DOCUMENT RESUME

ED 024 442 PS 001 173

By-Beiswenger, Hugo A.

Linguistic and Psychological Factors in the Speech Regulation of Behavior in Very Young Children.

Michigan Univ., Ann Arbor. Center for Human Growth and Development.

Spons Agency-National Inst. of Child Health and Human Development, Bethesda, Md.

Report No-UM-CHGD-63

Pub Date 12 Jul 68

Note-120p.

EDRS Price MF-$0.50 HC-$6.10

Descriptors-Attention, *Behavior Change, *Behavior Development, Behavior Patterns, Behavior Theories, Cognitive Processes, Developmental Psychology, Doctoral Theses, Language Development, *Language Research, *Language Role, Learning Theories, Linguistic Theory, Perception, *Preschool Children, Verbal Learning

This dissertation examines the thesis that it is the human language system which largely makes possible the human capacity for modifiability of responses called "intelligent" and "adaptive" modes of interaction with the environment. Chapter titles are (1) A Process View of Human Behavior, (2) Aspects of the Multi-Dimensional Nature of Cognitive Processes in the Very Young Child, (3) Linguistic Theory as a Model of Language Perception and Learning, (4) The Structure of Linguistically Initiated Behavioral Acts, (5) The Relationship of the Comprehension of Sentences to Their Complexity, (6) An Experimental Study of Linguistic and Other Psychological Factors in the R-EGULATION OF Behavior in Very Young Children, and (7) Discussion of Results. The author concludes that perceptual or attentional processes which involve expressions of orienting activity should be studied in regard to ontogenetic development and its relationship to the verbal system of preschool children. (MS)

THE UNIVERSITY OF MICHIGAN

CENTER FOR HUMAN GROWTH AND DEVELOPMENT
LANGUAGE DEVELOPMENT PROGRAM

Linguistic and Psychological Factors in the Speech Regulation of Behavior in Very Young Children

Hugo A. Beiswenger

Report Number 63
Development of Language Functions
A Research Program-Project

Supported by:
The National Institute for Child Health and Human Development
Grant Number 5 PH 1 HD 01368-03

Administered through:

July 12, 1968

OFFICE OF RESEARCH ADMINISTRATION · ANN ARBOR

The University of Michigan

Center for Human Growth and Development

Linguistic and Psychological Factors in the Speech Regulation of Behavior in Very Young Children

Hugo A. Beiswenger

Report Number 63

Development of Language Functions

A Research Program-Project

July 12, 1968

Supported by the National Institute for Child Health and Human Development

Grant Number 1 P01 HD 01368-04

ACKNOWLEDGEMENTS

I wish to express my appreciation to Drs. David Birch, Peter Fodale, John Hagen and Melvin Manis for their many helpful suggestions and criticisms throughout the preparation of this report. I am especially indebted to Dr. Birch for his assistance on the statistical treatment of the results. My many discussions with Peter Wolff, my fellow graduate student, helped clarify many of the ideas expressed in this report. The help of Nora, my wife, who insisted on my untangling unwontedly long sentences, and on clarity of expression generally, was invaluable. I wish also to express my thanks to Janet Bachman for her typing of the final version of this report under terrific time pressure.

The research for this report was supported in part by a Public Health Service training grant, PHS 1 T01 HD 00149-01 and in part by the Program-Project in Development of Language Functions in the Center for Human Growth and Development at the University of Michigan, NICH HD 01368-04.

TABLE OF CONTENTS

Page

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDIXES

Chapter I.

A Process View of Human Behavior

> There cannot be a highly developed capacity for learning--for that modifiability of response which we call 'intelligent,' unless the behavior system falls, not into distinct units of response, functionally complete, but into independently variable factors, functionally incomplete, which may be performed independently..... (DeLaguna, 1927).

DeLaguna stresses the functional flexibility of the behavioral act; that the behavior of higher organisms cannot be accurately characterized as drawing from a "repertoire of responses." DeLaguna's approach is consonant with contemporary information processing views of behavior such as the following:

> Compared to that of lower animals, human 'thought' is characterized by the generation of more alternatives. More meanings can be attributed to objects, and a greater number of connections (relations) between these meanings arise...a human engaging in complex thought processes can perceive stimuli in many ways and can consider many ways of interrelating these perceptions for his adaptive purposes. In this sense, human thought has more degrees of freedom.
>
> The difference between man and the higher-order-animals lies not so much in the ability to learn or to utilize the meanings of a large number of stimuli, but rather in the ability to learn and to utilize alternate meanings of the same stimulus and to build up and use different patterns of interrelationships within the same set of meanings. This change, from lower to higher levels of thought, is a matter of degree, paralleling the evolutionary scale across species and developing with age (to an upper neurological limit under optimal environmental conditions) within species. (Shroder, Driver, and Streufert, 1967.)

It is the thesis of this dissertation that it is the human language system, in large measure, that makes possible the human capacity for modifiability of responses which DeLaguna calls "intelligent," and Shroder, Driver and Streufert characterize as "adaptive" modes of interaction with the environment, i.e. modes that have more "degrees of freedom" for the making of alternative choices.

Before examining the specific problem studied in this thesis the assumptions that underlie this dissertation will be set forth in Chapter I. These assumptions are outlined under three headings: (1) Stages and goals, means and ends; (2) Cognition is formed in action; and (3) The complexity and multi-dimensionality of behavior.

1. Assumptions about stages and goals, means and ends

Behavioral acts, at all phylogenetic levels, are always goal-oriented. They may be described as goal-controlled (DeLaguna, 1927) for the lowest organisms, goal-directed, i.e. image-directed (Beritoff, 1965) for higher mammalian species, and goal-envisioned (Vygotsky, 1962) for humans.

Goal envisioned behavior as a description of human behavioral acts is another way of saying that human behavior is purposive. At this point there is no intent to discuss how much of human behavior, or under what conditions, it is purposive, but only to state that human behavior has a capacity for purposiveness.[1]

The distinctions made above correspond in a rough sense to involuntary or trophistic behavior, to image-directed behavior and to conscious behavior. Each of these distinctions, as a description of ascending levels of behavior, views the lower forms as preserved and incorporated but yet subordinated to the higher level synthesis that is represented by each higher level step in phylogenetic development.

The two higher levels of behavior (goal-directed and goal-envisioned) are characterized by the increasing numbers of "means-acts," which may be combined and re-combined in many ways, and which intervene between the initiation of a behavior and its goal. By means of what Sokolov (1963) calls orienting activity, or Neisser (1967) calls focal attention, the stimulus situation is capable of being analyzed and synthesized into a representation ("image," "expectancy," "plan," or "program") of the behavior to follow. Motor and sensory feedback (often recoded verbally by humans) keeps the intended behavior "on course." If the feedback signals from the confrontation with the environment show a discrepancy between intention and action, means-acts are modified or substituted by central decision processes, or the goal must be modified or abandoned.

Within this frame of reference it is obviously not adequate to describe conscious or purposeful behavioral acts by an a priori specified "stimulus" and "response," because stimulus and response are continuously interacting in the course of the behavioral act. The response constitutes (shapes) the stimulus, and the stimulus concomittantly shapes the response. Dewey (1896) recognized the inter-penetration of stimulus and response. Today his view is becoming an important theoretical concept in psychology. Dewey argued the conception logically. Today Dewey's idea has extensive behavioral, experimental, and neurological underpinnings.

2. The assumptions that cognition is formed in action

All behavior is behavior in the objective world outside the organism. Cognition is constituted by the interactions of the organism with the world (Piaget, 1962; DeLaguna, 1927). The behavior of all animal organisms is active, searching, information processing interaction with the environment (Berlyne, 1960; Miller, Galanter and Pribram, 1960). Each biological organism builds up a structure or representation (the resultant of cognitive activity) of the world consonant with the structure of its nervous system and its species specific mode of adaptation to a particular type of environment.

Chase (1966) states that the form of cognition of the world is species-specifically determined:

> A survey of receptor-system neurophysiology reveals so much variation in functional properties that we are forced to conclude that different species of animals literally function in different experiential worlds (Cohen, 1964; Marler, 1959; Tinbergen, 1957; Uexhüll, 1957; Vallancien, 1963)...the sensory systems of each species have evolved capabilities for selectively admitting information of special biological importance. One finds, in addition, that there is a close conformity between the information reception and information-generation capabilities of animals... Different species of animals have very different biological needs, dictated by extreme differences in the physical environment in which they must survive (Chase, 1966).

The human child is born with a species-specific brain structure which gives him the potential for developing a complex cognitive structure (representation) of the world in which he functions. A crucial role is played by his possession of the specialized speech areas of the brain which are capable of functioning as a unitary and unifying system which collates and organizes a structure of objective reality from the mass of information available to him from his experiences (Luria, 1966a).

Sensori-motor and verbal representations develop both in parallel and in integrated fashion in the child's total development, and form an integrated representation of the world outside him, with which he must cope. Correlative to the differentiation of external reality is the differentiation of self and the increasing ability of the self to act upon the external world in order to create and insure its own means of existence.

While the potentialities for creating a <u>human</u> cognitive structure and its <u>general</u> form are inherent in the physiology of the human organism, particularly its nervous system, the practical realization of these potentialities is conditioned by the experiences of the child in its environment.

The child need be neither the passive product of inherent unfolding biological processes nor the passive product of environmental conditions. His cognition of reality and his place in it is always an interactive process, with cognition ultimately proceeding from the external to the internal, i.e. from action in and on the environment to its internalized representation in neural tissue (Luria, 1966a; Leontiev, 1964).

3. Assumptions about the complexity and multi-dimensionality of behavior

MEDIATENESS OF BEHAVIOR. Behavior in higher organisms, and particularly human behavior, is complexly mediated behavior. In this discussion the mediateness of behavior will be used in two different frames of reference:

(1) Externally observable behavior has a sequential organization. The complete behavioral act starts with orienting reactions and ends with the attainment or completion of the envisioned goal. The first indications of mediateness in sequentially organized behavior are seen in infancy when the child begins to perform instrumental (mediate) acts in order to "cause something to happen (Piaget, 1952)."

(2) Internal neurophysiological processes intervene between externally observable stimulus situations and externally observable overt behavior. These processes are said to mediate behavior, whether or not the external behavior is of a "mediate" character or not. These internal processes are often specified to be the counterparts of either a verbal stimulus (word, phrase, sentence, or other verbal unit) or of a non-verbal stimulus situation.

DeLaguna (1927) stresses that one criterion of the complexity of cognitive behavior, viewed phylogenetically, is the mediateness of the behavior. Thus, she points to the relatively high level of mediateness demonstrated by chimps who use sticks in order to obtain bananas placed out of reach, or who are able to join two sticks together, a futher step in mediateness, to accomplish the aforementioned objective.

DeLaguna points out the limitations of the chimp's level of mediateness when it is compared with primitive man's fashioning of tools with a sharp stone used as a chisel or scraper. Tool-making behavior is a higher level of mediate behavior because it is performed to make possible future behavior (distant from the immediate perceptual situation) of a qualitatively different character (hunting game). Modern man has the capacity to work for goals weeks or months or a lifetime in the future, involving many complex mediating steps. Each mediate step itself becomes a sub-goal which in turn involves additional mediating "means-acts." The child must pass through many levels of mediate complexity of behavior before reaching maturity.

TYPES OF BEHAVIOR. The inter-relationships between major "types" of behavior constitute another dimension of the multi-dimensionality and complexity of human behavior.

Lenneberg (1968), for example, talks of "the complete universe of behavior--motor, perceptual and cognitive skills." More traditional behaviorist psychologists divide behavior into perception, motor skills, and problem-solving and other higher processes.

Sheldon White would bridge the gap between SR and more "mentalistic" theorists by saying that there are two levels of behavior--associative and cognitive, organized in parallel in a hierarchy (White, 1965).

Piaget (1952) speaks of sensori-motor behavior, concrete operations, and logical operations. Luria (1966b) speaks of orienting behavior (perception), motor behavior, and "higher mental processes" which are the basis of thought and reasoning. Bruner (1966) divides behavior into three chronologically appearing types of "representation": enactive, ikonic, and symbolic. There is a considerable amount of similarity and overlap in all of these approaches (but also important points of difference).

The point of view assumed in this thesis stresses the inter-connectedness and inter-dependence of the behaviors as they are viewed in a tri-partite division. Behavior may be divided into perceptual, motor, and higher mental processes. Yet it must be emphasized that any behavior, characterized in any of these three ways, includes the other two at some level of development. Thus, for example, the perception of a stimulus involves motor adjustments of the receptors, and often the skeletal musculature as well as an evaluation of the significance of the stimulus. If the perceptual act is a conscious one "higher mental processes" are brought into play. Productive speech is, in some sense a higher mental process, yet obviously also involves extensive perceptual and motor components.

VOLUNTARY AND INVOLUNTARY BEHAVIOR. The dichotomy of voluntary and involuntary behavior constitutes another aspect of the multi-dimensionality of behavior. Luria (1966a) and Zaporozhets (1961) identify voluntary behavior with conscious behavior and its self-initiation through the verbal system. It is thus also linked to "higher mental processes." The concept of involuntary behavior is applied to attention before it comes under verbal control, to conditioned motor behavior, to autonomic reflexes, and to the young child's memory, by Luria (1966b).

SIMULTANEOUS AND SERIAL SYNTHESES. Luria (1966c) speaks of another dichotomy in behavioral processes: simultaneous vs. serial processing of information from the external world. These two modes of processing are applicable to all three of the tri-partite aspects of behavior: perceptual, motor and higher mental processes.

The perception of the spatial organization of the world for example, becomes "simultaneous" and "instant," but was, in its genesis, serially organized behavior which, with overlearning, has become automatized. Higher mental operations (e.g., the use of mathematical algorithms) may at first be laboriously serial in nature, but when automatized are able to function as "instant" perceptions, and as such, constitute links in a chain of higher level algorithms. Verbal behavior also illustrates the dual processes of simultaneous spatial representation ("content words") and serial chains (sentences and connected or narrative discourse).

VERBAL AND NON-VERBAL BEHAVIOR. A final distinction that will be made is that between verbal and non-verbal behavior. Different psychologists perceive this division in different ways:

(1) For Piaget (Sinclair-de Swart, 1967) cognitive processes are basic. Cognitive operations become reflected in language. Language adds nothing to what is distinguishable without language by means of cognitive operations.

(2) Chomsky (1965; 1967) sees language development as in the main accomplished by the time the child is four years of age. He contrasts this accomplishment to a relative lack of comparable development in other cognitive spheres.

(3) Werner (1963) and Luria (1957) see language and cognitive development as advancing correlatively, with cognitive structure more and more becoming infused with language. Vygotsky (1962) and DeLaguna (1927), in a similar view, stress the fusion of speech and thought in ontogenetic development, and see the internalization of speech as creating the basis for

verbal thought. However, Vygotsky also sees a higher level of thought process which is capable of momentarily becoming severed from its verbal base.

4. Summary

Summarizing the above "process" view of human behavior, put together from many sources, the following assumptions are made *a priori* as a background against which the role of speech in directing and regulating behavior in young preschool age children is considered:

(1) The most useful unit for the analysis of behavior is the complete behavioral act which, in human purposive behavior, has a goal-envisioned objective. The goal of a behavioral action is reached through means-acts which are used flexibly in inter-changeable combinations and recombinations.

(2) Cognition is internalized inter-action between the organism and the outside world. The child through activity on and in the world elaborates a species-specific structural capability of human modes of behavior by modifying inherent neural structural systems.

(3) Human behavior takes place within a matrix of an integrated representation of the objective world and the relationship of the self to it.

(4) Human behavior characteristically is distinguished by its highly mediate and complex character.

(5) Behavior may be categorized into different "types," i.e. motor, perceptual and thinking. These divisions are useful for designating the dominant characteristic of the behavior under investigation. The essential thing is to stress, however, the inter-connectedness of types of behavior and the transition of one type into the other in all behavior.

(6) Voluntary behavior may be characterized as conscious and speech-initiated. Yet any voluntary behavior also includes involuntary components

that have become established in experience as, for example, autonomic, motor, and sensory conditional components.

(7) All behavior includes both simultaneous and serial processing of information from the environment. Again, both the "oppositeness" and the inter-connections of these processes in given behaviors and stages of behavioral acts should be stressed.

(8) Finally, the distinction of verbal vs. nonverbal behavior is drawn. The view stressed here is that of Luria and Werner who emphasize their correlative interaction within a single cognitive structure, formed in the process of development.

Chapter II

Aspects of the Multi-Dimensional Nature of Cognitive Processes in the Very Young Child

If the development of language and non-linguistic processes are correlative, and if the ability of speech to direct and regulate behavior depends on the ability of the child to handle increasingly complex sentences, in order to understand the processes at work in this seemingly purely *linguistic* accomplishment it will be necessary to examine some of the multi-dimensional aspects of the child's total cognitive development. To put it in another way, speech or language behavior can never be totally abstracted and divorced from its functional use in the real world. It is one element, albeit an important one, of an organismic interaction of the child with his environment.

The child's cognitive development may be divided into two broad categories: sensori-perceptual and language. Under the first I will consider object perception, the perception of spatial relations, and the perception of temporal sequences. All of these are involved in the verbal direction and regulation of the young child's behavior.

The features of language productivity and of language direction and regulation of behavior will be considered under the second category. This will be followed by a discussion of the relationship of the mediateness of behavior to cognitive complexity and the mechanisms which motivate the development of the young child toward more complex cognitive operations.

1. Aspects of sensori-perceptual development

OBJECT FORM PERCEPTION, ATTENTIONAL PROCESSES AND A THEORY OF PERCEPTION. Infants are able to distinguish between grossly different forms of solid objects (e.g. sphere vs. cube). However, the abstraction of spatial relations that makes possible the "instantaneous" perception of varied object forms takes place gradually over the first 6-7 years of the child's life. Object form recognition, as language, seems to start with external operations on objects by the child. As these sensori-motor operations become more familiar and automatized, they become internalized. The perceptual act then acquires an "instantaneous" quality.

Gibson (1963) reports on Zinchenko's experiments on form matching. He found that for the preschool child to match two-dimensional forms, directed orienting exploratory activity is necessary. Zinchenko presented 3-year-olds with two-dimensional forms for matching and found that at this age, examining the figure by vision alone, there were 50 percent errors, whereas by age 5 there were no errors. Recordings of the children's eye movements showed that the children of 3 to 4 years had saccadic (darting, random) eye movements within the figure, whereas the 5 to 6-year-olds showed eye movements following the contours of the figures. (Unfortunately no N's or significance levels given). The same type of experiment done in the tactual modality found 3-year-olds unable to perform the matching task at all; at age 4-5 there were still 73 percent errors, but these were reduced to 23.2 percent at ages 6 to 7. The older children used organized palpation of the contours of the forms, and this seemed crucial to forming an internalized "image" of the object.

