seriating different types of content is consistent with the notion that abilities generalize across content categories. An increase in association between abilities for seriating two types of content can be taken as evidence that performance on the task transferred or generalized from one content category to another. This suggests that the initially low degree of association was due to an experiential factor and that the abilities are not actually independent.

The increase in association between seriation skills following instruction is similarly consistent with Piaget's (in Flavell 1963) and Bruner's (1966) structural theories. Their models suggest that an ability may develop for seriating one type of content but fail to generalize to other types of content due to lack of experience with the new type of content. This implies that experience with unfamiliar materials should enhance transfer and thereby accelerate the development of abilities for seriating the new materials. In other words, an equal amount of content-relevant instruction should have a disproportionately
large effect on abilities for seriating the unfamiliar materials. Following instruction, there would be an increased correlation between abilities for seriating the two types of content. This inference is supported by the observed increase in correlation between abilities for seriating concrete and verbal content and quantitative and verbal content.

It should be noted that the increase in association between abilities is inconsistent with the Structure of Intellect model. The model predicts low intercorrelations among intellectual operations applied to different types of content. The observed increase in correlations suggests either (1) that the content categories used in the present investigation were not factorially distinct, or (2) that abilities for seriating some types of content are not independent.

Conflicting results indicating that content-related instruction failed to increase the relationship between seriation abilities is inconsistent with Piaget's and Bruner's theories. Instruction failed to modify the relationships between abilities for seriating concrete and interpersonal content, quantitative and interpersonal content, and interpersonal and verbal content. The failure of content-related instruction to modify relationships among abilities for seriating various types of content offers no support for the notion that content-related experiences are important to the development of abilities.

The observation that content-related instruction does not significantly alter the relationships among abilities for seriating various types of content is consistent with Guilford's Structure of
Intellect model. The model is predicated on the notion that intellectual operations applied to different types of content are independent. This rationale is supported by the observation that intercorrelations among abilities for seriating different types of content are initially low and remain low following instruction. There is evidence indicating that abilities for seriating different types of content are independent.

In summary, seriation abilities initially showed little tendency to generalize across content categories; however, a brief content-relevant instructional intervention showed promise for enhancing the transfer of seriation abilities from one content category to another. The low pretest correlations among abilities for seriating various types of content and the failure of content-related instruction to modify these relationships were interpreted as supporting the independent ability factors of the Structure of Intellect model. Conflicting results indicating that content relevant instruction significantly increased the relationship between abilities for seriating (1) concrete and verbal content and (2) quantitative and verbal content were interpreted as supporting Piaget's and Bruner's notion that content experiences do influence the development of ability patterns.
CHAPTER V

SUMMARY, CONCLUSIONS, LIMITATIONS, IMPLICATIONS, AND RECOMMENDATIONS

This chapter (1) summarizes the experimental rationale, procedures, and results, (2) lists conclusions of the study, (3) identifies some limitations, (4) offers some implications, and (5) makes some recommendations for further research action.

Summary

The study investigated the role of content experiences in the development of children's abilities. A review of literature suggested that children accumulate differing amounts of experience with concrete, quantitative, interpersonal, and verbal materials resulting in differential skills for processing these types of content. It seemed reasonable to attribute individual differences in ability for processing different types of content to differing amounts of experience with the various types of content.

This study was designed to observe the nature of children's ability patterns and the role of content-relevant instruction in modifying these ability patterns. Two questions were raised: (1) Do seriation skills generalize across content categories?, and (2) will a brief period of content relevant instruction alter the extent to which seriation skills generalize across content categories? These questions became two hypotheses: (1) There will be no significant relationships
among the abilities of children to seriate concrete, quantitative, interpersonal and verbal content; and (2) following content-relevant instruction with each type of content, there will be a significant increase in the relationship among the abilities of children to seriate concrete, quantitative, interpersonal, and verbal content.

Data were collected from children enrolled in three first grade classrooms in a middle SES level neighborhood elementary school. Seriation abilities were measured with a specially constructed Seriation Skills Test. Instruction was conducted in small groups by experienced first grade teachers, using materials representative of the content categories. Each child was exposed to one hour of instruction with each type of content.

The results revealed predominantly low intercorrelations (r less than .30) between abilities for seriating the four types of content. Content-relevant instruction failed to modify four of the six intercorrelations but did significantly increase the correlation between abilities for seriating concrete and verbal content and quantitative and verbal content.