Zinchenko and Zaporozhets (1965) conclude from these and other experiments that organized orienting-exploratory activity, effected by peripheral organs (hands, eyes, etc.) which move on and around the object, form an "image" or "model" of the object which reproduces its features. In subsequent perceptions the perceived object is compared with the model. ("Model" as used here can be interpreted both as a subjectively experienced perception of the object and also as a neural mechanism or constellation.) Feedback signals of differences between model and perception "correct" the model with each succeeding perception.

Perceptive actions in this view, which will be adopted here, thus include both exploratory and modeling processes, and corrective processes. In the ontogenesis of the perception of objects in the surrounding world, orienting and exploratory movements, extended in time, dominate at first. As the perception becomes more othoscopic, a much quicker recognition process takes place. In the internalization and automatization of the perceptual process, the movements of the receptor organs are attenuated and the object is recognized by some characteristic feature or sign. Zaporozhets finds that a similar ontogenetic process is at work in the perception of speech, of musical pitch, and in other spheres of perception. Zaporozhets' conclusions seem compatible with the approach of Neisser (1967) to attentive processes which function in perception and recall.

Neisser sees three levels of cognitive structure in both perception and recall: pre-attentive, focal attentive, and contextual. The latter includes the spatial, temporal and conceptual framework within which perception takes place. In perception, which is always "constructive," the distinction between preattentive and focal attentive processes is relative and is determined by previous experience. That is, aspects of the stimulus situation which may have required focal attention at a previous time may, by practice and repetition, become automatized, and function as pre-attentive processes in a new construction of the perception. The automaticity of the preattentive processes now allows focal attention to differentiate

<u>new</u> aspects of stimulus situations for analysis and synthesis. This may be thought of as receptor organ manipulation of objects which reveal new features or relations which would not be discernable without the previous experience of the more obvious aspects of the object.

This way of viewing perception incorporates both memory and learning as inextricable components of every perception which is at once both a reconstruction and a construction. In this context practice appears in a new light.

Practice, or the repetition of an action (perceptual, motor or mental operation), is not a mechanism of learning <u>per se</u>. If the practicing <u>S</u> is unaware of (not attentive to) any substantial differences in the perceptual situation, the practice only results in the automatization of what already has been learned (or "perceived"). But to the extent that automatization takes place, a necessary (though not sufficient) condition for new levels of perceptual learning has been created. Automatization based on practice makes possible penetrating to deeper, less obvious aspects of the object, to relations within it or between it and other aspects of the environment which were not initially visible.

THE PERCEPTION OF SPATIAL RELATIONS. The perception of spatial relations also undergoes development in the early pre-school years. Object perception is, <u>initially</u>, a matter of recognizing the permanence and location of various objects in the environment, and of such qualities or features as are revealed by a practical <u>manipulation</u> of the object. The perception of spatial relations involves the abstracting of properties or relations within objects and between objects. This involves more than the mere recognition of the perceived qualities themselves in a concrete exemplar. The ability to distinguish a quality or relation which is common to disparite objects and agglomerations of objects is required. The perception of a relation is more "abstract" because it does not depend on a direct sensory image as such.

A study by Smirnov and Tsareva (1967) is illustrative of the processes operating in perceiving spatial relations in the early pre-school period and draws conclusions about the processes involved. Smirnov and Tsareva conclude that "The process of understanding space takes place in accordance with the accumulation of experience by the child, the development of ideas as to its own organism, and knowledge of the objects of the surrounding world... In the process of the child's acquisition of speech, words strengthen the space connections already formed, making possible the imagination of abstract spatial relations, and the development of the concept of space."

Their data indicate that the 3 year old child, in a concrete situation, distinguishes both horizontal and vertical spatial relations and is able to translate this information into bodily movements which reproduces them, but is not able to do a mirror image transformation. Smirnov and Tsareva hypothesize that the child's initial perceptions of spatial relations are relative to the body, and that they are then projected onto the objects perceived.

PERCEPTION OF TEMPORAL ORDER RELATIONS. There is little experimental evidence or even good observations which specify in any great detail the 3-4-year-old child's concepts of temporal order and his integration of temporal and spatial relationships. What we know however, while neither comprehensive or conclusive, points to the conclusion that elementary perceptions of time and space--of object form recognition, spatial relations, and temporal order relations--develop first and are then mirrored in language.

Language development itself, at this stage (around 3 years) is also relatively undifferentiated. It mirrors the nonsubordinative nature of the child's cognition of relationships by a primitive, what Werner and Kaplan call a paratactic, grammar. The period between the ages of 3-4, during which spatial and temporal relations become more abstract, is also the period of linguistic development of a hypotactic syntax, a syntax that begins to be able to express subordinative relationships, and to some extent to abstract and separate the concepts of space and time. Many of the grammatical transformations which begin to be acquired at this time involve linguistic expressions of exactly these kinds of relationships. Any attempt to assess the ability of commands or instructions to direct and regulate behavior thus must take into account the intimate relationships between linguistic and nonlinguistic (sensori-perceptual) cognitive processes, although as yet little is known about these relationships.

2. Language and cognitive complexity

THE CREATIVE PROPERTY OF HUMAN LANGUAGE. Between 4 and 6 years of age the average child has achieved and is able to use practically what Chomsky and others have called the "creative" aspect of language. "Fluent speakers both produce and understand sentences that they have never previously encountered, and they can do this for indefinitely many such novel sentences. In the normal use of language, the production and comprehension of new sentences, created on the spot, is the rule rather than the exception (Katz, 1966)."

When one considers that the meaning of a sentence cannot be decoded without some kind of knowledge of the rules of syntax and that "indefinitely many such novel sentences" are encountered, it seems incontrovertible that the child must possess an internalized set of rules of some sort for decoding and encoding sentences.

The only alternative to the above assumption is the unlikely alternative that the child must have had "reinforced" all of the possible sentences which he meets and requires in his commerce with the environment in order for him to understand or use them. The acknowledgement that the child by the age 4-6 has internalized rules for encoding and decoding sentences does not, however, entail the additional assumptions that (1) only linguistic rules are used for coding and decoding language, and (2) the linguistic rules that are used are the set of base structure and transformational rules postulated as underlying the surface structure of sentences in Chomskyian linguistic theory. On the other hand, although the rules the child uses may not be isomorphic with Chomskyian rules, it is possible that they may bear some close relationship to them.

The child actually begins to use generative principles in a rudimentary way as soon as he begins to pass from the use of the monoreme (encompassing one-word expressions) to the duoreme (two-word expressions which are functionally complete).

Gregory's first use of two word combinations (Braine, 1963) illustrates this. Gregory used 14 combinations with "see," such as: "see boy," "see sock," "see hot." The use of an implicit "rule" (i.e. that you can combine a specific set of words with one "pivot" word such as "see") is typical of all children at this stage of linguistic development (Ervin, 1964; Brown and Bellugi, 1964; Braine, 1963; McNeill, 1966). The step by step development of the child which follows finally culminates in a basic level of linguistic competence between the ages of 4 and 6 (McNeill, 1966; Luria and Yudovich, 1959).

According to Brown and Bellugi (1964) "By the age of 36 months some children are so advanced in the construction process as to produce all the major varieties of simple English sentences up to a length of ten or eleven words." The use of these sentences implies the use of Chomskyian transformational operations from base to surface structure according to Menyuk (1963a). Menyuk concludes from a study of nursery school children's language that "...almost all the basic syntactic structures used by adults that we have thus far been able to describe are found in the grammar of children as young as 2 years 10 months. From 2 years 10 months to 7 years 1 month there was an almost steady increase in the number of children using these structures as an increasingly mature population was observed. However, most of the structures were used at an early age and used consistently."

The generalities implied by these assertions must be qualified. Menyuk (1963b) in a subsequent experiment, tested the ability of nursery school children between the ages of 2;10 and 3;8 to repeat after the experimenter sentences using 27 types of transformations employed in Chomskyian linguistic theory. Menyuk found that a significant number of the children were able to repeat 21 of the 27 sentences which contained different types of transformations. Bellugi and Brown (1963) considered that imitation does not involve processing the sentence through the "meaning system," and that imitation is easier than either "comprehension" of sentences or "production." Menyuk's study implies that imitation involves the child's use of grammatical rules. She found that children generally do not imitate non-grammatical constructions when grammatical constructions are available. These conflicting interpretations of imitation make it doubtful whether the child's ability to imitate a given more difficult transformational construction in a sentence necessarily means that he can decode or encode sentences which include the more difficult transformations.

Other investigators have found severe limitations in the young child's cognition of syntax. Karpova (1955) studied the ability of preschoolers to segment simple sentences into words. Some of the sentences used were: "Cold weather came." "Vanya went home." "The boy is laughing." "They brought up a kitten and two puppies.". Karpova found that only three percent of children between the ages of 3;6 and 5 were able to break down the sentence into all of its separate words. Even at age 6-7 the number was only 20 percent, to which can be added an additional 60 percent who could partly describe which were the words in the sentence, and these were usually the nouns.

Werner and Kaplan (1963) quote a study of Huth which analyzed narrations and conversations of children between the ages of 4;6 and 6, and found that at this age a large number of children expressed dependency relationships by paratactic (i.e. nondependent, equally conjoined) forms of syntactic structure. He called these grammatical structures "masked" subordinate clauses and found that 74.3 percent of children at age 4;6 used these incorrect grammatical forms to express dependency relationships. However, by age 6, 76.8 percent of the children had abandoned this traditional form of grammatical expression and were using grammatically correct usage of subordinate clauses.

The conclusion to be drawn, it would seem, is that the four year old child has achieved a remarkable degree of linguistic competence, i.e. in principle he has achieved the "productivity" or "creativity" property of human language. He is able to use and understand properly many of the simple and elementary grammatical transformations (questions, tense, negation, pluralization to some extent, etc.). This competence, however, may be considerably less than what is claimed for the 4-year-old by some transformational linguists, i.e. that the child of 4 has internalized the rules of Chomskyian linguistics. Indeed, it is questionable whether the rules that adults use to encode and decode sentences can be simply equated to the linguist's rules (Matthews, 1967).

3. Language direction and regulation of behavior

Luria has traced the ontogenetic development of the directive and regulative aspect of language in an experimental program. What begins as a functional use of language, and language infused into cognitive functioning, leads, in later nodes of development, to purposive mental processes, in Luria's view. Luria's experiments and his interpretative model have been discussed elsewhere (Beiswenger, 1968) so that only a brief summary will be included here.

According to Luria the ability of language (a sentence-command or instruction) to direct and regulate complex behavior which is consonant with the full semantic content of the sentence, is not generally achieved until around the age of 5-6. The ability of command-sentences to regulate behavior follows an ontogenetic progression which is related to the complexity of the sentence and to the non-linguistic cognitive capacities which correspond to the child's level of development. Both are conditioned by neurological maturation as well as by experience.

The child of 10-24 months thus is capable of responding adequately only to commands which are direct and simple. The sentence is perceived mainly in terms of content words (nouns, verbs) and situational cues. At this stage the sentence functions like a conditional stimulus. In the next stage (2-4 years) the relations of words within a sentence (syntax) are perceived if the syntax is not too complex. In addition there is some verbal control over orienting activity (attention) and motor behavior. In the third stage (4-6 years) the child perceives more complex syntactical structures--structures which place behavior in the context of a sequence of actions governed by different kinds of contingent relationships. The ability to visualize the structure of behavior in advance requires increased linguistic competence, an increased planning and regulation function within the level of the speech system itself, and its control over the sequenced relationships of future behavior. The latter includes bringing the child's orienting processes under verbal control in all stages of the complete behavioral act.

Luria sees these stages in perfecting verbal regulation and direction of behavior as following a genetic sequence. Regulation of behavior by speech is at first external (first by the mother, then by the child's speaking aloud as he acts), and then becomes internalized during the 4-6 age period. An interior process of organization, direction, and regulation, formulated in and through the speech system, develops. Once internalized, speech becomes the basis for verbal thought, and later, of higher level thought processes.

DeLaguna (1927) also discusses the role of language in directing and regulating behavior. She emphasizes that the developed sentence makes possible the explicit predication of objects, their properties and relations, and of plans and purposes that are of interest to the actor.

The psychological features of explicit predication, according to DeLaguna, include such factors as (1) the need to inhibit the features of a situation to which responses must not be made, or to specify the features of a situation to which response must be made, and differentiating them from other features of a situation; (2) the explicit specification of details for carrying out a course of action; (3) the simplification of complex situations by focusing attention on the relevant property of a situation for a given purpose; (4) the specifying of the relationship of objects to one another, or of the properties of many objects, or of the absence of a property.

The psychological processes making possible explicit predication are among the necessary prerequisites for human purposive behavior, and language makes it possible to employ them precisely, quickly, and flexibly. DeLaguna, like Luria, sees verbal behavior as incorporating image-controlling processes. "Anticipatory verbal response need not entirely replace the perceptual image" she writes, but now "the image which is mediated by the act of speaking is a new thing..." Neisser (1967) appears to express a similar view when he says: "Recall in words...is a new verbal synthesis which may be based on information from a number of sources, including not only traces of earlier verbalizations, but perhaps visual images and other constructions as well." Thus, in this view, verbal images are capable of encompassing more or less ramified aspects of sensory images as well as being able to function without specific sensory image content.

DeLaguna, in a formulation remarkably similar to that of Vygotsky (1962) and Luria (Luria and Yudovich, 1959) sees internalized verbal behavior as the first step, ontogenetically, of thinking. "The saying over to onesself what one is about to do is a preparation for the primary acts that are to follow. It is not simply that each act is individually and separately prefigured and thus prepared, but the serial organization of behavior is thus preestablished by speech..." Thinking, for DeLaguna, in the initial form in which it appears ontogenetically, is subservient to purposive behavior. It later becomes an independent activity in its own right.

The very ability of speech to control behavior in a subtle and flexible way is dependent on its increasing autonomy and independence from the speaker's own immediate behavior and the concrete context in which it occurs. It is only when speech becomes a somewhat autonomous system that is capable of predicating subtle and intricate relationships that it acquires its greatest power to modify reciprocally the interaction of the child's behavior with the situation in which it takes place. In the child's development speech makes it possible for the child perceptually to organize and differentiate the situation in order to adjust his behavior to it. At the same time the ability to differentiate the situation gives the child a new power--the capacity to act on and modify the situation--i.e. to control or change the situation.

4. Mediateness of behavior and cognitive complexity

DeLaguna sees an intimate relationship between language and its ability to control behavior expressed in the concept of the mediateness of behavior. Cognitively complex (intelligent) processes are not indexed simply by the ability to adapt to a wide range of very complex conditions--if these are permanent, nor by the ability to cope with complicated changes in situations--if they are constant.

Cognitively complex processes make possible the ability to modify responses to a regularly changing environment, to variations in the usual and regular order of things, and to integrate the unexpected into the stream of purposeful behavior. It is these capacities that are characteristic of human behavior. Behavior with these potentialities is behavior characterized by a mediated psychological structute, according to DeLaguna.

It is not possible to produce a state of affairs objective to the individual which is of mediate utility or interest to the actor by sensory images, according to DeLaguna. A perception is required of the objective relations of things or persons to each other. The perception of such relationships is indirect or mediate. Objective relationships do not necessarily stand in an immediate relationship to the perceiver. Relationships must be perceivable as interchangeable, as functionally neutral, as utilizable in many different kinds of situations rather than as specific to the action situation of the moment. The perception of such objective relationships requires a preliminary stage of analysis before action rather than direct action in response to a sign.

In its early ontogenetic stages language is not able to direct complex (mediate) behavior. "...in its beginnings speech is used to control immediate action only, with reference to objects at hand (DeLaguna, 1927)." This type of behavior control is limited, adjusting the individual to what is already existent in the environment. On the basis of this conception of DeLaguna it is postulated that complex sentences generally are correlative with the complexity of the behavior required in the objective environment. If the behavior is mediate in structure, so also will be the prior psychological processes which are productive of the psychic image of the anticipated behavior, and these must be reflected in the syntax of the complex sentence.

The foregoing discussion of the cognitive behavior of the very young child has postulated that it is multi-dimensional, that it includes both sensori-perceptual elements and language aspects. The two become fused, and the child's behavior assumes an increasingly mediate structure.

It is now postulated that the result of these interacting processes is that the child forms an increasingly complex and integrated veridical representation of the environment in which he functions. This leads to the last question to be considered in this phase of the inquiry. What is the motivational force which propels the young child in the direction of the increased use of language as the integrating force for constructing his representation of reality?

5. Motivational factors which lead to cognitive complexity

It is postulated that the child develops a need for the use of speech of increasing complexity in order to organize, direct and regulate his behavior in the environment, to "master" the environment. The impulse that propels this need comes from adult and peer expectations as to what the young child's behavior should be, and from the successes which the child has already attained in his struggle to understand and manipulate the environment for his own ends.

This need for mastery of the environment is shown in all areas of the child's activity (White, 1959). Leontiev (1964) discusses it in relation to the child's play activity, one of the principle forms of the young child's intercourse with the world.

According to Leontiev the child of 3 would make objects serve his own ends. He sees, in the actions of older children and adults, operations on objects which he also would like to be able to perform. However, he is not able to understand the purposes of these operations and is incapable of performing them. He therefore copies the external aspects of the adults' actions on objects. His actions with and on objects become actions for their own sake rather than as steps which lead to a real, purposive result. However, by acting on objects he learns something of the properties of objects and relations in the objective world.

To learn to master the environment by play and games, or by directly doing as instructed by adults, necessitates that the child coordinate his actions beyond the limits of the perceptually present situation which he shares in common with other persons, and that he analyze his own and others' behavior into its components, their relationships and sequence in complex and varied situations.

DeLaguna (1927) feels that the child is able to perceive the "advantage" of language as an independent instrument for controlling constancies inherent in situations, objects, properties of objects, events, relations, affective states of humans and animals, all of which continuously appear and reappear in his experience. Once these constancies become objects of his perceptions, they may be used and combined in different ways in varying situations.

Thus, part of the need for mastery of the environment is a need for structure, order, comprehensibility and regularity in the child's perception of the objective environment. Language functions preeminently as that medium which is capable of coding all of the multi-variant aspects of reality and linking them into a comprehensible whole, a veridical representation of reality.