An analysis of the results indicated that the initially low intercorrelation among seriation abilities and the failure of content-relevant instruction to modify these relationships could be interpreted as consistent with Guilford's Structure of Intellect model. The instances in which content-relevant instruction did alter relationships between seriation abilities were interpreted as supporting the structuralists' (Piaget in Flavell 1963 and Bruner 1966) model of intellectual development.
Conclusions

In view of the results of the investigation and within the limitations of the study, the following conclusions appear to be justified:

1. Seriation abilities do not tend to generalize across content categories; i.e., a well-developed ability for seriating one type of content does not necessarily imply equally well-developed abilities for seriating other types of content. Although a relatively high correlation was observed between abilities for seriating concrete and quantitative content (r = .43) and between abilities for seriating interpersonal and verbal content (r = .30), the conclusion was supported by evidence of low intercorrelations among abilities for seriating the following types of content: (1) concrete and interpersonal, r = .05; (2) concrete and verbal, r = -.11; (3) quantitative and interpersonal, r = .13; and (4) quantitative and verbal, r = .14. Additional evidence supporting the notion of independent abilities for seriating different types of content is provided by the observation that content relevant instruction had no significant effect on relationships between abilities for seriating concrete and interpersonal content, quantitative and interpersonal content, and interpersonal and verbal content.

2. Content-relevant instruction can, in some instances, alter the extent to which seriation abilities generalize across content categories. The conclusion is supported by evidence that content-relevant instruction significantly increases the correlation between abilities for seriating (a) concrete and verbal content, from r = .11 to r = .37, and (b) quantitative and verbal content, from r = .14 to r = .36.
Limitations

It should be emphasized that results of the present study are restricted by a test ceiling effect and limited to populations similar to those from which the experimental sample was obtained, namely, middle socioeconomic level first grade children enrolled in a neighborhood elementary school.

Also, it should be noted that the investigator's assumption that test ceiling effects would only occur for children with seven to eight months of school was not valid. The test ceiling effect was observed with children who had only three months of schooling.

Implications

The study offers evidence inconsistent with Piaget's concept of accommodation. The concept of accommodation is based on the notion that intellectual processes or abilities develop in response to the content of one's experiences. Uneven ability patterns, observed as low intercorrelations among abilities as applied to different types of content, are attributed to differential amounts of experience with the various types of content. The implication is that content relevant experiences should stimulate accommodation and result in the accelerated development of weak abilities to a level commensurate with that of strong abilities. This would be observed as increased intercorrelations among abilities following instruction.

The present study observed low intercorrelations among abilities for seriating concrete, quantitative, interpersonal, and verbal content; however, content-relevant instruction was not generally effective in
modifying intercorrelations among abilities. While content-relevant instruction did increase the correlation between abilities for seriating concrete and verbal content and between abilities for seriating interpersonal and verbal content, there was no observed increase in relationships between abilities for seriating concrete and interpersonal content, quantitative and interpersonal content, and interpersonal and verbal content. The implication is that a brief content relevant instructional period may not be sufficient for prompting accommodation to new materials and fostering the transfer of intellectual processes across content categories.

The study offers little support for the assumption, imbedded in process-oriented curriculum, that intellectual processes transfer from one content category to another. The findings of the present study reveal little tendency for the intellectual process of seriation to generalize across content categories. Further, there is only limited evidence that exposure to unfamiliar materials fosters transfer of abilities to the new type of material. The implication is that people designing process-oriented curriculum should use psychologically meaningful content categories as a framework for selecting materials to use in instructional units. Intellectual processes systematically developed with materials chosen from each content category would be applicable to the categories of content which factor analysis has suggested are psychologically meaningful within Western culture.

The results are pertinent to the reliability of infant and preschool intelligence scales. Stott and Ball (1965) have collected
evidence indicating that the low reliability of infant and preschool mental tests can be traced to changing factor composition of various age levels. They identified the Structure of Intellect factors which describe test items at each age level of the Stanford-Binet, California Infant Scale, the Cattell Infant Intelligence Scale, the Gesell Developmental Schedules, and the Merrill-Palmer Scale. They concluded that one reason for change in a child's mental age scores at different age levels is that, due to the changing content, the child is being tested for different abilities at the different age levels. The findings of the present study, demonstrating low intercorrelations among seriation abilities as applied to different types of content, confirm Stott and Ball's conclusion that, as one changes test content, one should expect little correlation among abilities. The implication is that persons interested in constructing reliable infant and preschool intelligence tests should use materials representative of each content category at each age level.