Chapter III

Linguistic Theory as a Model of Language Perception and Learning

According to Chomsky one goes from what a sentence means (its semantic interpretation) to what it says (its phonological interpretation, i.e. the sentence as it is actually heard) via the syntactic component of grammar. "Consequently, the syntactic component of a grammar must specify, for each sentence, a deep structure that determines it semantic interpretation and a surface structure that determines its phonetic interpretation (Chomsky, 1965). Deep and surface structures are not the same however.

> The base of the syntactic component is a system of rules that generate a highly restricted (perhaps finite) set of basic strings, each with an associated structural description called a base Phrase-marker. These base Phrase-markers are the elementary units of which deep structure are constituted... Underlying each sentence of the language there is a sequence of base Phrase-markers, each generated by the base of the syntactic component... In addition to its base, the syntactic component of a generative grammar contains a transformational subcomponent. This is concerned with generating a sentence, with its surface structure, from its basis (Chomsky, 1965).

Sentences with a single base Phrase-marker are called "kernel sentences." They are simple sentences and "involve a minimum of transformational apparatus in their generation." However, they should not be confused with the basic strings that underlie them. Kernel sentences are in surface structure but have a closer correspondence to the base structure Phrase-marker than do more complex sentences.

As a linguistic theory, Chomsky's approach to the syntactic structure of language is judged by many to represent important progress in developing a linguistic theory which has greater explanatory adequacy than other contemporary theories of grammar. The concern in this analysis however, is the relevance of Chomsky's linguistic theory to an understanding of the psychological processes involved in the learning, perception and production of language and the relationship of language to other aspects of cognitive functioning.

The specific question relative to Chomskyian linguistic theory with which this thesis is concerned is: does Chomsky's description of the distinctions between base and surface structure of language, together with his analysis of the base and transformational rules which explain the relationship between base and surface structure, specify in some sense the psychological processes involved in decoding and encoding sentences?

Chomsky states that "A grammar does not tell us how to synthesize a specific utterance; it does not tell us how to analyze a particular given utterance. In fact, these two tasks which the speaker and hearer must perform are essentially the same, and are both outside the scope of grammars of the form (35) (Chomsky, 1957)." This appears to say that the grammar of a language is not a model for the psychological processes of decoding and encoding sentences.

Again, Chomsky says: "...let me repeat once more that this discussion of language learning in terms of formulation of rules, hypotheses, etc., does not refer to conscious formulation and expression of these but rather to the process of arriving at an internal representation of a generative system, which can be appropriately described in these terms (1965)." This seems to say that the generative system (rules) of transformation do become internally represented, but not consciously.

In Aspects of a Theory of Syntax (1965), Chomsky says: "No doubt, a reasonable model of language use will incorporate, as a basic component, the generative grammar that expresses the speaker-hearer's knowledge of the language; but this generative grammar does not in itself, prescribe the character or functioning of a perceptual model or a model of speech production."

Finally, in another context Chomsky, in describing the end result of the child's acquisition of language, says: "Clearly, a child who has learned a language has developed an internal representation of a system of rules that determine how sentences are to be formed, used, and understood. Using the term 'grammar' with a systematic ambiguity (to refer, first, to the native speaker's internally represented 'theory of his language' and, second, to the linguist's account of this), we can say that the child has developed and internally represented a generative grammar in the sense described(1965)."

In the first of these quotations, Chomsky seems to have introduced qualifiers to the notion that linguistic theory does not specify the mechanism of coding and decoding sentences by saying that the processes are not the "conscious" formulation and expression of linguistic rules, and also that the "generative grammar does not in itself prescribe the character or functioning of a perceptual model or a model of speech production." Yet, the last quotation (above) states that the child has internalized rules of grammar that "determine how sentences are to be formed, used and understood."

The first quotation apparently must be read as leaving open the possibility that the rules of generative grammar are, nevertheless, the <u>basic</u> component of a model of language use but that they function "unconsciously." The latter qualification, i.e. that the generative rules function unconsciously, would explain why "A grammar does not tell us how to synthesize a specific utterance," inasmuch as "synthesizing a specific utterance" presumably is a conscious process. The last quotation (above) categorically states that the learning of a language means that an internal representation has been formed of a system of rules that "determine" how sentences are to be "formed, used, and understood." As it stands, this statement seems to remove the qualifiers and ambiguities of the previous statements and to state definitely that the linguistic model can be used as the cognitive model of verbal behavior.

Reconciling the meaning of these somewhat ambiguous statements is risky. They seem to suggest that learning a language means the internalization of the set of generative linguistic rules of the base structure which are used for perceiving and producing sentences, as well as the transformational rules, and that these rules function unconsciously. However they function in conjunction with other, non-linguistic factors such as memory limitations and states of attention, which may modify their optimally effective use in a given situation.

Chomsky uses the idea of the unconscious functioning of linguistic rules also in his model of the child's learning of language. The child begins language acquisition with an innate, unconscious structure of linguistic knowledge, consisting of generative rules and conceptual categories. This innate knowledge forms the core around which the complete deep structure of the adult is built.

It is of course an empirical question to determine whether or not adults or children possess in internalized form the distinction between base and surface structure as used by Chomsky in his linguistic theory, or in any other form. If the mind does indeed in some sense possess a deep structure of internalized rules of grammar, one is confronted by the question: what is their origin? Are they given *a priori*, as an innate faculty of the mind (whatever meaning can be given to that phrase), or are they acquired as a result of the process of language learning, i.e., do they develop as abstractions derived from the learning and using of language? These questions are relevant to the experimental investigation which is the subject of this thesis inasmuch as a number of psycholinguists have adopted the Chomskyian model of grammatical theory, some explicitly, some implicitly, as their model for the psychological processes involved in language learning and verbal behavior.

Menyuk states that Chomsky's explanatory model as presented in Syntactic Structures "provides us with a technique for describing the rules from which the child may generate the sentences in his language (Menyuk, 1963)." Epstein (1965) and Turner and Rommetveit (1967) have compared the performance of children and adults on "simple sentences" as contrasted to sentences involving various types of transformations and found the latter more difficult, presumably because of the transformational processes involved.

Stoltz (1967) however, explicitly rejects linguistic theory as a basis for explaining how a speaker-listener perceives or produces sentences and identifies this with Chomsky's own position. "Clearly, linguistic theory cannot itself serve as a theory of linguistic behaivor, since Miller and Chomsky (1963) have pointed out, any straightforward use of a generative grammar as a sentence producer or recognizer would yield highly implausible psychological predictions."

Suci, Ammon and Gamlin also question the identification of Chomsky's analysis of language structure with the psychological processes involved in verbal behavior. "Although very little is known about the actual processes which intervene between sound and language, a great deal of agreement exists that a primary function of the processes is to 'organize' the input into the 'structure of language.' Structure is relatively well defined by the linguist (Chomsky, 1956; 1965), but it is not clear what structure is from a psychological point of view (1967)."

Mehler and Carey (1967), using the Chomsky base-surface structure distinction, found that changes in both surface structure and base structure can disrupt the perception of sentences, but that changes in surface structure have the stronger effect. [If surface structure has the greater effect on the hearer, this suggests some kind of short-circuiting of the use of the base structure in the perception of sentences.]

McNeill (1966) is one of the strongest advocates of the application of the Chomskyian model which distinguishes between base and surface structure in the child's acquisition of language and attributes the possession of deep structure to innate formal and substantive linguistic universals.

McNeill holds that Chomsky's formal and substantive universals exist as "templates" in the child's mind when he begins language development. These templates are of ideas, i.e. the categories and categorization rules of the base phrase-markers and the transformational rules which link them to the utterance itself.

The whole innate structure does not become manifest at once, however, but unfolds between the ages of two and four in a logical order dictated by the hierarchical structure of the deep structure phrase-marker. In McNeill's view the child requires exposure to the language environment only to match language samples he hears against his innate templates, in order to discover how the universal rules take concrete form in the particular language community into which he was born. Thus, the core of the base structure (innately determined universals) is already present when the child starts language development. In development the universal core is elaborated with specific base components peculiar to the particular language at hand. Language acquisition is treated by McNeill as an autonomously developing "faculty of the mind" which is considered apart from the child's total cognitive development.

2. <u>An interactionist cognitivist model of language perception and learning</u>

It will be considered in this analysis that in the initial stages of the child's language development no meaningful distinction can be made between deep structure and surface structure in terms of any necessary close isomorphism with the Chomskyian model of base structure phrase-markers. It is in the process of development itself that a distinction between surface structure and a more abstract representation of syntactic relationships becomes differentiated, based on experience with the use of language. The development of an abstracted structure of syntactic relationships results, also, not from an autonomously developing language faculty but from the inextricable relationship of language with other cognitive processes developed by the child's activity in the world.

The development of an abstract representation of syntactic relationships, in this view, is a product of the child's total cognitive development within which language is a leading motif. The posing of the interrelated development of language and other aspects of cognition raises the often asked question: does language determine cognitive development or does cognitive development determine language development? As in all interactive processes, once they are set into motion, which is "cause" and which "effect" is always a relative question.

Actually, at any particular stage of the child's development language may exist as either cause or effect <u>vis-a-vis</u> other cognitive processes, a relationship to be empirically determined, but one which soon becomes transformed into its opposite as development proceeds. The process of development by negation may be illustrated by reference to the transition from monoreme (holophrase) to the duoreme and other simple syntactic structures.

The child's use of the holophrase may be viewed as causing cognition to advance because it enables the child to distinguish and fix a variety of action-situations in his perceptions and memory although they are still relatively nondifferentiated. However, the perceptual fixation of these constancies of the child's environment now makes it possible for the child to begin to apprehend more specific features of objects, people, and relations in the world.

This new differentiation in cognition now becomes reflected in the child's language by his use of different words for actions, people, things, and attributes, whereas before these aspects of complex stimulus situations were probably not distinguished. Linguistically they were given a combined undifferentiated expression in a single word. That single word, the monoreme, is thus negated by cognitive differentiation which, in the next phase of development, becomes the cause of language differentiation.

The duoreme and other forms of primitive syntax which follow the monoreme stage (Werner and Kaplan, 1963) express the increased cognitive differentiation, but also now become the cause of yet further cognitive differentiation. This process of development is self-perpetuating once it begins, yet language and cognition always develop in intimate interaction with all other aspects of the child's actions in the environment.

Once even simple syntax appears in language development, development progresses rapidly, making possible the expression and comprehension of increasing complexities and subtleties in the child's representation of the environment. Correlative with the increasing complexity of syntax, words become both more specific in their reference and meaning and more abstract--standing for classes of objects, actions, relationships and ideas. The child's actual language development is a rich and complex process, interrelated with all other aspects of cognitive development, and this is lost in the schematization which result from using linguistic theory alone as a one-to-one model of language acquisition.

The helical process in language development is aided, as in other spheres of perception, by an increasing automatization of past perceptual experience. Simple syntactic relationships and simple transformations become automatized through "over-learning" and in this sense become "unconscious." The automatization of syntactic structures in the process of development makes possible, at each new stage, the child's orientation to and perception of new syntactic relationships. This process, discussed here in very simplified form, is a long extended one, lasting in many areas of cognition, into adulthood.

Chapter IV

The Structure of Linguistically Initiated Behavioral Acts

The complete behavioral act, beginning with a linguistic input in the form of a command or instruction, and terminating with a behavioral action which corresponds to the meaning of the command or instruction, has been chosen as the most effective unit for the present study of the regulative role of language.

The behavioral act is conceived as integrating external movements and internal processes, and the latter are conceived as involving simultaneous and serial modes of processing. The complete act is conceptualized further as a closed loop or circle, initiated and terminated on the basis of a plan or program, rather than as an open-ended linear chain of events (Dewey, 1896; Anokhin, 1955).

The structure of the complete behavioral act is conceived to be essentially similar whether the act is one of "perception," "motor activity," or "mental operations," whether relatively brief or extended in time, whether simple or complex.

This approach removes rigid distinctions between "attention," "perception," "memory," and "learning," as well as between "sensori-motor" and "conceptual" or "cognitive" tasks. None of these hypothesized entities should be hypostasized and considered separately as isolated forms of behavior with their own laws and evolution. The usefulness of these classificatory terms is as an emphasis of particular aspects of a specific behavioral action under investigation.

Linguistically initiated behavioral acts, as all behavioral acts, have a serially organized structure over time. Viewed as a whole, however, the behavioral act occurs in the context of a relatively fixed representation of the environment, as a structural inter-action of the organism with the environment in a moment of time. If the serially organized individual components of behavior are examined, they also reveal a structured or simultaneous quality. While they also are extended in time, they function as "chunks" or automatized units. Thus, the behavioral act is a unity of serial and vertical interacting processes, with the central nervous system mediating the organism's activity relative to both internal and external milieu.

The crucial processes for explaining behavior, in this view, are, at a given moment of time, internal or psychological processes which are aspects of systemic neurological processes. These are processes about which we have relatively little knowledge. Nevertheless, it can be said that at a given moment of time the external stimulus situation and the actions of the organism have meaning only as constituted, interpreted and directed by the internal psycho-physiological processes.

The existent internal processes, in ontology, result from previous interactions of the organism with the objective world. However, the psychological processes acquire a reality of their own, even though they are correlative aspects of physiological processes, and a description of the latter is not a substitute for an understanding of the former.

The nature of the internal processes must be inferred. The process of inference, to be adequate, should rely on a number of methods. Hopefully all methods will converge in some meaningful way so as to make possible an explanation of the nature and functioning of the internal psychological processes. Useful methods will include: (1) the external behavioral method: naturalistic observation, and experimentation based on setting up stimulus situation-action contingencies; (2) experimental psychophysiological methods: the monitoring of physiological processes (GSR, vasomotor changes, heart rate, etc.) which have been experimentally associated with behavior under various conditions; and (3) neurophysiological methods: the study of the relationship of specific brain areas and structures, and their inter-relationships in conjunction with behavior. The desideratum would be the mutual congruence or translatability of the results based on any of the hypothesized processes, investigated by one method, into the vocabulary and methodology of any of the other methods of investigation.

There exists at the present time no agreed on or even adumbrated scheme for the structure (in the sense discussed above) of the verbally initiated behavioral act. The conception which follows has been put together from various sources, and is necessarily tentative and provisional.

The behavioral act may be divided into four parts: (1) the reception and decoding of verbal input into its meaning; (2) organizing processes required to transform meaning or understanding into a plan of behavior--into the structure of the behavioral action itself; (3) the performance of the action; and (4) termination of the action. A breakdown in any of the stages will result in a failure to achieve performance that is fully consonant with the meaning of the command.

The factors that can affect any of the four above mentioned stages of the behavioral act may be divided into linguistic, attentional, and motor factors. Linguistic factors, semantic and syntactic, operate in the first stage. Motor factors come into play in the execution of the "plan of behavior," in the third stage. Attentional factors, which include memory processes, operate across all four stages.

Stages of the verbally initiated behavioral act

Stage 1. Attentive processes first of all affect to what extent the full verbal input is attended to, and what is distinguished or perceived in the verbal input. It is hard to conceive of either semantic or syntactic competence in the perception of a novel sentence apart from these attentional processes. The attentional processes are the form (mechanism) by which competence (semantic and syntactic knowledge) is employed, and the operation of the attentional processes of the first stage is the decoding of the command.

There is experimental evidence that sentences are perceived as wholes in a way which is determined by their syntactic structure. At the same time the linguistic input is received in serial order so that, at various nodes of sentence surface structure, tentative hypotheses of the nature of the structure of the sentence as a whole are made. The requirements for these two types of psychological operations suggest the almost simultaneous operation of Luria's serial and simultaneous modes of information processing. There is little evidence as to the precise nature of the decoding processes. There is evidence, and there are theories, about the brain structures which are involved (Jakobson, 1966; Luria, 1966a).

The decoding of the sentence results in what can be described (by adults at least) as a subjective consciousness of its "meaning." It may be that the decoding process is simultaneously an encoding process by the hearer. That is, the process of arriving at the sentence's meaning by the hearer may involve either (1) a sub-vocal shadowing of the speaker's words, or (2) alternatively, the activation of central auditory-articulatory connections which are triggered by the perception of the phonological string (Sokolov, 1967), without necessarily producing peripheral articulatory movements.

In the effort to determine experimentally whether the young child has decoded the sentence (i.e. understood its meaning), there is a practical problem of determining whether and in what sense the sentence is in fact "understood." The adult's ability to confirm his understanding of a sentence, while not infallible, is one important type of evidence that he comprehends or understands the verbal input.

The young child is not yet expert at giving accurate introspective reports on whether or how he (or she) has understood the meaning of a sentence. His ability to repeat the sentence, for example, does not necessarily require that it has been processed through the meaning system (Brown, Fraser, and Bellugi, 1963). Thus, with very young children, one must fall back ultimately on some kind of performance as the criterion of understanding. However this criterion must be qualified by taking into consideration whatever other factors are operating in a given experimental situation.

The approach taken in this thesis is that only the understood sentence as a whole directs and regulates complex behavior in conformity with its meaning. Three assumptions are made about the child's ability to decode novel sentences, such as those used in the present experiment.

(1) The child has never before heard the command or instruction, but his knowledge of vocabulary and syntax are adequate for an understanding of the meaning of the new sentence.

(2) The child has never before performed the behavioral act which the sentence directs, but the nature of the component physical actions is such that they already exist or potentially exist in his perceptual and motor repertoire, and that particular sequences, combinations and timing (although novel) are within the existing perceptuo-motor abilities of the child.

(3) Within the limits of understanding the command's meaning, and the ability to perform the component motor acts, only one reception of the verbal input is required for the production of entirely novel behavior, i.e. novel behavior may be organized, directed, regulated and terminated correctly on its initial performance, a form of one-trial and relatively "instantaneous" learning.

Stage 2. Forming a plan of behavior consonant with the meaning of the command requires the continued adequate operation of attentional factors. These include holding the command in immediate memory until the behavioral plan is constructed, keeping the several elements of the intended behavior simultaneously in a working memory (focal attention) while the plan is constructed, and then keeping the constructed plan in working memory while it regulates the course of behavior to its completion. In the case of verbally initiated behavior, at least on its first performance, the nature of these operations would suggest that they are conscious processes, i.e., they involve mental operations which the subject chooses and of which he is aware.

The plan exists as some type of neuronal mechanism which prefigures the behavior as a whole, from beginning to end (Luria, 1966a; Anokhin, 1955). Thus, the neural mechanism of the plan must be connected to all the motor and sensory areas (internal and external) required to execute it.