Persons interested in selecting materials for home intervention programs and Head Start programs would similarly be well advised to use Structure of Intellect content categories as a framework for guiding their choices. In the past, decisions regarding curriculum materials have been guided by efforts to duplicate circumstances found to be associated with early intellectual development, such as trips to museums, mealtime conversations, and stable adult male figures. A more sophisticated approach would include factor analytic studies of the process and content factors underlying impoverished and enriched
backgrounds. If process and content factors could be isolated, curriculums could be based on the essential ingredients of experience rather than a haphazard duplication of circumstances. The findings of the present study indicated that considerations of content factors is essential in the design of programs intended to develop intellectual processes useful in a wide variety of situations.

To the extent that the content of test or curriculum materials does represent an important dimension of individual differences, it may be of value to group children on the basis of their proficiency in dealing with various types of content. For example, children might be grouped on the basis of their skill in dealing with interpersonal situations or their skill in handling quantitative or symbolic concepts. Tests similar to the Seriation Skills Test could be developed to measure level of proficiency in applying a given intellectual process to various types of content. Information from these measures could be used to group children and individualize instruction in a manner to enhance the development of relatively weak abilities. This sort of grouping would be useful in providing the specific content-relevant remediation, which findings of the present study suggest may be necessary to compensate for uneven ability patterns.

Recommendations

The analysis of data from the present study has identified some desirable refinements of measuring instruments and some areas for further investigation.
1. It is recommended that the Seriation Skills Test be refined by making the content categories more similar to Guilford's Structure of Intellect categories and by adding more difficult items to elevate the test ceiling.

2. It is further recommended that the present study be repeated with a larger sample, a longer instructional period, and more stringent criteria for the rejection of null hypotheses.

3. Additional studies might deal with the following issues: (a) Do intellectual processes—such as inference, hypotheses formulation and data interpretation—generalize across Structure of Intellect content categories? (b) What sort of instruction is useful in prompting transfer from one content category to another? (c) What is the factor content of those experiences and circumstances associated with early intellectual development?
APPENDIX A

MANUAL FOR ADMINISTRATION OF THE
SERIATION SKILLS TEST

for

Concrete
Quantitative
Verbal
and
Interpersonal
Content Categories
**SERRATION SKILLS TEST**

This test is designed to measure children's ability to seriate materials drawn from concrete, quantitative, verbal and interpersonal content categories. Seriation is defined as the ability to impose hierarchical order on the environment. It involves sequencing or ordering objects and events in place or time. The test provides a standardized observation of a child's ability to seriate materials representative of the four content categories.

The test is suitable for use with four to seven year old children. Testing time varies from 10 to 15 minutes with four and five year olds to as much as 40 minutes with seven year olds.

This manual describes test materials and prescribes administrative techniques. A separate scoring sheet is provided for recording answers. Reliability and validity depend in large measure on the examiner's skill in establishing rapport and adhering to prescribed testing methods.

The test yields a score for each type of content and a total score. The maximum on each content subtest is 25 and the maximum total score is 100. The subtest scores provide an index for comparing a child's skill in seriating concrete, quantitative, verbal and interpersonal content.

In administering the test, the examiner should provide a primary size table and chair and sit opposite the child. The test materials are presented to the child according to the directions given in the following pages. Subtests are discontinued following failure on two consecutive items.
CONCRETE CONTENT

**Materials:** Seven balsa wood sticks. The sticks vary in length from 3 to 6 inches. The unit of difference between the sticks is $\frac{1}{2}$ inch resulting in sticks of the following lengths: 3". 3\(\frac{1}{2}\)", 4", 4\(\frac{1}{2}\)", 5", 5\(\frac{1}{2}\)", 6".

**Discontinue:** Following failure (0 points) on two consecutive items.

**Directions:**

1. The examiner should present the materials to the child by dropping the sticks on the table in a random stack or heap. The examiner says,

   **E:** "LOOK AT ALL THESE STICKS. YOU CAN PLAY WITH THEM IF YOU WANT TO". (The child is allowed a minute of two to examine, handle or consent upon the sticks).

   **E:** "NOW LOOK AT THE STICKS AND PICK UP THE LONGEST ONE".

2. The examiner builds a "staircase" with the sticks as the child observes. The three shortest sticks should be arranged from the child's left in an ascending series: CHILD

   \[
   \begin{align*}
   &\ | \ | \\
   \end{align*}
   \]

   As the examiner is constructing the "staircase" he should say,

   **E:** "WATCH WHAT I'M GOING TO DO. I'M BUILDING A STAIRCASE. I START WITH THE SHORTEST STICK, THEN I TAKE THE NEXT SHORTEST ONE, THEN THE NEXT SHORTEST ONE, NOTICE THAT BOTH SIZES ARE THE SAME SIZE".

   The examiner presents the remaining four sticks to the child and says,

   **E:** "NOW YOU TAKE THESE STICKS AND FINISH THE STAIRCASE".

   If necessary, the examiner may prompt the child by pointing to the next position in the series and saying,

   **E:** "WHICH STICK WOULD GO HERE?"
3. The examiner should begin constructing another "staircase" beginning with the 3 longest sticks in a descending series:

Child

As the examiner is constructing the "staircase" he should say,

E: "NOW WATCH US BUILD ANOTHER STAIRCASE. THIS TIME I'LL START FROM THE TOP AND GO DOWN. NOTICE AGAIN THAT THE STEPS ARE THE SAME SIZE".

The examiner should hand the remaining four sticks to the child and say,

E: "NOW YOU TAKE THESE STICKS AND FINISH THE STAIRCASE".

4. The examiner mixes up the sticks and drops them on the table in a random stack. He says,

E: "NOW YOU BUILD A STAIRCASE ALL BY YOURSELF".

5. The examiner places the 2nd, 4th, and 6th longest stick in ascending order before the child:

Child

As the examiner is constructing the "staircase" he should say,

E: "LOCK, THIS IS A STAIRCASE WITH SOME OF THE STEPS MISSING".

The examiner presents the remaining four sticks to the child and says,

E: "TAKE THESE FOUR STICKS AND PUT THEM WHERE THEY GO TO FINISH THE STAIRCASE".

6. The examiner places the 5th and 7th longest sticks in ascending order before the child:

Child
6. Score four points for completing the staircase according to Figure 2.

Figure 2

One point of partial credit is awarded for each multiple unit correctly constructed.

One point of partial credit is awarded for each relationship properly established.

The arcs represent scorable relationships within the series.

Score two points for completing the staircase according to Figure 3.

Figure 3

One point of partial credit is awarded for each relationship properly established.

Maximum credit for the Concrete Content Subtest is twenty five points.
E: "LOOK AT THE STAIRCASE I'M BUILDING NOW. SEE THE STEP IS HIGHER THAN BEFORE".

The examiner presents sticks numbered 1, 2, 3, 4, and 5 (stick number 6 is not used in this exercise) to the child and says,

E: "YOU TAKE THESE STICKS AND FINISH THE STAIRCASE. MAKE SURE THE STEPS ARE THE SAME SIZE AS THIS ONE. SEE IF YOU CAN FIGURE OUT HOW TO USE ALL THE NEW STICKS WITHOUT CHANGING THESE TWO OLD ONES IN ANY WAY".
QUANTITATIVE CONTENT

Materials: Seven bell shaped aluminum jello molds, a collection of marbles.

Discontinue: Following failure (0 points) on two consecutive items.

Directions:

1. The examiner should present the containers to the child by placing them in a line on the table in front of the child. The examiner says,

   E: "SEE THESE CUPS, THEY'RE SHAPED SORT OF LIKE BELLS".

   The examiner should present the marbles to the child by handing him the box of marbles and saying,

   E: "LOOK AT ALL THESE MARBLES. YOU CAN PICK SOME UP IF YOU WANT TO". (The child is allowed a minute or two to examine, handle or comment upon the materials).

   The examiner places two marbles in the cup to the child's left, three marbles in the next cup to left, and five marbles in the next cup:

   CHILD

   O O O O 5 3 2

   The examiner says,

   E: "POINT TO THE CUP WITH THE MOST MARBLES...".

   The examiner may enlist the child's aid in pouring the marbles back into the box.