Stage 3. If the behavior is complex, composed of juxtaposed elements, contingencies, sequences, etc., the plan or program performs the function of guiding and regulating, i.e., keeping the behavior on track. In a practiced situation this function, accomplished by feedback signals which compare the behavior in progress with the plan, is fairly automatic. However, if changes occur in the situation in which the behavior is performed, discrepancy signals cause orienting reactions which in turn cause adjustments to take place which modify the behavior, so that it more effectively carries out the plan.

The effective regulation of the course of behavior also involves attentional processes. In terms of Neisser's division of attention into pre-attentive and focal-attentive processes, practiced behavior requires mainly pre-attentive mechanisms. The meeting of unexpected contingencies requires a shift from pre-attentive to focal-attentive processes.

The regulation of behavior under conditions of meeting varying or unexpected contingencies may be viewed also in terms of Sokolov's work (1963a) on the physiological mechanisms of the orienting reflex. The activation of active orienting and investigatory reactions increases the acuity of the receptors, and raises the arousal level of the brain, facilitating the quick establishment of new connections which reflect the new conditions.

There are probably also relatively "pure" motor factors which influence motor aspects of the execution of the behavior. Using Luria's conceptualization (1966a), these could be excitatory factors which can tend to perseverate, causing motor actions which have been performed to occur again, out of their proper sequence, as well as inhibitory factors. The inhibition of action, required for particular sub-acts, may persist and affect other sub-acts which should not be inhibited. If these hypothesized processes are operating with proper "mobility" (Luria, 1966a), both excitatory and inhibitory processes will function with full strength when required, and will give way without perseveration to the opposite process when it is required in the next sub-act of the sequential behavior.

The participation of the verbal system in the behavioral plan makes possible modifications of the original plan by and within the verbal system. This means that "immediate" adjustments in behavior may be effected as contrasted to adjustments being the resultant of prolonged trial-and-error actions. "Immediate," of course, is relative to the complexity of the plan and the magnitude of changes in conditions under which the plan operates. If the plan is sufficiently complex, or conditions drastically change, corrective trial-and-error procedures on the verbal level may also be required. Certainly the verbal system makes possible relatively immediate correction of ongoing behavior, causing it to conform to the plan or intention, greatly increasing behavioral flexibility.

Stage 4. The final stage of the complete behavioral act is the termination of the act once it has fulfilled all aspects of the plan. Termination of behavior as a function of its antecedent program is based on the results of the action. Feedback from the organism's periphery and internal milieu are matched with the intention or plan. A match causes the behavior to end. Otherwise a given behavior once begun, would tend to perseverate. This happens in cases of certain types of pathology and in some of the actions of young children.

The concentrated and unified activity of the whole brain, which has been guiding the behavioral act, is "released" when results match intention. Now the brain is ready to be taken over by a new program (either externally or internally initiated) for a new sequence of behavior of greater or lesser duration.

Before completing this sketch of the basic scheme of the organization of the verbally initiated behavioral act, a few additional suggestions will be made about attentional processes which operate in some form over all stages of the behavioral act. Attention is one of those global terms with many different, and in some cases, imprecise meanings. Four types of attentional mechanisms will be suggested from among various conceptions of attentional factors that could be described. Deficiencies in any of these mechanisms in very young children, due to insufficient neurological maturation, would impair the child's ability to perceive and execute verbal instructions.

Attentional Processes

The first type of attentional process involves the ability to hold a command in immediate memory long enough for it to be used to guide the organization of the structure of the behavioral action to follow.

Gardner (1966) discusses another type of attentional mechanism, the "capacity to maintain an effectively consistent level of attentional intensity." A deficiency in this parameter of attention is expressed as a waxing and waning of attention (Rosvold, 1956). Gardner suggests that "phasic surges of attentional intensity may be somewhat longer in duration than the apparently momentary limitations of attention span."[2]

The momentary span of attention is another postulated attentional mechanism. It is the ability to maintain a number of ideational materials in consciousness at one time. This ability is prerequisite to being able to manipulate ideas in various combinations and relationships. If two or three ideas are required to be kept in mind at the moment, "one or more of them may suddenly 'disappear' from consciousness..." when there is a deficit in this type of attention. This then makes it particularly difficult for the child to deal with relationships among several ideas.

The selective factor in attention is yet another hypothesized mechanism. It involves the capacity to distinguish the essential from the nonessential and, according to Gardner (1965), involves sensory feedback mechanisms that reach the cortex via the reticular formation.

Little or nothing is known about the time of appearance in ontogenesis of these various attentional processes based on maturational aspects of development. It is clear that a maturational deficit in any of these attentional mechanisms in very young children would affect in various ways the hypothesized stages of the complete behavioral act discussed earlier.

The author's scheme of the behavioral act is particularly indebted to Anokhin's analysis of the structure of behavior (1956), which Anokhin postulates as applicable to higher animals as well as man. The input with animals is, of course, sensory, especially visuo-spatial stimulus configurations, rather than verbal.

The great difference between behavioral acts of which man is capable, and those of animals, is the purposefulness and flexibility of human behavior. In great part this derives from the existence and participation of the verbal system in initiating, forming and executing plans of behavior. In human behavior, orienting factors which perform crucial functions at all stages of the behavioral act come under verbal control.

The verbal control of orienting acts may be regarded as an operationalization, in psycho-physiological terms, of the concept of consciousness. The verbal system makes possible the control of such orienting actions as: the rapid and extensive surveying and investigation of the factors operating in any complex stimulus situation; the adopting of "hypotheses" and strategies; the formulating of plans, checking their execution, and bringing them to a conclusion.

The verbal system is not able to play its organizing and regulating role in optimal form, however, until it has matured sufficiently in all of its many-sided inter-related aspects. The maturation and use of its regulatory function takes its first big steps at the early preschool age, from 2-4. At this age, however, verbal direction and regulation of behavior exists as yet in incomplete form. It is to an investigation of some of the linguistic and other psychological factors that are involved in this developmental process that the present experimental investigation is addressed.

Chapter V

The Relationship of the Comprehension of Sentences to Their Complexity

Some aspects of the problem of the verbal control of behavior are dealt with in psycholinguistic experiments with young children, which investigate the comprehension of sentences as related to their transformational complexity. Those studies that are pertinent to the present investigation are reviewed in this chapter. They will be examined under the following headings: (1) the relative difficulty of understanding (comprehending) a sentence and of creatively producing it; (2) age correlations on the length of sentences understood and produced; (3) classificatory approaches to sentence complexity and age-correlations.

1. The relative difficulty of comprehending and producing sentences

Fraser, Bellugi and Brown (1963) studied the relationship between sentence imitation, comprehension and production with twelve 3-year-old children. *Ss* were tested by presenting them with ten sentence pairs which employ grammatical contrasts. "The deer is running" vs. "The deer are running" is an example of a sentence pair used to test the child's knowledge of pluralization.

The criterion of comprehension was the child's ability to point to a picture which depicted correctly the meaning of each of the contrasting sentences. Imitation was operationalized as the child's ability to repeat the senctence correctly after the experimenter. Creative production of the respective sentences was tested by showing the child the appropriate picture and having him produce the sentence in the contrasting pair that described the picture. Fraser, Bellugi and Brown's findings were that creative production was "less advanced than understanding in 3-year-old children," i.e., fewer children could perform the production than the comprehension task. Across all sentence pairs, representing various levels of complexity, they found that imitation was easier than comprehension and that comprehension was easier than production. A pretest of children 4-years or older had shown them able to perform accurately on all three tasks for most of the sentence pairs presented.

Selecting sentences of the appropriate level of syntactic and semantic difficulty for the age level was, therefore, crucial in illustrating the progression in performance from easiest to most difficult of the three tasks. Thus, their experiment also provides data on levels of complexity based on the types of transformations in the sentences imitated, understood, and produced at the 3-4 age level, and this data will be noted under the third topic of this chapter.

2. Age-correlations on length of sentences understood and produced

Brown and Bellugi (1964) state that "By the age of 36 months some children are so advanced in the construction process as to produce all the major varieties of English simple sentences up to a length of ten or eleven words." The children to which this observation applied, were, as a group, obviously more advantaged than the average child and perhaps more gifted.

The average length of sentence which Fraser, Bellugi and Brown (1963) used in their study was six words, yet the ability of children of 3-4 years to comprehend these relatively short sentences or produce equivalent sentences varied greatly, indicating that factors other than the word-length of sentences were involved in these tasks.

Templin (1957) found the following mean number of words per productive utterance in children from 3-4 1/2:

Table 1

Age	Mean words per response	Mean no. of words in five longest remarks
3	4.1	7.89
3 1/2	4.7	9.06
4	5.4	10.51
4 1/2	5.4	10.76

If one applies the hypothesis that comprehension leads creative production in the child's learning to use language, and if one takes the longest remarks as the criterion of the child's competence for production, then sentences somewhat in excess of eight to eleven words for the 3-4 1/2 age level should be comprehensible insofar as the factor of length alone is concerned.

3. Classificatory approaches to sentence complexity and age correlations

There are two principle types of classification of sentence complexity in studies on language acquisition. One is based on traditional grammatical classifications. The other is based on the more recent Chomskyian transformational linguistics. In the Templin study (1957) the former is used; in more recent psycholinguistic studies the Chomskyian criteria are used by most investigators.

Templin (1957) found that very young children use many incomplete sentences and sentence fragments, but that these decrease rapidly between the ages of 3 and 6. During this same age period the use of complete sentences of various types increases.

Templin classifies complete sentences into five structural categories: (1) simple sentences without phrase; (2) simple sentences with phrase; (3) complex sentences, which have one main clause and one subordinate clause;

(4) compound sentences (with two independent clauses); (5) elaborated sentences of three types. An elaborated sentence may be (a) a simple sentence with two or more phrases, or compound subject, or predicate and phrase; (b) a complex sentence with more than two independent clauses; or with a phrase or phrases; (c) a compound sentence with more than two independent clauses, or with a subordinate clause or phrase. A number of the categories are specified in more detail as to the kinds of clauses and the compounding of subject and predicate. Templin also classified sentences according to their functional use as declarative, imperative, interrogative and exclamatory.

The Templin studies showed that the order of difficulty of the different structural sentence types for 3-4 1/2-year-olds to be (from easiest to most difficult): simple without phrase, simple with phrase, compound and complex, and, elaborated. The latter two types are almost identical in percentage of use in this age range. Templin also found that the use of all types reached approximately the same levels at age 6 except compound and complex, which continued to increase in percentage of use to age 8. In addition to these findings, she found that for the functional types "...the declarative sentence is the most common, interrogative next, and the other types are infrequently used."

The classificatory schemes used by most recent psycholinguist investigators have been based on the Chomskyian distinction between surface and base structure. The simplest surface structure sentences are called "kernel" sentences. They are simple active declarative sentences in the present tense. In Chomskyian grammar even these are considered to involve minimum obligatory transformations on base structure kernel phrase-markers. All other surface structure sentences (i.e. non-kernel) result from various types of transformations performed on more than one base structure phrase-marker.

Children in Menyuk's study (1963a) were tested on 27 different types of Chomskyian transformations. Menyuk's list of these transformations as well as a sentence which exemplifies each one, taken from preschool children's own productive speech, is reproduced in Appendix I. Some of the simplest of the transformations include: negative, question, contraction, inversion, relative question, imperative, separation, and got.

The primary concern of the psycholinguistic studies has been to establish the thesis that young children comprehend and creatively produce language on the basis of grammatical rules. These grammatical rules are organized in a hierarchical structure. It is hypothesized that the rules the children use coincide, to some degree, with the structured rules of Chomskyian grammar. Sentence complexity for young children is thus presumed to be related to the various types of transformations they contain and to the number of these transformations.

In Menyuk's (1963b) study of the ability of children to repeat sentences containing various grammatical transformations, she found that "length of the sentence is not critical in determining the success of repetition even for children as young as 3 years." She concludes that "the differences in the ability of children to repeat the various sentences seems to be dependent on the particular rules used to generate these sentences rather than sentence length."

The number and level of transformations may be determined a priori from Chomskyian linguistic rules. The qualitative differences in difficulty between individual transformations, however, apparently can only be determined empirically. Thus, in the last analysis, linguistic factors are dependent on more general cognitive and psychological factors.

In Menyuk's (1963a) study which compared the use of transormations by nursery school children (mean age 3;8) and first grade children, she found that ten of the fourteen simple transformations (i.e., those based on kernel sentences) were used by almost all of the nursery school age children. Simple transformations that proved difficult for these children were the passive ("He was tied up by the man"), pronominalization ("There isn't any more"), and the use of the auxiliary have ("I've got a book").

Of twelve general transformations (i.e., derived from two or more phrase structure strings) half proved difficult for the nursery school children. These were: the conditional ("I'll give it to you if you need it"), so ("He saw him so he hit him"), the causal ("He won't eat the grass because they will cry"), the participial complement ("I like singing"), iteration ("You have to clean clothes to make them clean"), and nominalization ("She does the shopping and cooking and baking").

The difficult simple transformations were produced by between 40 and 60 percent of the children, whereas the difficult general transformations were produced by only 25 to 40 percent of the children.

Slobin (1966) investigated whether or not Chomsky's syntactic competence model would correctly predict which sentences were simpler and which were more complex. Slobin used as a criterion of the children's understanding of sentences their ability to verify whether the sentence, which was spoken by E in connection with a picture depicting the sentence's meaning, was true or false. The children's reaction time for evaluating the different sentence types (i.e., containing different transformations) was used as the measure of whether the sentence was simple or more complex.

Four grammatical types were used: kernel, passive, negative, and passive negative. Semantic and pragmatic variables were introduced into the experimental situation by making some of the pictures to which the sentences applied reversible (the object of action could also serve as the subject) and others nonreversible (the object of action could not serve as the subject).

Slobin found that "Chomsky's syntactic competence model correctly predicted that passives would take more time to evaluate than kernels, and passive negatives more time than negatives." However, contrary to predictions based on Chomsky's model, syntactically simple negatives took more time than relatively more complex passives.

Slobin attributed this finding to semantic and psychological (as contrasted to linguistic) factors (e.g. the difficulty of making positive or negative evaluations of negative sentences). He also found that whether the pictured action situations presented to the child were reversible or nonreversible "largely washed out the difference in syntactic complexity between active and passive sentences, making passives about as easy as kernels, and passive negatives about as easy as negatives." Slobin concluded: "All of the factors considered--syntactic, semantic, and pragmatic --are important in accounting for the performance of Ss as young as 6."

Fraser, Bellugi and Brown (1963), in the study referred to earlier in this chaper (p. 46) found an order of difficulty among the sentence pairs for children 3-4 across the three tasks of imitation, comprehension, and production. The children had to relate sentence pairs, involving one transformation (i.e., one of the sentences of the pair used the transformation, one did not), to pictures depicting the sentence's meaning. The order of difficulty of the transformations, starting with the easiest and progressing to the most difficult, were: affirmative, plural of third person possessive pronoun, object in active voice, future tense, plural marked by <u>are</u>, past tense, count noun, plural marked by inflections, object in passive voice, and indirect object.

Fraser, Bellugi and Brown attributed the relative difficulty of sentences using different transformations to the following factors: nature of the sentence's embeddedness, its familiarity, its number of redundant features, its total length, the "perceptual obviousness" of the syntactic structures it contains, and the frequency with which a syntactic structure has been heard.

Turner and Rommetveit (1967) tested five age groups from nursery school (4.2 years) to third grade (9 years) for their ability to imitate, comprehend and produce active and passive sentences and reversible and non-reversible sentences. They found the same order of difficulty for the three tasks as had been found previously by Fraser, Bellugi and Brown. The performance of the nursery school group on the sentence types was similar to that of the older children. That is, active-voice sentences were easier than passive-voice sentences, and non-reversible sentences were easier than reversible sentences. The order of difficulty as among the four types of sentences was found to be: non-reversible active < reversible active < non-reversible passive < reversible passive.

Two assumptions had been made prior to the experiment as criteria of sentence complexity by Turner and Rommetveit. They were that any word order deviating from actor-action-acted upon (subject-verb-object) is more complex (as for example the passive) because it "places an additional load on processing." Also, "a reversible sentence (R) is considered to be more complex because correct and accurate processing involves dealing with the additional information of what is the actor and what is acted-upon." Thus, "within a given verb tense the simplest possible type of sentence is one with (a) basic actor-action-acted-upon word order and (b) non-reversible elements." Their study showed, however, that the effect of sentence voice was stronger than the effect of sentence reversibility.

Thus, there is empirical support for the existence of age differences in the ability of children to deal with sentences based on both the Templin and the transformational psycholinguistic classificatory schemes. The

Templin classification, however, does not afford the possibility of rank-ordering sentence complexity *a priori* across gross categories (such as complex vs. differentiated). Rank-ordering is further complicated by the maintenance of two parallel classifications: structural and functional. The hierarchically arranged base phrase-marker of Chomskyian linguistics, by contrast, with its exactly specified structural and transformational rules, makes it possible to rank-order individual sentences on grounds of syntactic complexity. Some of the above reviewed studies [Fraser, Brown and Bellugi (1963) and Slobin (1966)] show, however, that in addition to linguistic processing factors, other psychological processes play a role in children's pragmatic use of language.

Chapter VI

An Experimental Study of Linguistic and Other Psychological Factors in the Regulation of Behavior in Very Young Children

1. Introduction--Studies on the Verbal Regulation of Behavior

Luria and co-workers (Luria, 1967) first established that the ability of commands with complex syntactic structure to control (organize and regulate) behavior increases with age and does not become relatively effective until between the ages of 4 and 6. This developmental age trend has been supported by findings in experiments by Beiswenger (1968), Birch (1966), and Jarvis (1968). The common meeting ground in these various experimental approaches was the behavioral operationalization of "control" as the correspondence of the behavioral action with the content of the command addressed to the child. However, the experiments by the American psychologists listed above were concerned, in each case, with a limited specific aspect of the conception of "verbal control." They also did not necessarily agree with Luria's model of verbal control.

Beiswenger's Ss were first tested on their ability to perform a complex command which made the behavior (a lever press) conditional on which of two lights flashed: "When the red light flashes, don't push down. When the green light flashes, push down." Then the significance of the two signals was reversed in a new command to the child: "This time, when the red light flashes, push down, but when the green light flashes, don't push down."

Ninety-six percent of all Ss between the ages of 5 1/2 and 6 1/2 were able to perform the initial command correctly, as contrasted to 59 percent for Ss between the ages of 3 1/2 and 4 1/2. In addition, those Ss who were able to perform the complex command also were able to reverse their responses to conform to the change in significance of the colored lights, immediately and without errors. Thus, by the age of 5-6 the verbal command not only organized and regulated behavior but also made possible a flexibility of response dependent on an "instantaneously" established change in the meaning of a conditional signal, rather than the subject having to learn the signal's changed meanings from overt behavioral experience.

Jarvis (1968) was concerned whether, with Ss from 47 to 81 months of age, using an externally spoken word, "Push," or "Don't push," differentially strengthened overt and inhibitory responses made to different color light flashes which had been verbally designated as positive ("Push") or negative ("Don't push"). A control group was told to use no speech when performing in response to either stimulus. Jarvis found no differences within this age span among the different conditions, although the number of errors across Ss declined with increasing age in all groups. He interpreted his result as conflicting with Luria's claim that the child's own use of external speech (prior to its internalization) helped him more on positive than on negative conditional signals.

Birch (1966) was interested in how long a command which a child understood was able to control his behavior, i.e., cause it to persist, and whether or not the repetition of the command at intervals would tend to sustain the effectiveness of the command's control of the Ss behavior.

Birch also found an age difference in children from 3-7 in the initial and persisting effectiveness of the command "with the older children performing more proficiently than the younger." He also found that if the content of the command was verbally transferred to a non-verbal stimulus (a buzzer), the buzzer initially maintained the behavior instigated by the command for all children, but with repetitions, the buzzer lost its effectiveness as a stimulus for the younger Ss. Birch says of these results that "These relations between the effectiveness of verbal control and age agree with the findings of Luria (1961) on the same topic and emphasize again the importance of the years about 3-5 in the development of the child's verbal skills."

Luria's theory of the verbal control of behavior is a complex and ramified one (Beiswenger, 1968) and uses explanatory concepts from linguistics and neurophysiology to account for the various stages through which verbal control passes before it becomes operationally capable of eliciting behavior which corresponds to the content of complex commands. However these explanations mainly center around weaknesses in the "mobility" of hypothesized excitatory and inhibitory processes in motor cortex, and the ability of speech levels of cortical organization to control the flexible succession of these processes.

Luria makes passing reference to linguistic factors in these reports. Contrasting the ability of the 3-year-old to obey a "complex command" with the inability of the 2-year-old to do the same, Luria describes the required complex behavior as dependent on a sentence where a "relation, a synthesis of words" has become crucial, as contrasted to sentences where the content words can be directly associated with the corresponding behavior without the need for syntactic analysis and synthesis by the child. However, in these reports Luria does not concern himself with the stage-by-stage effects of syntactic factors which become operative as the child begins to be able to perform complex behavior in response to complex commands. He also does not explicitly discuss attentional processes which are probably operative across all stages of the behavioral action starting with the verbal input. Finally, Luria reports on but one paradigm, the conditional sentence, used to designate positive and negative conditional signals, as the instigator of behavior patterns of excitatory and inhibitory responses.

2. The present experiment

The present experiment was undertaken with the aim of probing more deeply into the linguistic and psychological factors which operate in the verbal organization and regulation of behavior when children first begin to encounter complex commands. The experimental design was based on the following four general considerations:

(1) Two sets of complex sentences were constructed as shown in Table 2.

Table 2

Set I Sentence Packages

1. Get a blue marble out of the box and put it in the dish.

2. (1) Get a yellow marble out of the box and put it in the dish.
   (2) Get a blue marble out of the box and put it in the dish.

3. Every time the blue light comes on, get a blue marble and put it in the dish.

4. (1) When the blue light comes one, get a blue marble and put it in the dish.
   (2) When the yellow light comes on, get a yellow marble and put it in the dish.

5. Every time the blue light comes on, get a blue marble and put it in the dish, and every time the yellow light comes on, get a yellow marble and put it in the dish.

6. (1) Get a blue marble out of the box and put it in the dish.
   (2) Don't get a blue marble and don't put it in the dish.

7. (1) Get a blue marble and put it in the dish.
   (2) Don't get a marble and don't put it in the dish.
   (3) Get a yellow marble and put it in the dish.

8. (1) When the blue light comes on, get a blue marble and put it in the dish.
   (2) When the white light comes on, don't get a marble and don't put it in the dish.
   (3) When the yellow light comes on, get a yellow marble and put it in the dish.

9. Every time the blue light comes on, get a blue marble and put it in the dish, and every time the white light comes on, don't get a marble and don't put it in the dish.

Set II Sentence Packages

10. (1) Touch the spoon with your finger.
    (2) Touch the toothbrush with your finger.
    (3) Touch the pencil with your finger.

11. (1) With the spoon touch the toothbrush.
    (2) With the toothbrush touch the pencil.
    (3) With the pencil touch the spoon.
    (4) With the toothbrush touch the spoon.
    (5) With the pencil touch the toothbrush.
    (6) With the spoon touch the pencil.

12. (1) Get the spoon and touch the toothbrush with it.
    (2) Get the toothbrush and touch the pencil with it.
    (3) Get the pencil and touch the spoon with it.
    (4) Get the toothbrush and touch the spoon with it.
    (5) Get the pencil and touch the toothbrush with it.
    (6) Get the spoon and touch the pencil with it.

13. (1) Touch the spoon with the toothbrush.
    (2) Touch the toothbrush with the pencil.
    (3) Touch the pencil with the spoon.
    (4) Touch the toothbrush with the spoon.
    (5) Touch the pencil with the toothbrush.
    (6) Touch the spoon with the pencil.

The two sets presumably involve different types of psychological operations. This makes possible a comparison of age trends in verbal control between two different types of complex commands, "conditional" vs. "instrumental."

(2) The motor task on the Set I commands (see Table 2) was changed from squeezing a bulb or balloon (Luria's paradigm) to the performance of a gross motor activity, i.e., removing a marble from a box and placing it in a nearby dish, to see whether the nature of the motor task played a role.

(3) Set I commands were constructed to represent nine gradations in behavioral complexity, with all commands using as a minimum the same two kernel sentences, i.e., "Get a blue marble out of the box," and "Put the blue marble in the dish."

(4) The commands of Set II were constructed to represent the same kernel sentence in four forms that had only minor syntactic variations.

The syntactic variations used in both sets I and II were constructed with a view to ascertaining the role which linguistic factors of a complex command played in the control of the ensuing behavior. The differences in the behavioral actions instigated by the commands of Sets I and II were designed to help ascertain psychological factors operative in the verbal control of the respective behaviors.

The following more specific considerations were involved in the construction of Set I commands:

(1) Commands 1, 3, 5 and 9 were given and scored individually, while the others were given in pairs (SPs 2 and 6) or triplets (SPs 4 and 8), and scored as a unit. All commands, whether administered individually or grouped, are called a sentence package (SP) for this discussion.

(2) The reason for giving SPs rather than individual commands to Ss in the case of the simpler commands was so that the more differentiated commands (5 and 9), which include the simpler ones as components, would have had each component performed an equal number of times prior to the child's performance on the differentiated command.

(3) SPs 1 through 5 are all affirmative commands, with SPs 3, 4 and 5 being, in addition, conditional. All SPs, 6 through 9, include a negative component, with SPs 8 and 9 also being, in addition, conditional. SPs 5 and 9 are both double-complex sentences. The differences between them are that in the case of SP 5 the two conditional signals and actions are posi-

tive, whereas in the case of SP 9 one signal and action is positive (overt) and the other negative (inhibitory).

The following specific considerations were involved in the construction of Set II commands:

(1) All commands are of approximately the same length (three have six words, one has nine). This length is well within the processing limits established by empirical findings for children within this age range (Templin, 1957), in contrast to the length of some of the sentences in Set I.

(2) The syntactic variations between the four types of commands are very small as compared with those of sentences in Set I.

(3) The structure of the behavior instigated by Set II commands is identical in each case, and consists of an instrumental action ("Get the spoon," or "With the spoon") which is used to accomplish a target action ("Touch the pencil"). Inasmuch as all the commands of Set II are reversible (i.e., semantically touching the spoon with the pencil is just as feasible as touching the pencil with the spoon) they were given in the indicated permutations (see Table 2) to eliminate the chance, insofar as it was possible, that the child's performance represented guessing rather than an understanding of the command.

(4) The order of instrumental and target actions in the command is the same as its order in behavior in SPs 11 and 12, and it is in reverse order to its order in behavior in commands 10 and 13.

(5) SP 10 involves using a member of the body as the instrument for performing the target action on an object in the environment, whereas in SPs 11, 12, and 13 an object in the environment is used as the instrument for performing the action on another object in the environment.

(6) The word order of SPs 10 and 13 would, on intuitive grounds, probably be the one most familiar in the child's listening experience with that

of SP 12 next, leaving SP 11 as having the word order that the child had probably heard least often.

Chomsky's transformational grammar has been used as the basis for making syntactic comparisons.

The following hypotheses were advanced:

Set I Commands

1. The most difficult commands will be those which contain a series of conditional, and particularly juxtaposed positive and negative components, i.e., SPs 3, 5, and 9. The behavior instigated by these commands is of longer duration than that required by the other commands, and it contains a greater number of individual sub-acts which must be organized into the plan of behavior. The plan of behavior must be flexible enough to allow for varying intervals of time between conditional signals, and in the case of SPs 5 and 9, to allow for the random alternation of different conditional signals which evoke sub-acts with different colored marbles.

The difficulty of these commands as compared with the other commands should hold for all Ss across age. All of the commands should show an age trend, decreasing in difficulty with increasing age. The age trend should be particularly pronounced with the most difficult commands, SPs 3, 5, and 9.

2. The order of increasing difficulty of behavioral performance by individual SPs for Set I Commands should be: non-conditional (SPs 1, 2, 6, 7; "Get a blue marble out of the box and put it in the dish") < single-action conditional (SPs 4 and 8; "When the yellow light comes on, get a yellow marble and put it in the dish") < series-action conditional (SP 3; "Every time the blue light comes on, get a blue marble and put it in the dish") < juxtaposed positive series-conditional (SP 5; "Every time the blue

light comes on, get a blue marble and put it in the dish, and every time the yellow light comes on, get a yellow marble and put it in the dish.") < juxtaposed positive-negative series-conditional (SP 9; "Every time the blue light comes on, get a blue marble and put it in the dish, and every time the white light comes on, don't get a marble and don't put it in the dish.").

This rank-ordering of difficulty is based on the same criteria mentioned under point 1. In general, conditional commands are more difficult than non-conditional, series-conditional are more difficult than single-conditional, series-conditionals with positive juxtaposed elements are more difficult than just series-conditionals and series-conditionals with negative and positive juxtaposed elements are more difficult than just series-conditionals with positive juxtaposed elements. In each case increased difficulty results from the fact that more sub-acts are involved which must be organized over a longer time span. An analysis of the syntactic difficulty of the foregoing commands also results in the same rank-ordering, with the exception that there is no syntactic difference in complexity between SP 3, and SPs 4 and 8.

Set II Commands

1. The order of difficulty should be: instrumental action performed by a member of the body (SP 10; e.g., "Touch the spoon with your finger.") < instrumental and target action performed in the same order as given in the command (SP 11; e.g., "With the spoon touch the toothbrush," and SP 12; e.g., "Get the spoon and touch the toothbrush with it.") < instrumental and target action, in the command in reverse order to their order in behavioral performance (SP 13; e.g., "Touch the spoon with the toothbrush."). An age trend on all Set II Commands was expected.

These predictions were based on:

(1) DeLaguna's thesis that behavior, involving a direct relationship between the organism's body and objects in the external world, is less mediated and therefore less complex than behavior that involves relationships between two objects both external to the organism. This is the case in SP 10 as against SPs 11 and 12.

(2) Luria's hypothesis on simultaneous processing factors would predict that verbal commands, requiring a transformation from the spatial order of actions as given in the command to the opposite spatial order in objective behavior, are more difficult than commands not requiring this psychological spatial transformation. SP 13 fits this description as against SPs 10, 11 and 12.

Syntactic analysis would predict that SP 11, which includes one extra transformation on an otherwise identical sentence (syntactically), would be the most difficult. It was expected that this factor would be superseded by the above listed psychological factors.

METHOD

Subjects

Forty-eight Ss, between the ages of 2;8 and 4;6 from the Jack and Jill Nursery School in Ann Arbor were used in the experiment. Ss were divided into three equal-sized groups of 16 Ss each, representing approximately a half year's difference in age, and with an equal number of boys and girls in each group. The mean ages of the groups were as follows: in the 3-3 1/2 group, boys' mean age was 3.2 years, girls, 3.3 years; in the 3 1/2-4 group, boys' mean age was 3.9 years, girls 3.9 years; in the 4-4 1/2 group, boys' mean age was 4.3 years, girls, 4.3 years. The socio-economic composition of the group as a whole was white upper-middle class professional. The Ss constituted most of the children attending the nursery school who were in the indicated age range at the time the experiment was conducted. There were six children in the age range in the nursery school who refused to participate in the experiment. Of the 48 Ss who participated in the study, four expressed apprehension or anxiety during the experimental sessions, and three Ss were bi-lingual and had only been speaking English consistently for approximately three months before testing took place; they were in the oldest age group. This was learned later, after the experiment was completed.

Apparatus and Materials

Ss sat at a table on which there was a stimulus display unit in the form of a kitty-cat's face, with round reflector lenses behind which there were lights in the positions of the two eyes and the nose of the kitty. The left "eye" was blue, the right "eye" yellow and the "nose" was white. A cable went from the back of the kitty stimulus display under the table and terminated on a small aluminum box with buttons for actuating the three lights. The box was held in E's right hand in order to program the light stimuli involved in SPs 3, 4, 5, 8, and 9.

The manipulanda available for the child's response consisted of a plastic box with ten blue and ten yellow marbles in it for all conditions except for SPs 1, 3, and 6, when only one of the colors was left in the box. An empty dish to receive the marbles was just to the right of the box. For the session which used SPs 10, 11, 12 and 13, the manipulanda consisted of a tray made of plywood covered with colorful upholstery fabric which was placed before the child. On the tray there were three common objects: a toothbrush, a plastic spoon, and a pencil, all of approximately the same length.

Procedure

The experiment was conducted in a room adjacent to the main playroom of the nursery school, with the door closed. Experimental conditions were not ideal, inasmuch as some of the louder noises filtered into the experimental room. Forty-four of the Ss were run between 9 and 10:30 a.m.; the remaining four between 1 and 2:00 p.m.

The experimental tasks were presented as a game with marbles and a make-believe kitty-cat that had one blue eye, one yellow eye and a white nose. The child was told that the object was to see if he could play the game by doing exactly what he was told. No positive and/or negative reinforcements in the form of objects or informational feedback were given. Each child was periodically reinforced for cooperation by E remarking approvingly that he was a "good game-player" during pauses between sets of commands. Each sentence was read by E to insure uniformity of presentation to all Ss. The programmed stimuli (light flashes) followed a random sequence, the information for which was written on the same sheet from which the questions were read to Ss.

Prior to beginning the experimental session a brief conversation was held with each child about things in which he might be interested (brothers and sisters, clothes, Halloween, Thanksgiving, etc.). Before beginning the first experimental session the child was shown the stimulus display kitty and E demonstrated that a blue light came on behind the blue eye, that a yellow light came on behind the yellow eye and a white light behind the white nose. The color of each light was emphasized intonationally during this demonstration. The child was then shown the marbles and asked to name their colors, and it was pointed out that the blue and yellow colored marbles corresponded to the blue and yellow lights. It was pointed out that the marbles were kept in the plastic box and that there was a dish next to the box. In the session that used the toothbrush, spoon, and pencil, the child was shown this array on the tray and asked to identify each object before the testing began. The performance on each SP for both groups of sentences was recorded manually by _E_ after it was made.

The length of stimulus presentation following series-conditional commands varied randomly from 3/4 second to 2 seconds. Inter-stimulus intervals ranged between 1 and 3 seconds, randomly varied. The decision to make the stimulus time parameters variable was to prevent habituation to a repetitive, monotonous series of stimuli which has an inhibiting effect (Magoun, 1963). On SP 3 there were six presentations of the stimulus. On SPs 5 and 9 there were ten presentations of the stimulus, randomly varied. SP 5 used the sequence: Y-B-Y-B-B-Y-B-Y-Y-B, and SP 9 used the sequence B-W-W-W-B-B-W-B-B-W. (Yellow was substituted for blue for half the _S_s on SP 9.)

Each SP sentence was spoken clearly and slowly enough for comprehension by children of this age. Each command in each SP was given once, then time was allowed for the child to perform the command. An exception to this rule was made for SP 1 which was given six times, with pauses and conversation between some trials. This was done to insure that this command, which was the basic component of all the commands, was understood as indicated by correct performance and that the performance was not a random one.

Each sentence type (SP) of the set of Group II sentences was reiterated in six different forms. Each form of the sentence changed the instrumental and target objects. This procedure was followed in order to insure that performance was not the result of guessing. SP 10 was an exception inasmuch as the nature of the action only permitted action with three different objects.

All Ss were given the Group I SPs in the same order, starting with SP 1 and proceeding chronologically. SPs 1, 3, 6 and 9 were counter-balanced for color, half the Ss getting blue and half yellow, inasmuch as only one of the colors was used in these SPs. Group II SPs were counterbalanced for the command that started the series for each child, with one-quarter of the Ss starting with each of the four commands and proceeding through the series in serial order from that starting point. The last task of the experiment was a control command (SP 14) for memory.

The experiment was conducted in two or three sessions, depending on the attention span of the child, in the same order for each child. Session 1 covered SPs 1 through 5; Session 2, SPs 10 through 13; and Session 3; SPs 6 through 9, and SP 14. For children with adequate attention spans, sessions 1 and 2 were combined into one session. One minimal type of assistance was given Ss. On the SPs that required a series of responses to conditional stimuli, if the child's attention strayed so that he didn't watch the lights continuously, E interjected "Watch the lights." When this happened it was noted on the child's record. This procedure made it possible to obtain data on attentional and motor errors, the bulk of which were made on these SPs.

Scoring

Performance on SPs 1 through 9 was judged to be adequate to the content of the command if the child's performance coincided with that content, with no mistakes. This apparently rigid criterion may be justified on both theoretical grounds (Beiswenger, 1968) and on empirical grounds, i.e., out of 432 performances on the nine commands by the 48 children, 312 were completely correct performances. SPs requiring E's assistance in the form of "Watch the lights," (SPs 3, 5, and 9) were scored incorrect.