2. The cups remain in a line on the table in front of the child. The examiner places one marble in the cup to the child's left, two marbles in the next cup to the left and three marbles in the next cup. This is the beginning of an ascending series with a unit difference of one between clusters:

   CHILD

   O O O O 3 2 1

   The examiner drops the marbles in the cups, one marble at a time, being careful not to count or state the number of marbles placed in a cup. He says,

   E: "NOW YOU PUT THE RIGHT NUMBER OF MARBLES IN THE REST OF THE CUPS".
3. The cups remain in a line on the table in front of the child. The examiner begins a descending series with a unit difference of one between clusters by placing seven marbles in the cup to the child's extreme left, six marbles in the next cup to the left and five marbles in the next cup:

CHILD

After the examiner has dropped the marbles in the cups according to the procedure described above, he should say,

E: "NOW YOU PUT THE RIGHT NUMBER OF MARBLES IN THE REST OF THE CUPS".

4. The cups remain in a line on the table in front of the child. The examiner says,

E: "NOW YOU MAKE A SERIES JUST LIKE YOU DID BEFORE. DO IT ALL BY YOURSELF. START BY PUTTING ONE MARBLE IN THIS CUP". (The examiner points to the cup to the child's extreme left).

5. The examiner begins another ascending series by placing two marbles in the second cup from the left, four marbles in the fourth cup from the left and six marbles in the sixth cup from the left:

CHILD

The examiner drops the marbles in cups according to the above procedure and says,

E: "LOCK, THIS IS A SERIES IN WHICH SOME OF THE CUPS ARE EMPTY. YOU PUT THE RIGHT NUMBER OF MARBLES IN THE EMPTY CUPS".

6. The examiner begins an ascending series with a unit difference of two between adjacent clusters. He places two marbles in the cup to the child's extreme left, four marbles in the next cup to the left and six marbles in the next cup:

CHILD

The examiner drops the marbles in the cups according to the usual procedure and says,

E: "NOW YOU PUT THE RIGHT NUMBER OF MARBLES IN THE REST OF THE CUPS".
INT:PERSONAL CONTENT

Materials: Four sets of pictures. Each set includes either three or four independently mounted pictures which can be ordered to depict a logical sequence of events.

Discontinue: Following failure (0 points) on two consecutive items.

Directions:

1. The three pictures in Set I show a child going out in the rain without a coat. The cards are initially presented in mixed up order and the child is asked to rearrange the cards to tell a story. The examiner initially places the cards on the table in front of the child with card B to the child's left, then card A and finally card C:

   Child
   C A B

   The examiner says,

   E: "LOOK AT THESE PICTURES. THEY TELL A STORY ABOUT SOMETHING THAT HAPPENED TO A LITTLE BOY BUT THEY'RE IN THE WRONG ORDER. WATCH ME WHILE I PUT THE PICTURES IN THE RIGHT ORDER SO THEY'LL TELL A STORY".

   The examiner picks up picture A, then B, then C replacing them slightly below the initial line to form a new sequence which does depict a logical story. He says,

   E: "THIS PICTURE (A) WOULD COME FIRST BECAUSE IT SHOWS THE FIRST THING THE LITTLE BOY DID. HE WAS GOING OUT IN THE RAIN WITHOUT HIS COAT AND HIS MOTHER TOLD HIM TO STOP. WE'LL PUT THE PICTURE RIGHT HERE. THIS PICTURE (B) WOULD COME NEXT BECAUSE IT SHOWS THE NEXT THING THAT HAPPENED. THE BOY'S MOTHER HELD HIM PUT HIS COAT ON. SINCE THIS PICTURE COMES NEXT IN THE STORY, WE'LL PUT IT RIGHT HERE. THIS PICTURE (C) COMES NEXT BECAUSE IT SHOWS WHAT HAPPENED NEXT IN THE STORY. THE BOY HAS HIS COAT ON AND IS GOING OUT IN THE RAIN. WE'LL PUT THE PICTURE RIGHT HERE TO FINISH THE STORY".

   The child is allowed a moment to examine the picture sequence. Then the examiner shuffles the pictures and re-presents them in the mixed up order specified above.