Performance on SPs 11 through 13 was adjudged to be correct if there was not more than one erroneous performance in six for each sentence type. In the case of SP 10 all three performances had to be correct for the SP to be scored correct. The first six signals were scored on SPs 5 and 9.

Failure patterns on Set I SPs were categorized as either of two types: gross or minimal. Behavior patterns which resulted in little or no performance in response to the command consonant with its meaning were categorized as gross type failure patterns. One such pattern was the performance of irrelevant activity (e.g., playing with the marbles, or performing an action different from the one commanded). Another was the absence of response to the whole series of conditional signals on series-conditional commands.

Behavior patterns that generally followed the meaning of the command, but included individual errors were categorized as minimal type failure patterns. These patterns included the following types of errors: (1) failing to respond to not more than two of the series of six conditional signals; (2) making not more than two out-of-context responses in a series of six signals, i.e., responses before, between, or in the absence of the appropriate conditional signal; (3) momentary looking away from the kitty's face from which the signals were being flashed, which was corrected by the experimenter's "Watch the lights" admonition (also occurring not more than twice in a series of six conditional signals).

The types of errors made on SPs 11 through 13 were to reverse the instrumental and target objects in behavioral performance relative to their specification in the command. In addition, the three Ss who performed SP 10 incorrectly made a perseverative type error, i.e., instead of pointing to the appropriate object with their finger they took the object and touched it to the opposite hand. All three had begun the Set II SPs with an SP other than SP 10.

Results

Before presenting the statistical analysis of the age differences shown in the data, certain features of the overall results will be presented descriptively. The data will be discussed separately for Set I and Set II commands.

Overall differences--Set I

The effectiveness of Set I SPs in organizing and regulating the child's behavior, as demonstrated by correct performance, is shown in Table 3. The number of Ss performing correctly and incorrectly is given for each SP,

Table 3

Number of Ss Performing Correctly on Group I Sentences

Age	Sentence Package Number																	
	1		2		3		4		5		6		7		8		9	
	C	I	C	I	C	I	C	I	C	I	C	I	C	I	C	I	C	I
3-3 1/2	13	3	10	6	2	14	12	4	2	14	15	1	11	5	9	7	5	11
3 1/2-4	15	1	15	1	6	10	14	2	6	10	15	1	16	0	13	3	7	9
4-4 1/2	15	1	15	1	10	6	16	0	14	2	14	2	14	2	14	2	14	2
Total	43	5	40	8	18	30	42	6	22	26	44	4	41	7	36	12	26	22

broken down into the three age groups. A perusal of the data on all Ss across ages (shown in the total row) shows that six of the nine SPs (1, 2, 4, 6, 7, 8) were performed correctly by 40 or more of the total of 48 Ss. Correct performance on the other three SPs (3, 5, 9) was achieved by from 18-26 Ss, which is from 38-54 percent of all Ss. The existence of overall differences in difficulty was evaluated by chi square analysis by pooling total data over ages for the nine SPs, yielding $\chi^2(8) = 82.59$, $p < .001$. Dividing the nine SPs into two sub-sets (3, 5, 9 and 1, 2, 4, 6, 7, 8) and testing for a difference in overall difficulty by pooling total data from each subset over ages, yields a $\chi^2(1) = 114.8$, $p < .001$.

The data, displayed by sex for each age level, are given in Table 7, Appendix B. The expected frequencies are too small to make a chi square analysis of the age trend on each SP separately for boys and girls. However, an inspection of the data of Table 7 shows that the age trend and other differences are very similar for boys and girls. All subsequent statistical analyses were therefore made on the combined data of both sexes as it is shown in Table 3.

Looking down the columns for each SP, there is a clear age trend on each one (with minor discrepancies on SPs 6 and 7). The data show that the youngest Ss' performance on SPs 1, 2, 4, 6, 7, 8 is at a high level, i.e., 9-15 Ss, over half, perform correctly, whereas on SPs 3, 5, 9, the numbers who perform correctly at the youngest age are well under half, from 2-5. Thus SPs 3, 5, 9, those categorized *a priori* as the most difficult, have few correct performers at age 3-3 1/2, whereas the sub-set 1, 2, 4, 6, 7, 8, shows a substantial majority of correct performers at the youngest age. Both sub-sets, however, show a substantial majority of correct performers by age 4-4 1/2. Performance by age is plotted and shown on a bar graph, Figure 1.

Statistical Analysis of Age Differences--Set I

The statistical analysis of differences due to age was begun by computing chi square values for the data on each SP in Table 3. Significant differences due to age are found for SPs 3, 5, and 9. For SP 3, $\chi^2(2) = 8.53$, $.02 < p < .01$; for SP 5, $\chi^2(2) = 18.795$, $p < .001$; for SP 9,

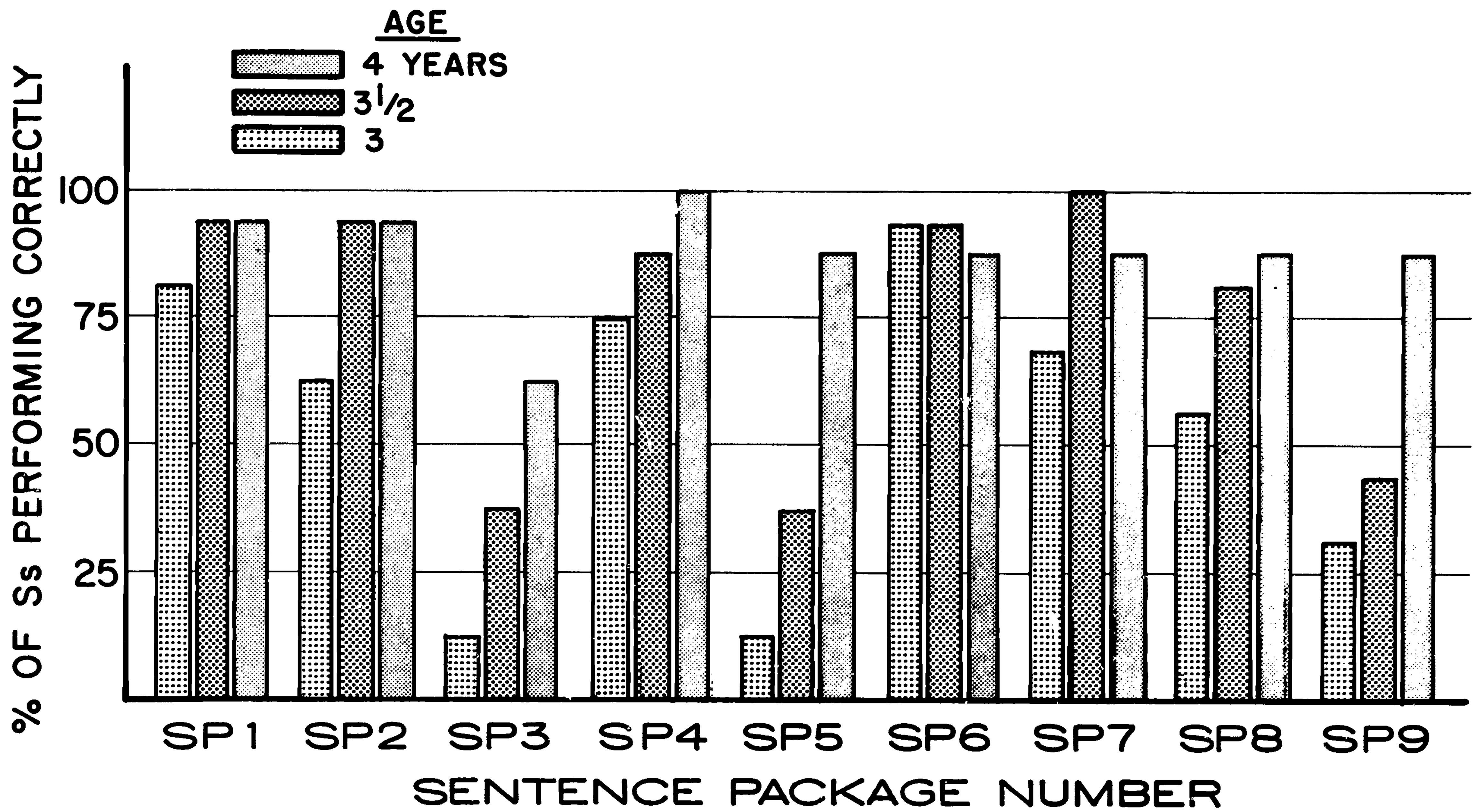

Fig. 1. Percent of Ss Performing Correctly by Age on Each Set I SP.

$\chi^2(2) = 12.43$, $.01 < p < .001$. It is not possible to compute individual chi squares on the remaining SPs because expected frequencies are too low.

A look at the data in Table 3 shows that the remaining SPs, 1, 2, 4, 6, 7, 8, contain two types of commands: non-conditional and single-conditional. By pooling the SPs of each type, two groups are formed. The group of non-conditional SPs, 1, 2, 6, 7, show a significant difference due to age, with $\chi^2(2) = 11.15$, $p < .01$. The group of single-conditional commands, SPs 4, 8, also shows a significant difference due to age, yielding $\chi^2(2) = 8.62$, $.02 < p < .01$.

The earlier examination of the data of Table 3 suggested that, while the age trend in performance is in the same direction on all SPs, correct performance on SPs 3, 5, 9, at age 3 is limited to a small number of _Ss_, but by age 4 these commands are able to regulate the behavior of most _Ss_. In contrast, correct performance on the two pooled groups of SPs regulates the behavior of most _Ss_ at age 3 and, therefore, improves only slightly by age 4-4 1/2. An interaction chi square was computed to evaluate this difference.

The total χ^2 is highly significant. It is calculated from the five categories, SP 3, SP 5, SP 9, pooled SPs 1, 2, 6, 7, and pooled SPs 4, 8, resulting in $\chi^2(10) = 59.525$, $p < .001$ (see Table 4, line 1). The pooled chi square across all five categories is also highly significant, $\chi^2(2) = 38.7$, $p < .001$ (Table 4, line 2). The interaction χ^2, found by subtracting the pooled χ^2 from the total χ^2 yields $\chi^2(8) = 21.825$, $p < .01$ (Table 4, line 3). The chi square analysis of the age differences thus far indicates that (1) the difference due to age for the individual and pooled groups of SPs is highly significant, and (2) the age-correlated differences shown for the aforementioned five categories, which have different percentages of correct performers at the youngest age and different rates of improvement, are also significant.

Table 4

Chi Square Analysis of Performance on Group I SPs by Ages

	Differences Tested	χ^2	df	p
1.	Total, all SPs--Set I. (SPs 4 & 8 pooled; SPs 1, 2, 6, 7 pooled; and 3, 5, 9.)	59.525	10	< .001
2.	Pooled, all 9 SPs	38.7	2	< .001
3.	Interaction (Total minus pooled, above)	21.825	8	< .01
4.	Total, SPs 3, 5, 9.	39.755	6	< .001
5.	Pooled, SPs 3, 5, 9.	36.4	2	< .001
6.	Interaction (Total minus pooled, above)	3.355	4	.5
7.	Total (pooled SPs 4 and 8, and pooled 1, 2, 6, 7)	19.77	4	< .001
8.	Pooled, SPs 1, 2, 6, 7, 4, 8.	18.06	2	< .001
9.	Interaction (Total minus pooled, above)	1.71	2	.5
10.	Total, Pooled 1, 2, 6, 7, 4, 8, and Pooled 3, 5, 9)	54.46	4	< .001
11.	Pooled--SPs 1, 2, 3, 4, 5, 6, 7, 8, 9.	38.7	2	< .001
12.	Interaction (Total minus pooled, above)	15.76	2	< .001

A perusal of the data of Table 3, it was noted earlier, also suggests that the nine SPs can actually be divided into two sub-sets, based on difficulty, (rather than five), with the series-conditional SPs 3, 5, 9 in one sub-set, and the remaining six SPs in the other. In order to show that the difficulty-age relationships are comparable within both sub-sets of SPs, further analysis is necessary. An interaction χ^2 was calculated for each sub-set, to establish that each sub-set is homogeneous. Then the two sub-sets were evaluated against the pooled χ^2 across the two sub-sets.

The first sub-set, SPs 3, 5, 9, was tested for homogeneity by calculating the difference between the total and pooled chi squares, to give the interaction χ^2. Total $\chi^2(6) = 39.755$, $p < .001$ (Table 4, line 4) and the pooled $\chi^2(2) = 36.4$, $p < .001$ (Table 4, line 5). The interaction $\chi^2(4) = 3.355$, $p \approx .5$, is nonsignificant, indicating that there is no reason to reject the hypothesis of homogeneity in the age-difficulty relationship for this group of SPs. The second sub-set, pooled SPs 4, 8 and pooled SPs 1, 2, 6, 7, was tested for interaction by calculating the difference between the total $\chi^2(4) = 19.77$, $p < .001$ (Table 4, line 7) and pooled $\chi^2(2) = 18.06$, $p < .001$ (Table 4, line 8), yielding the interaction $\chi^2(2) = 1.71$, $p \approx .5$ (Table 4, line 9). Thus there is no reason to reject the hypothesis of homogeneity in the age-difficulty relationship for this group of SPs either.

As a final step in the analysis of differences in correct performance due to age, the interaction between the two groups of SPs: 3, 5, 9 and 1, 2, 4, 6, 7, 8 was evaluated. A total χ^2 for these two groups yields a $\chi^2(4) = 54.46$, $p < .001$ (Table 4, line 10). Subtracting the pooled χ^2 across the two groups (previously obtained, Table 4, line 2),

$\chi^2(2) = 38.7$, $p < .001$, yields an interaction $\chi^2(2) = 15.76$, $p < .001$ (Table 4, line 12). This shows a highly significant difference between the age trends of the SPs when they are divided into sub-sets, based on their difficulty for the youngest Ss, each of which is homogeneous within itself.

Performance on Set II SPs

The data showing performance on Set II SPs are given in Table 5. The data on Set II SPs showed little difference as between age or sex, as shown in Table 8 in Appendix B. Therefore all statistical analyses were performed on the data pooled across age and sex as shown in Table 5. A look at the data shows there are three SPs on which 40-44 Ss performed correctly. Performance on SP 13 shows an almost complete reversal compared with the other three SPs, i.e., 39 Ss performed incorrectly, and only eight correctly. One Ss refused to cooperate in this phase of the experiment, which accounts for the total number of Ss as 47 rather than 48.

Table 5

Number of Ss Performing Correctly on Group II Sentences

(Summed Over Ages)

	Sentence Package Number				
	10	11	12	13	Total
Performed Correctly	44	41	40	8	133
Performed Incorrectly	3	6	7	39	55
Total	47	47	47	47	188

For Set II commands, chi square analysis shows a significant difference in Ss' performance among Set II SPs, $\chi^2(3) = 86.24$, $p < .001$. Inspection of the data in Table 4 shows that it is mainly SP 13 which accounts for the difference. Comparing SP 13 against SP 12, (the SP closest to it in results) yields a significant difference, $\chi^2(2) = 43.58$, $p < .001$.

A Set I and Set II Difference

Figure 2 combines Set I and Set II SPs into one set and rank orders them according to overall difficulty. The most difficult Set I SP is SP 3, with 38 percent of all Ss able to perform it correctly. The most difficult Set II SP is SP 13, with only 17 percent of all Ss performing it correctly. This difference is significant, $\chi^2(1) = .05 < p < .02$.

Patterns of Performance

The data shows that those Set I commands which were least able to regulate the child's behavior had these characteristics: (1) the most complex syntactic structure; (2) required simultaneous attention to a larger rather than a smaller number of conditional factors in the situation; and (3) the behavior they instigated extended over a longer rather than a shorter time period.

In an effort to gain further insight into the factors which caused the failure of the verbal regulation of behavior an analysis of errors was undertaken. The analysis was complicated, however, by the variety and seeming lack of pattern in the errors made on different SPs, and by different Ss. Moreover, errors made on different SPs, classified on the basis of an external criterion (e.g., failure to respond to a positive conditional signal) might, in fact, not be the "same" kind of error, and therefore not really comparable. That is, the failure of cognitive processing causing an error of the type just mentioned on a simple single-

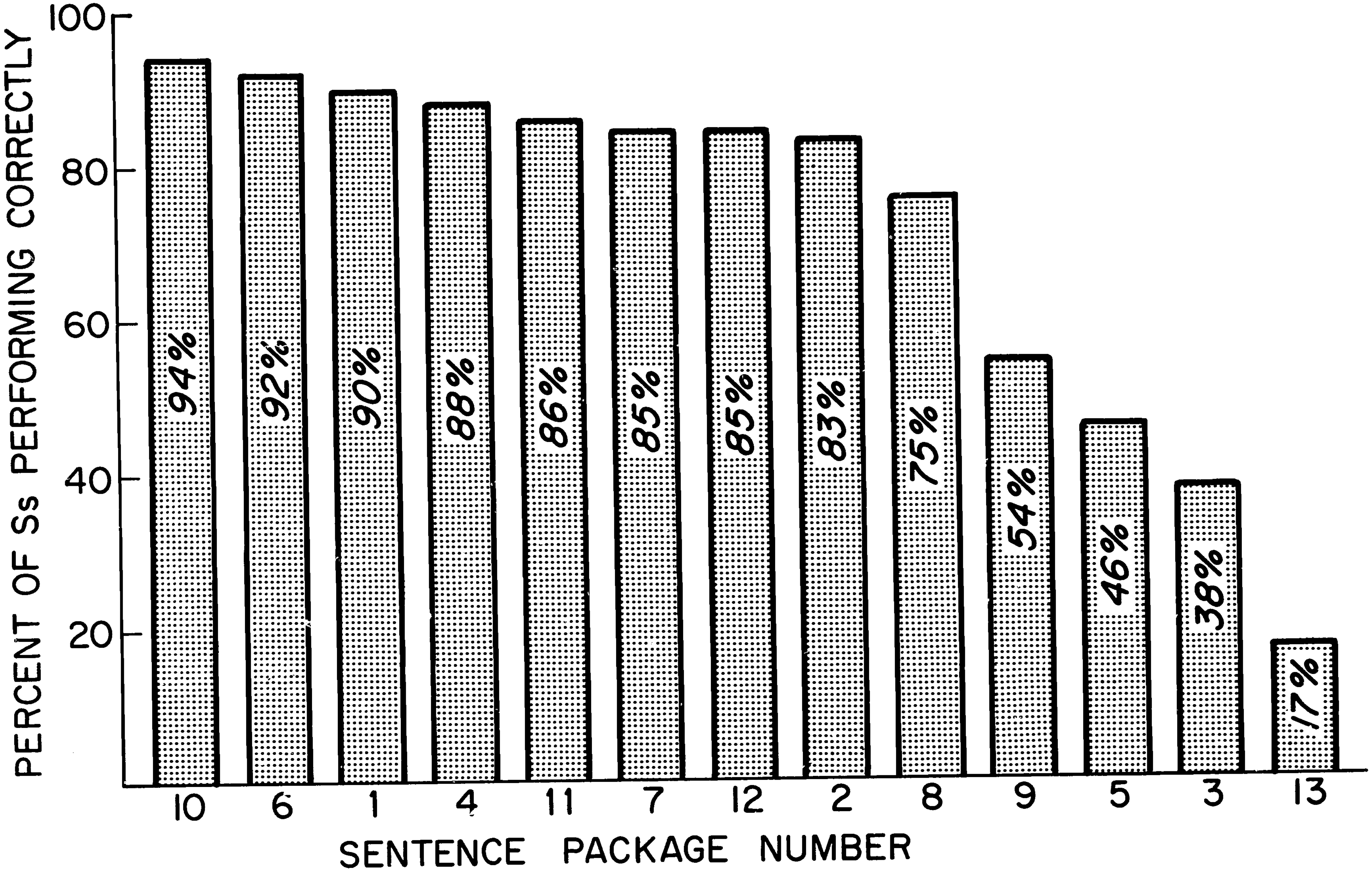

Fig. 2. Percent of <u>Ss</u> Performing Correctly Across Age on Each Set II SP.

conditional command might be of an entirely different character than the cognitive failure which causes the "same" error in response to a complex series-conditional command. Therefore, instead of categorizing error types, it was decided to characterize failure to perform correctly as a type of behavior failure pattern. One SP, SP 3, was selected for this analysis.