   E: "NOW I'M GOING TO MIX THE PICTURES UP AND LET YOU PUT THEM IN ORDER TO TELL THE STORY. START THE STORY RIGHT HERE. (The examiner points to a spot just below the original line where the child is to start the story)."
If the child seems confused or puts the pictures in the wrong order, the examiner should briefly repeat the demonstration and re-present the cards in mixed up order saying,

E: "NOW YOU PUT THE CARDS IN A LINE JUST LIKE I DID TO TELL THE STORY".

If the child fails to respond correctly after the second demonstration, the examiner should proceed to item 2.

2. The three pictures in Set II show two boys meeting in a park and beginning to play baseball. The examiner places the cards on the table ordered from the child's left BDAC:

    CHILD
    0 V A B

The examiner says,

E: "NOW I'M GOING TO SHOW YOU SOME MORE PICTURES THAT WILL TELL A STORY. YOU PUT THEM IN CORRECT ORDER TO TELL THE STORY, PUT THE PICTURE THAT COMES FIRST IN THE STORY RIGHT HERE".

If the child seems confused or puts the pictures in the wrong order, the examiner should reshuffle the pictures and re-present them in the mixed up order saying,

E: "THINK OF THE STORY THAT THE PICTURES TELL. THEN PUT THE PICTURES IN ORDER TO TELL THE STORY. START RIGHT HERE". (E may add, "WHICH PICTURE WOULD COME NEXT"?)

3. The four pictures in Set III show a girl running down the street waving at friends and falling over a box. The examiner places the cards on the table ordered from the child's left BDAC:

    CHILD
    0 V A B

The examiner should repeat the verbal directions given in the initial presentation of item 2. There is, however, no prompting if the child gives a wrong answer.

4. The four pictures in Set IV show a boy entering a store, buying a cupcake and sharing it with a friend. The examiner places the cards on the table ordered from the child's left BDAC:

    CHILD
    0 V A B

The examiner should repeat the verbal directions given in Sets II and III.

If the child has received maximum credit on items 3 and 4, the examiner should proceed with the following Bonus Problem. Otherwise the examiner consider the Interpersonal Subtest completed and proceed with the Verbal Subtest.
The bonus task requires the child to synthesize some interpersonal events that might plausibly have occurred before during or after a familiar sequence of events. The cards of Set III are re-presented to the child in correct order. The child is asked to draw a picture to illustrate what the people might have been doing just before, during or after the existing story. The examiner will need some blank sheets of paper 3 inches by 4 inches and a pencil.

The examiner places the cards of Set III before the child in proper order and says,

**E:** "NOW WE'LL TRY SOMETHING DIFFERENT. I WANT YOU TO DRAW A PICTURE TO SHOW WHAT THE CHILDREN WERE DOING JUST BEFORE THE STORY STARTED. DRAW YOUR PICTURE ON THIS PIECE OF PAPER."

The examiner should respond to the child's questions in a manner to help him understand the task without indicating what picture should be drawn.

If the child does not respond, the examiner should add,

**E:** "YOU MAY WANT TO DRAW A PICTURE TO SHOW WHAT HAPPENED JUST AFTER THIS PICTURE (pointing to A) AND JUST BEFORE THIS PICTURE (pointing to B) OR YOU MAY WANT TO DRAW A PICTURE SHOWING WHAT THE CHILDREN DID JUST AFTER THIS PICTURE (pointing to D)."

The examiner should inquire about what is happening in the picture. The child's comments should be recorded on the back of the picture.
**Verbal Content**

**Materials:** Four independently mounted pictures: 1) a girl feeding an infant a bottle, 2) two children scolding a dog in a park, 3) a boy kicking a tin can down the street, 4) a dog and a cat watching a parade.

**Discontinue:** After the child has had an opportunity to tell stories about two of the pictures.

**Directions:**

In this subtest the child is to tell a three scene sequential story with a distinguishable beginning, middle and end. The pictures serve as stimuli and framework for the stories.

1. The examiner arranges the four pictures before the child and says,

   E: "I WANT YOU TO LOOK AT THESE PICTURES AND CHOOSE ONE THAT YOU WOULD LIKE TO TELL A STORY ABOUT".

   If the child is unable to make a choice within a minute, the examiner should pick up picture 4 and hand it to the child.

   If the child does not pick up the picture he has voluntarily chosen, the examiner should hand the picture to the child.