SP 3 was chosen for the following reasons: (1) it was the most difficult Set I command (i.e., had the most failures); (2) it came first chronologically in the sub-set of SPs 3, 5, 9 (all of which had the basic similarity in that they were series-conditional commands and were found by Ss to be the most difficult to perform); there was, thus, no opportunity for learning to have taken place on SP 3, whereas Ss' experience with SP 3 may, to some extent, have helped them when they met SPs 5 and 9; (3) the differences in performance between SPs 3, 5, 9 were not significant. Therefore performance on SP 3 could be considered representative of performance on all commands of Set I that had the characteristic of organizing behavior to a series of conditional signals.

Table 6 shows the distribution of types of behavioral failure patterns on SP 3 by age when failure is characterized as either gross or minimal. The data, when scanned, shows that at age 3, Ss are divided into

Table 6

Distribution of Behavior Failure Patterns on SP 3

Age	Gross Type Failure	Minimal Type Failure	Correct Performance	Total
3-3 1/2	7	7	2	16
3 1/2-4	6	4	6	16
4-4 1/2	3	3	10	16
Totals	16	14	18	48

three performance groups for this type of complex command: (1) those for whom the command shapes at least the basic structure of their behavior; (2) those on whose behavior the command has virtually no effect, and (3) a very small group whose behavior is effectively regulated by the command. The age trend is clear for all three performance types. The number of both failure types decreases across the 3-4 1/2 age range while the number in the correct performance group increases. Curves plotted for the three groups are shown in Figure 3.

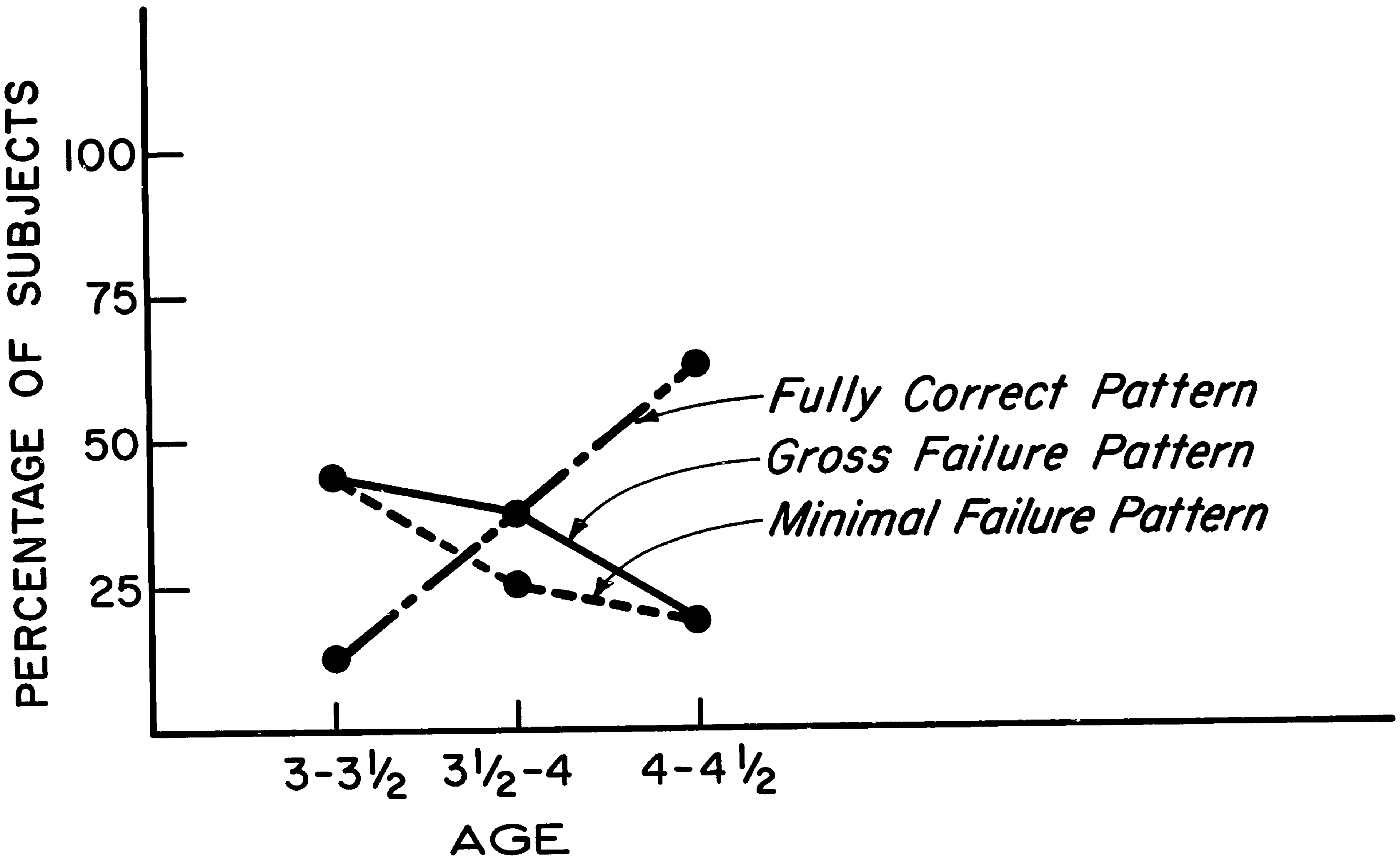

Fig. 3. Performance Patterns on SP 3 by All Ss by Age.

Chapter VII

Discussion of Results

Set I Hypotheses and Predictions

It was hypothesized that the ability of a verbal command to organize and regulate the child's behavior would decrease as a function of whether the behavior was conditional, involved a series of actions, and included responses to different positive signals or positive and negative signals. This hypothesis was confirmed. The commands least effective for regulating behavior were SPs 3, 5, and 9. SP 3 was series-conditional ("Every time the blue light comes on, get a blue marble and put it in the dish."); SP 5 was series-conditional with juxtaposed positive components ("Every time the blue light comes on, get a blue marble and put it in the dish, and every time the yellow light comes on, get a yellow marble and put it in the dish."); SP 9 was series-conditional with juxtaposed positive and negative components ("Every time the blue light comes on, get a blue marble and put it in the dish, and every time the white light comes on, don't get a marble and don't put it in the dish.").

The above prediction was based on Luria's hypothesis that the ability of a command to control complex behavior is a function of the complexity of the behavioral action which must be carried out. It could also be made based on using Chomskyian transformational grammar to make the analysis of syntactic complexity. SPs 5 and 9 are more complex syntactically than all other commands in Set I. SP 3 is more complex than SPs 1, 2, 6 and 7, and perhaps equivalent to SPs 4 and 8; it may be semantically more difficult than SPs 4 and 8 because of the words "Every time" used in SP 3 as contrasted with the conditional "When" in SPs 4 and 8. Thus, the general prediction that SPs 3, 5, and 9 (with the qualifications respecting SP 3 noted above), which are the most complex grammatically, would be least effective in organizing and regulating the behavior of children at this early stage of development, was also borne out by the results of the experiment.

A stronger form of the hypothesis was also used to predict that within the aforementioned grouping (SPs 3, 5, 9) the order of difficulty would be: series-conditional (SP 3) < juxtaposed positive series-conditional (SP 5) < juxtaposed positive and negative series-conditional (SP 9). The actual order of difficulty, as shown by the performance of the children in the experiment, was: juxtaposed positive and negative series-conditional < juxtaposed positive series-conditional < series-conditional, the opposite of what was predicted. The differences in performance among these three SPs, however, was not close to being significant. These differences can either be attributed to unknown, uncontrolled for factors, or an attempt can be made to make inferences as to possible causes. The latter course, although it involves some highly speculative assumptions, will be followed in this discussion.

Factors in the Failure of Set I Commands to Regulate Behavior

It would appear that within the design used for the present experiment, some learning was possible for some Ss as they progressed from command to command and performed the corresponding actions. All children were given the Set I SPs in the same order, and in two experimental sessions in most cases. In the first session SPs 1-5 were given (conditional and non-conditional, but affirmative) and in the second session, SPs 6-9 conditional-non-conditional, with negative components) were given. Thus, each succeeding command was built on the previous one, using it as a sub-component of the new command. The increasing order of difficulty therefore may have been offset to a small extent by an automatization of action on sub-components due to their repetition.

If learning did take place for a few Ss, due to an automatization of sub-components, it would appear to be perceptual (in the sense discussed in Chapter II, pp. 12-14) rather than response learning. The basic action, i.e., getting a blue marble out of the box and putting it into the dish, was already adequate in response to the first command of the experiment. This action formed the core sub-component of all the subsequent commands. The pattern, however, of sub-component responses for SPs 3, 5, and 9 was entirely novel. Novelty in the case of SP 3 was in the number and timing of the conditional signals requiring the designated response. For SPs 5 and 9, number and timing, plus the random appearance of differing conditional signals, including (in the case of SP 9) negative signals, were the novel elements. There was, thus, no possibility of a prior automatization of the entire response pattern in the three series-conditional commands. Each signal of the series presented to the child required a choice based on a plan of behavior. However, the impossibility of automatization of the response pattern of SPs 5 and 9 does not apply to the sub-components.

The sub-components for SP 9, for example, are "Every time the white light comes on, don't get a marble and don't put it in the dish," and "Every time the blue light comes on, get a blue marble and put it in the dish." The basic kernel of each had been performed before, in SP 8. Sub-components of the two foregoing sub-components had also, in turn, been performed before their use in SP 8, viz., "Get a blue marble and put it in the dish" had been performed in SPs 1, 6, and 7.

Thus, by the time the child was given SPs 5 and 9 to perform, we have a situation described by DeLaguna in the opening paragraph of this dissertation: "the behavior system falls, not into distinct units of response, functionally complete, but into independently variable factors, functionally incomplete, which may be performed independently..." If those Ss who improved their performance between SP 3 and SP 9 were able to do so because the automatization of their perception of one or more sub-components of the more complex command enabled them to process the longer and more complicated command more easily, this learning would tend to counteract the increase in difficulty of the behavior instigated by the more complex command.

This argument must be speculative of course. The experiment was not designed to bring out this effect, and the differences are not significant. The differences between SPs 3, 5, and 9 may have been due to some other, unspecified, uncontrolled for factors. If something of the nature indicated in the preceding discussion did in fact take place, it would lend support to the concept that perceptual learning is particularly important in the acquisition and use of language, in accord with ideas derived by the author from Sokolov and Neisser.

A second interesting difference between the results reported by Luria and those derived from the present experiment is related to the role of negative components in series-conditional commands. In studies reported by Luria (1967) and Beiswenger (1968) it was found that the ability to perform a command of the type of SP 9 was not attained by most Ss until between 5-6 years of age. However, a majority of Ss in the present experiment who were in the oldest group (mean age 4.3 years) were able to perform this command. Luria has emphasized in his various reports the difficulty for children of 3-4 to inhibit a response to an inhibitory signal when presented in the context of randomly mixed excitatory and inhibitory signals. Two factors may account for these results, which differ from those reported by Luria.

(1) Luria's experimental task required the squeezing or withholding of a squeeze on an inflated balloon or bulb held in the child's hand. This task is apparently a very sensitive indicator of the mobility of excitatory and inhibitory processes in the kinesthetic representation of the motoranalyzer; and thus is more likely to be sensitive to maturational weaknesses in the mobility of these processes. The task used in the present experiment, by contrast, was a gross motor task--removing a marble from a box and placing it in an adjacent dish. The tendency for excitatory processes to spread to and overcome inhibitory points may not be as likely in the cortical constellations that control gross motor actions as they are when finger and hand kinesthesis is extensively involved.

(2) Luria's Ss, who received the juxtaposed positive and negative series-conditional command, appear to have heard it in its entirety for the first time, rather than having had two previous trials on which the inhibitory component of the total behavioral action was performed by itself and was thus possibly automatized to some degree (see previous discussion).

If these indeed are the reasons it would show how important it is, in interpreting experiments of this kind, to supplement a description of the gross behavioral characteristics of a response with a more precisely defined characterization, based on correlate neurophysiological knowledge when this is available (e.g., a gross motor action vs. one with largely kinesthetic components). It also shows that it is important in verbal control experiments for the experimenter to be aware of possible learning which can result from familiarization procedures or order of performance, in the case of a series of related commands.

It should also be noted that the order of difficulty within the subset of the most complex commands also was not predicted by the grammatical complexity of the commands. Whatever the psychological processes were which reversed the order of difficulty from that predicted (i.e., those discussed above or others), they superseded the factor of sentence syntactic complexity in the present experimental situation.

Syntactic complexity of the command also failed to predict the difference in performance between SP 3 and SPs 4 and 8. SP 3 is simpler syntactically, or certainly no more complex, than the commands of SPs 4 and 8.

Yet the differences in performance between SP 3 and either of the other SPs is very significant ($< .001$). Here again, the complexity of the behavioral action itself, and thus the complexity of the psychological processes required to organize and regulate it, are the determining factors. In many cases the complexity of the behavioral action is faithfully mirrored in the syntactic complexity of the command. But it need not be, and proved not to be in this phase of the present experiment.

Analysis of SP 3 Maximal Failures

An analysis of failures by Ss to perform correctly on SP 3 may also be examined for clues as to the processes operating in the verbal regulation of behavior. Of the 3-3 1/2-year-olds, 14 of 16 Ss had either gross or minimal type failures. Seven Ss were in each category. The numbers and rate of decline in the number of Ss failing both ways were a function of increasing age and were the same for both categories, while the number of Ss making no errors steadily increased as age increased (see Figure 3). Of all 48 Ss, across ages, 16 had a gross failure pattern on SP 3, and 14 had a minimal failure pattern. The possible reasons for these patterns will be discussed on the following pages.

First, the behavior of 16 of the 30 Ss who failed maximally to perform adequately on SP 3 was as follows: eight performed actions with marbles, but they were actions which were not consonant with the meaning of the command. They took marbles out of the box indiscriminately, relative to the time of the conditional signals, played with them, did not put them into the dish, or put them into the dish and then back into the box, etc.

Eight other Ss also had a maximal failure pattern. In their case it was a pattern of not responding to the series of signals. A few Ss responded to the first of the series of signals, but not to any of the subsequent signals. The other children did not respond to any of the series of signals. Of the total of 16 children who were of the maximal type failure on SP 3, taking both types together, half improved on SP 5, i.e. they made some correct responses to some of the series of conditional signals, which they had not done on SP 3. Those who improved, however, did not closely correlate with either of the two varieties of maximal failure.

The reasons for the gross behavior failures seem to be either a semantic failure (i.e., not understanding "Every time") or a failure of one of the postulated attentional mechanisms required for the successful verbal regulation of behavio` (see Chapter IV), or both. However, neither of these reasons for failure can be correlated with one of the two types of maximal failure patterns (above). The reasons for believing that maximal failure was due to either semantic or attentional factors will now be examined.

In a pilot project, SPs 3, 5, and 9 had originally been started with the word "When." Some children performed as if they did not expect any conditional signals (light flashes) after the first one under these circumstances. They then shifted their attention from watching for additional light flashes, thus failing to perform in consonance with the command. The command was then changed to begin with the words "Every time" instead of "When," for the present experiment, and this apparently eliminated the semantic problem. It is possible, however, that there were some children of this age who did not interpret "Every time" to mean that they should expect a succession of light flashes to which they would need to show continuing attention and response.

The first attentional mechanism that may have caused a gross failure pattern on SP 3 is immediate memory. Two facts should be pointed out which bear on this hypothesis. First, there were fewer (although not statistically significant) failures on SPs 5 and 9, which were double the length of SP 3. Second, the length of SP 3 is the same as the length of the commands in SP 4, yet most Ss performed SP 4 correctly and most did not perform SP 3 correctly. A failure of immediate memory seems thus to be ruled out. A second hypothesized attentional mechanism, the waxing and waning of attention, would also seem to be excluded as a reason inasmuch as there was no partial execution of the command to which "waxing and waning" could be applied.

This leaves two other attentional mechanisms to consider: the ability to hold the command in working memory long enough to organize a plan of behavior, and/or the ability to hold an organized plan of behavior in working memory over the time period required for the execution of the command. In the latter case it would seem that there would be at least some correct performance of the action designated by the command, at least for the first portion of the behavioral act. This, however, did not exist in either of the two types of maximal failure: nonconsonant activity or failure to respond. The elimination of the foregoing three hypothesized attentional mechanisms leaves only one of those previously discussed: the process (or processes) which operate in the holding of the several components of the command in verbal memory long enough to organize a behavioral plan consonant with the meaning of the command.