   After the child is holding the picture, the examiner should proceed by saying,

   E: "REMEMBER A STORY HAS A BEGINNING, A MIDDLE AND AN END. THE PICTURE IS THE MIDDLE OF THE STORY. NOW YOU MAKE UP A STORY TELLING WHAT HAPPENED BEFORE THE PICTURE, WHAT IS HAPPENING IN THE PICTURE AND WHAT HAPPENS AFTER THE PICTURE". E may say, "YOU CAN START HERE".

   The child's response following these directions is considered spontaneous and should be recorded verbatim in the spontaneous section of the record blank. The only directions the examiner may add and still consider the response spontaneous is "ANYTHING ELSE"?

   If the child fails to respond the examiner may prompt a response. All responses after prompting begins are recorded in the prompted section of the record blank.

   The examiner should begin prompting the completely unresponsive
child by saying,

E: "TELL ME ABOUT THE PICTURE".

If the child still fails to respond, the examiner should encourage the child to choose another picture. The original directions should be repeated. (The Verbal Subtest is discontinued after the child has had an opportunity to respond to two pictures)

If the child tells only part of a story (response limited to labeling, action verbs or less than three scenes), the examiner should prompt the child with whichever of the following statements is appropriate.

For the child who has only labeled objects, the examiner should say,

E: "NOW TELL ME WHAT IS HAPPENING IN THE PICTURE".

For the child whose story is incomplete, the examiner may say,

E: "NOW TELL ME WHAT HAPPENED BEFORE (AFTER) THE PICTURE".

The picture about which the child has just told a story is laid aside and the remaining three pictures presented to the child. The examiner says,

E: "NOW I WOULD LIKE FOR YOU TO CHOOSE ANOTHER PICTURE THAT YOU WOULD LIKE TO TELL A STORY ABOUT. CHOOSE ONE OF THESE".

The examiner should proceed with the directions given in item one.
SCORING

CONCRETE CONTENT

1. Score one point for correctly identifying the longest stick.

2. Score four points for correctly completing the staircase (see figure 1).

In incomplete staircases, one point of partial credit is awarded for each relationship properly established. A seven unit staircase includes six hierarchial relationships:

```
    (1) (2) (2) (3) (4) (5) (6)

Figure 1
```

The arcs indicate relationships which must be established to complete a seven unit staircase.

It should be noted that most of the sticks are imbeded in two relationships. In an ascending series, sticks are one unit longer than the previous stick in the series and one unit shorter than the succeeding stick in the series. Each relationship (as illustrated by an arc in Fig. 1) is credited with one point.

3. Score four points for correctly completing the staircase.

In incomplete staircases, one point of partial credit is awarded for each relationship properly established.

4. Score six points for correctly constructing a staircase.

In incomplete staircases, one point of partial credit is awarded for each relationship properly established.

5. Score six points for correctly inserting sticks 1, 3, 5, and 7 into the existing staircase. This represents one point for each relationship (as illustrated by an arc in Fig. 1) correctly established.

One point of partial credit is awarded for each relationship correctly established.
1. Score one point for correctly identifying the cup with the most marbles.

2. Score four points for correctly completing the series (see Figure 4).

In incomplete series, one point of partial credit is awarded for each relationship properly established. A seven unit series includes six hierarchial relationships:

![Figure 4](image)

The arcs indicate relationships which must be established to complete a seven unit series.

3. Score four points for correctly completing the series.

One point of partial credit is awarded for each relationship properly established.

4. Score six points for correctly constructing a series.

One point of partial credit is awarded for each relationship properly established.

5. Score six points inserting cluster of 1, 3, 5 and 7 marbles within the existing series.

One point of partial credit is awarded for each relationship properly established. It should be noted that each cluster correctly inserted in the series is worth two points. This stems from the fact that the subject must establish a cluster which is both one unit larger than the preceding cluster and one unit smaller than the succeeding cluster. In this manner two relationships are established.

6. Score four points for correctly completing the series,

![Figure 5](image)

One point of partial credit is awarded for each relationship properly established.

Maximum credit for the Quantitative Content Subtest is twenty five points.
SCORING

INTERPERSONAL CONTENT

1. Points are awarded according to the following schedule:

<table>
<thead>
<tr>
<th>Trial I</th>
<th>Order</th>
<th>Points</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>ABC</td>
<td>4</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Trial II</th>
<th>Order</th>
<th>Points</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>ABC</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>CAB</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>BAC</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>ACB</td>
<td>1</td>
</tr>
</tbody>
</table>

2. Points are awarded according to the schedule in item 1.

3. Points are awarded according to the following schedule:

<table>
<thead>
<tr>
<th>Order</th>
<th>Points</th>
</tr>
</thead>
<tbody>
<tr>
<td>ABCD</td>
<td>6</td>
</tr>
<tr>
<td>DABC</td>
<td>4</td>
</tr>
<tr>
<td>ABDC</td>
<td>3</td>
</tr>
<tr>
<td>BACD</td>
<td>2</td>
</tr>
</tbody>
</table>

4. Points are awarded according to the schedule in item 3.

5. Points are awarded according to the following criteria:

<table>
<thead>
<tr>
<th>Criterion</th>
<th>Points</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. A picture depicting people in an activity which could plausibly have preceded picture A or followed picture D. The picture must include, 1) the same objects and people shown in the original series and 2) a different but related activity.</td>
<td>5</td>
</tr>
<tr>
<td>2. A picture depicting an apparently unrelated activity but including either the same objects or people.</td>
<td>4</td>
</tr>
<tr>
<td>3. A picture showing different people and objects but engaged in a related activity.</td>
<td>3</td>
</tr>
<tr>
<td>4. A picture showing a single person.</td>
<td>2</td>
</tr>
<tr>
<td>5. A picture showing a single object.</td>
<td>1</td>
</tr>
</tbody>
</table>
SCORING

VERBAL CONTENT

1. In scoring the Verbal Subtest the examiner must first establish whether the child has merely described the scene in the picture or told a story. The criterion for a story is a sequence of at least two related events. Describing the activities of the persons in the pictures is not sufficient to be considered a story. The subject must introduce the idea of a sequence of events in time.

If the child has not told a story either spontaneously or with prompting, the examiner should award points in the following manner:

1) labeling ..................... 1 point
   labeling refers to using nouns
to describe the picture

2) acting ......................... 1 point
   acting refers to using action verbs to describe events in the picture

The child may receive a point for labeling and another point for acting.

If the child has told a story, the examiner should attempt to identify at least three scenes in the story. Some of the scenes may be in the spontaneous section and others in the prompted section. Some stories will have only two scenes while others will have four or more. A scene is defined as a division of a sequence of events in which there is no change of place or lapse in continuity of time.

For present scoring purposes a maximum of three scenes are scored. These may all be in one section or distributed between spontaneous and prompted sections.

For the spontaneous parts of the story, the examiner should award four points for each scene. This includes one point for labeling, one point for acting and two points for relating the scene to other events.

For prompted parts of a story, the examiner should award three points for each scene. This includes one point for labeling, one point for acting and one point for relating the scene to other events.

If there are more than three scenes, the child is awarded one bonus point. Only one point is awarded regardless of the number of scenes in excess of three. Also, the bonus point is awarded only once for an individual.

2. Scoring is the same as in item 1.
APPENDIX B

A SUMMARY OF TEACHERS' ANECDOTAL RECORDS
OF INSTRUCTIONAL SESSIONS

First Week - Concrete Content

In the first session most of the students were able to make a simple staircase. Only one child did not attempt the task. In the second session, children entered with comments such as, "We already know how to make a staircase." All of the children proceeded to prove their skill in the staircase task but only three-fourths of them succeeded in the replacement task.

Second Week - Quantitative Content

The children readily lined up to go with the project teachers and did not object to missing the recess period. In the first session with quantitative materials, the children readily made sequences increasing by one unit but only about one-quarter of the children grasped the idea of counting by two's. In the second session, the children from the two high classrooms caught on to counting by two's, three's, and four's, but the children from the low group were limited to counting by one's.

Third Week - Interpersonal Content

In the first session, the children enjoyed putting pictures in order to tell familiar stories. All of the children seemed to
do well. In the second session, children from the low classroom and selected children from the higher groups had difficulty telling what would happen before or after a picture. Their peers readily volunteered information.

Fourth Week - Verbal Content

In the first session, most children were quite verbal and seemed excited about the prospect of telling stories. They particularly liked the spacemen. In the second session, children's stories were quite creative, some having difficulty staying on one theme. Three children, however, participated only after special encouragement from the teacher.
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