The interesting fact that, of the 16 children who had maximal type behavior failures on SP 3, half made some improvement on SP 5, would seem to rule out for them any gross attentional deficits (i.e., a total operational deficit of one of the types of attentional mechanisms as given above). In fact, the performance of these Ss on SP 5 would argue for well-developed attentional processes, because they apparently picked up cues from their experience with SP 3 which enabled them to improve to some degree their performance on SP 5. Some of these children may not have been sure on SP 3 what every time meant, but after the experience of being presented with a series of conditional signals, they "perceived" that every time "meant" (i.e., was followed in experience by) a series of signals, to each of which responses had previously been made, and to which responses were presumably to be made now. However, for the eight Ss who did not improve on SP 5, attentional mechanism deficits may have operated.

In an operational sense, SP 3 had little or no influence on the ensuing behavior of those children who performed various kinds of irrelevant actions (eight in number). The novelty of the chance to play with the marbles competed for and dominated their actions rather than those actions being organized by the verbal command. Yet there was some gross resemblance between even these irrelevant actions and the command, i.e., marbles were transferred in and out of the box and dish, etc. Those children who performed one or no response to a series of six conditional signals also seemed unable to use the command to organize the required complex behavior over time. Some of them showed attention to the situation as a whole, even though they didn't act, while others were diverted by extraneous noises or acted "fidgety." All three of these types of behavior may have been at least partly due to a failure to organize a plan of behavior. However, even those who improved on SP 5 may not have done so because they were able to organize a plan of behavior, but rather because they had already automatized the appropriate motor response to the corresponding conditional signal.

The foregoing discussion of possible reasons for the maximal failure behavior patterns exhibited by 16 Ss does not allow for any very firm conclusions as to the causes. Two plausible reasons have been advanced, but it is not possible to assign them to specific Ss. They are: (1) A semantic failure, not understanding the meaning of the words Every time. A closer control in planning the experiment, to insure that all Ss did in fact understand these words (without giving them practice similar to the action commanded in the experiment) would have eliminated this ambiguity. (2) A failure in attentional processes at the stage of a working memory organization of the several components of the command into a behavioral plan.

Analysis of SP 3 Minimal Failures

An analysis of the factors that may have caused the minimal failure patterns is somewhat more clear-cut. One type of minimal error was clearly attentional. A number of Ss only required one or two "reminders" to keep looking at the lights in order to perform generally correctly (i.e., with only minimal errors) on the more complex commands. (This reminder was given all Ss who failed to keep their attention on the lights. In the case of Ss who made gross errors the reminder had no effect.) The failure here, evidently, was in sustaining the plan of behavior in working memory across the required time period. It only took this slight reminder to keep the plan in working memory for these children.

Luria's explanation of reasons for the imprecision of the motor component of the behavioral act in Ss of comparable age seems a likely explanation for many of the minimal type errors made in this experiment on SP 3. According to Luria, the diffuseness and persistence (inertness) of excitation, resulting from stimuli, and responses already made to them, may cause unwanted additional responses. Many of the minimal errors on SP 3 were in fact "impulsive" responses, made either before a signal occurred, between signals, or after signals had ceased. But there was also a small number of failures to inhibit to an inhibitory signal and/or to respond to an excitatory signal. All of the foregoing errors were, however, within a context of a behavioral action structurally consonant with the command.

It is not entirely clear whether even these "motor" errors should be categorized in all cases as purely motor errors, or whether attentional factors may also play a role in their production. If the verbally organized plan of behavior were generally appropriate, but if there were some waxing and waning of attention, or if there were an inability to keep the plan of action in working memory for the duration of the action, these types of attentional weaknesses could account for some of both the "excitatory" and "inhibitory" motor errors.

In this view, motor impulsivity (lack of precise motor control in a contingent situation) would exist as an age-correlated maturational weakness, but would be capable, to some extent, of control by verbally formulated intention, if all the requisite attentional mechanisms were adequate. However, both processes (attentional and motor) are probably maturationally incomplete at this age, and both improve concomittantly with further maturation. Here again, further experimental investigation is needed to differentiate the role played by different cognitive processes to produce behavior which externally appears to be homogeneous, i.e., of one type.

Set II Hypotheses and Predictions

The predicted order of difficulty for Set II commands was confirmed, insofar as it was predicted that SP 13 should be the most difficult to perform (and thus, most complex psychologically) and SP 10 the least difficult. The difference between performance on SP 13 and any of the other Set II commands was highly significant, $p < .001$. The other three Set II commands (SPs 10, 11, 12) showed differences among themselves which did not reach significance. Within this group of commands, the greatest difference from the others was shown by SP 10, which was performed by 94 percent of all *Ss*, proving to be the easiest, also as predicted.

It will be recalled that the prediction that SP 13 would prove most difficult was based on Luria's hypothesis that a transformation from the spatial order of actions as given in a command to the opposite spatial order in objective behavior is more difficult psychologically than performing a command not requiring this psychological spatial transformation. The prediction that SP 10 would be the easiest (even though it contains the same spatial transformation factor as SP 13, as well as the same syntactic structure) was based on DeLaguna's thesis that mediateness (complexity) of behavior increases when it involves perceiving relationships between persons or objects in the objective environment rather than between the organism's body and the environment.

In the case of Set II commands, complexity of syntactic structure does not predict the order of behavioral difficulty. All Set II commands are variants of one basic kernel sentence. SP 13 is syntactically simpler than SPs 11 and 12, and equivalent to SP 10. SP 11 contains the simple inversion transformation, and SP 12 contains the pronomial transformation and links together two kernel sentences by the conjunction "and." Yet SP 13 proved to be, by a wide margin, the most difficult to execute for children between 3-4 1/2 years of age.

There were no semantic problems for any of the children involving the understanding of word meanings in Set II commands. All of the commands are reversible, which increases their difficulty, i.e., the child cannot use a semantic cue (which would be the case if the instrumental and target actions could be performed in only one logical order) to assist him, but must rely entirely on the syntax of the sentence. Frequency of experience with the word orders that the commands embody should have been roughly equivalent for all commands but SP 11, which had a nontypical word order, probably infrequently heard by the child. Thus, on the grounds of familiarity with the kind of word order used in the command in the child's previous experience, one might have predicted that SPs 10 and 13 would be easiest, and that SP 11 would be most difficult. SP 13 proved to be the most difficult.

It was also hypothesized that there would be an age trend in Set II commands similar to what was found in Set I SPs. This did not prove to be the case. There was a slight age trend for SPs 10, 11, and 12, with better performance correlating with increased age. However there was already a substantial majority of the youngest Ss able to perform these commands, not leaving much room for age-correlated changes. SP 13, on the other hand, proved beyond the ability to perform by most Ss from 3-4 1/2, and the inability to perform the command was about equally spread between the three age groups.

Factors in the Failure of Set II Commands to Regulate Behavior

The overwhelming number of the failures to perform properly on Set II commands, at all age levels, was due to reversing the instrumental and target objects which are used in performing the behavior instigated by the command, rather than to the gross forms of failure to perform correctly found in connection with the series-conditional commands of the Set I commands. Thus, in response to the command "Touch the pencil with the toothbrush," the failure was, in all instances, that the child picked up the pencil and touched the toothbrush with it.

The cognitive failure involved in transforming SP 13 into the appropriate behavior would appear to be the inability to hold two ideas (in this case two opposite spatial relationships of objects) in a working memory at one time in order to be able to manipulate or shift them around. In order to perform any of the Set II commands correctly it is necessary to be able to identify which is the instrumental action and which the target action. If instrumental and target action are given in the same temporal order in the command as in the behavior, a direct translation from the command to organizing the behavioral action is possible. However, when the order of actions in the command is the reverse of that in behavior (as it is in the case of SP 13), it is necessary to transform them into their correct spatial and temporal relationship in the plan that organizes the behavioral action from the verbal stimulus.

This reversal or oppositeness transformation is apparently particularly difficult for very young children, and may be associated with an inability to maintain and reverse the relationship of two ideas in working memory at the same time. The ability to do this, in the form of the problem set in SP 13, does not appear until between the ages of 5-6. It is suggested that the ease with which older children and adults make this transformation from the syntactic form embodied in SP 13 requires more than practice, i.e., it requires a maturation of the attentional processes necessary for performing this type of psychological transformation. The first correct uses of this transformation would probably be quite conscious and hesitant. However, once in the child's repertoire of usable syntactic constructions, it becomes automatized with repeated practice so that before long it seems completely natural and obvious.

If the above explanation is tenable, why then was SP 10, which also involves the same type of psychological transformation from syntax to behavior as is the case with SP 13, the easiest Set II SP for most children? Here the factor of the mediateness of the behavioral act itself supersedes the need for the psychological transformation. Performing an action with a member of the body seems a direct action, whereas performing an action in the environment on an object with another object which is also in the objective environment involves perceiving more complex relational processes than is required by direct bodily action.

There still remains a transformation operation from the sentence to the admittedly simpler behavioral action, even so. It is logical to suppose that this transformation relative to actions with body organs (hands, arms, feet, etc.) is learned much earlier and may have a different cognitive structure than the transformation that becomes operative between ages 5 and 6. The psychological structure of an action in response to a command to perform an act with a bodily organ may come close to an automatic type conditional reflex, i.e., the key words in the command "Touch the pencil with your finger" may be "Touch-pencil." The clause "with your finger" may be redundant, as most "touching" is done with the fingers in all situations. Thus the relationship between the command and behavioral action in this situation, which is established by or before age 3, may be closer to a conditional reflex association than it is to a type of verbal control which depends on the syntactic relationships between the constituent components within the command-sentence.

Comparing Set I and Set II Commands

Set I commands involved complexity associated with conditionality of behavior and an adequate response to positive and negative conditional signals in a complex behavioral act. Set II commands involved perceiving spatial relationships between objects in the environment and the instrumental use of one to affect the other. It was assumed that the psychological operations involved in organizing these two types of behaviors would be different. No predictions were made as to which might prove more difficult.

The data showed that the instrumental command, SP 13, simpler syntactically, shorter in length, and probably equivalent in experience to the types of conditional actions which were the basis for the Set I commands, was more difficult than the most difficult Set I command. This was only true when the instrumental command was formulated linguistically so that the order of objects used in the sentence was opposite their order of use in behavior. The other linguistic variants of the instrumental command, SPs 10, 11, and 12, were shown empirically to rank with the simpler of the Set I commands in difficulty. Thus there is no basis for an overall generalization that instrumental commands are more or less difficult than conditional commands.

Is there anything in common between SPs 3 and 13, the two most difficult commands from both sets, about which a generalization can be made? Although the reasons for failure in both cases, discussed earlier, are speculative, it may be that both failed at the stage of fashioning a plan of behavior from the verbal instruction. It was hypothesized that this involves attentional and memory mechanisms which are able to shift around and combine different ideas until they constitute an organized plan of behavior. This may be a cognitive mechanism which does not mature until after age 4 and it may constitute the common element making for difficulty in the case of SP 3 of Set I and SP 13 of Set II. But there also was a difference in difficulty between these two most difficult commands, which was significant. It may be that an oppositeness transformation which seems to be required for performing SP 13 is a more difficult operation for the postulated attentional-memory mechanism than arranging a sequence of conditional responses, which is required of the mechanism in the case of the conditional commands. This, of course, merely restates that empirically SP 13 was found to be more difficult than SP 3. Nevertheless, this empirical finding, and others with which it may be compared, may provide clues which will help define what to look for in a further investigation of attentional processes.

Perspectives

The concept of the verbal control of behavior as used by Luria and in this thesis is basically an information-processing conception. As such it emphasizes and attempts to make concrete what happens to information from the environment once it gets inside the organism. It also endeavors to explain externally observable behav ior in terms of a sequence of internal processes. However, the experimental approach until now, including the present one, has been an effort to correlate an externally observable input (the verbal stimulus, a complex command), which has certain parameters, with the observable behavior which results. The effort is to discover which of the command's parameters e.g., syntactic complexity, length, familiarity, or meaning, are able to predict the ease or difficulty of performance in accordance with the command's meaning. The Ss are young children at a developmental stage where they are just beginning to process such verbal inputs.

In Luria's studies, as well as in the other verbal control studies reveiwed at the beginning of Chapter V, and also in the present study, it has been found possible to establish certain parameters of commands, defined in terms of complexity, that predict which commands are able to regulate the child's behavior at various ages in the pre-school period. The psycholinguistic studies also have concentrated on associating parameters of verbal inputs (transformations) given to children of this age with the ease or difficulty of processing the sentence as emboddied in some behavioral task. In both cases, various internal processes, whether attentional, motor, or rule-utilization, are invoked as explanations of the child's behavior in response to sentences of different complexity.

There are at least three possible roads to follow in a continuing experimental investigation of the verbal regulation of behavior. One is to specify in greater detail the external characteristics of the verbal stimulus which appear to predict the requisite behavior. Another is to increase the variety of types of commands which can be used as behavior-instigating stimuli, cataloging and comparing them and their ability to determine performance. A third approach is to try more precisely to specify and operationalize hypothesized brain processes which presumably operate in the verbal regulation of behavior.

This latter approach, in the light of the burgeoning psychophysiological and neurophysiological research into brain mechanisms underlying cognitive processes, would appear to be a most fruitful one. All three of the approaches referred to, however, can be correlative, as each is capable of supplementing and clarifying the other.

Possibly the most important of cognitive mechanisms of the brain are attentional mechanisms. The term attentional mechanisms as used throughout this thesis involves broader questions, i.e., concerning the nature of perception and memory. One may pose the question: isn't much learning basically learning to perceive, to direct one's attentional or orienting mechanisms to the appropriate aspects of a situation, rather than learning to make responses *per se*? There is abundant evidence that perceptual or attentional processes involve various expressions of orienting activity. Orienting reactions and processes have been extensively investigated psychophysiologically in the past decade and much is known of their make-up. The ontogenetic development of their appearance in pre-school age children and their relationship to the verbal system seems to provide a crucial area for investigating and explaining the increasing purposiveness in behavior which develops as the child matures.

Notes

[1] There is, of course, much evidence that humans in their behavior often do not utilize their inherent potential for purposiveness (Marcuse, 1964). This study is concerned with the earliest stages of the appearance of the processes and mechanisms which lead later to voluntary, purposive, and rational behavior, rather than with the social conditions which may blunt or inhibit the normal human potential.

[2] Gardner and Rosvold's discussion of the maintenance of attentional intensity as a type of attentional process is in the context of a discussion of attentional deficiencies shown by brain-damaged children. In those cases, the deficiency may be due to damage to a part of the brain that subserves the attentional mechanism, either at birth or in subsequent development. If the neural substrate for such attentional processes does not mature until later pre-school age (5-6 years), it is possible that a normal maturational deficiency of the attentional mechanism in younger children may be similar to the brain damage related deficiency at a later age.

Appendix A

Transformations

Simple Transformations

1. Passive--He was tied up by the man.

2. Negation--I am not.

3. Question--Is he sleeping?

4. Contraction--He'll choke.

5. Inversion--Now I have kittens.

6. Relative question--What is that?

7. Imperative--Don't use my brushes.

8. Pronominalization--There isn't any more.

9. Separation--He took it off.

10. Got--I've got a book.

11. Auxiliary verb

    a. be--He is not going to the movies.
    b. have--I've already been there.

12. Do--I did read the book.

13. Possessive--I'm writing daddy's name.

14. Reflexive--I cut myself.

Generalized Transformations

15. Conjunction--They will be over here and momma will be over there.

16. Conjunction deletion--I see lipstick and a comb.

17. Conditional--I'll give it to you if you need it.

18. So--He saw him so he hit him.

19. Causal--He won't eat the grass because they will cry.

20. Pronoun in conjunction--Blacky saw Tippy and he was mad.

21. Relative clause--I don't know what he's doing.

22. Adjective--I have a pink dog.

23. Complement
    a. Infinitival--I want to play.
    b. Participial--I like singing.

24. Iteration--You have to clean clothes to make them clean.

25. Nominalization--She does the shopping and cooking and baking.

26. Nominal compound--The baby carriage is here.

From: Menyuk, Paula. Syntactic structure in the language of children. Child Develpm., 1963, 34, Pp. 410-411.

Appendix B

Table 7

Number of Ss Performing Correctly on Set I Sentences by Age and Sex

Age	Sentence Package Number																																			
	1				2				3				4				5				6				7				8				9			
	B		G		B		G		B		G		B		G		B		G		B		G		B		G		B		G		B		G	
	C	I	C	I	C	I	C	I	C	I	C	I	C	I	C	I	C	I	C	I	C	I	C	I	C	I	C	I	C	I	C	I	C	I	C	I
3-3 1/2	8	0	5	3	5	3	5	3	1	7	1	7	6	2	6	2	1	7	1	7	7	1	8	0	4	4	7	1	4	4	5	3	2	6	3	5
3 1/2-4	8	0	7	1	7	1	8	0	3	5	3	5	6	2	8	0	3	5	3	5	8	0	7	1	8	0	8	0	7	1	6	2	2	6	5	3
4-4 1/2	7	1	8	0	7	1	8	0	4	4	6	2	8	0	8	0	7	1	7	1	6	2	8	0	6	2	8	0	7	1	7	1	6	2	8	0
Totals	23	1	20	4	19	5	21	3	8	16	10	14	20	4	22	2	11	13	11	13	21	3	23	1	18	6	23	1	18	6	18	6	10	14	16	8

Appendix B

Table 8

Number of Ss Performing Correctly on Set II Sentences by Age and Sex

Age	Sentence Package Number															
	10				11				12				13			
	B		G		B		G		B		G		B		G	
	C	I	C	I	C	I	C	I	C	I	C	I	C	I	C	I
3-3 1/2	7	1	7	1	7	1	7	1	7	1	8	0	2	6	1	7
3 1/2-4	6	1	8	0	6	1	7	1	4	3	6	2	2	5	0	8
4-4 1/2	8	0	8	0	7	1	7	1	7	1	8	0	3	5	0	8
Totals	21	2	23	1	20	3	21	3	18	5	22	2	7	16	1	23

References

Anokhin, P. K. Features of the afferent apparatus of the conditional reflex and their importance for psychology. _Voprosy Psikhologii_, 1955, _6_, 16-38. Reprinted in N. O'Connor, (Ed.) _Recent Soviet psychology_. New York: Liveright, 1961, and in A. N. Leontyev, A. R. Luria and V. M. Smirnov, (Eds.) _Psychological Research in the U.S.S.R._, Vol. 1. Moscow: Progress; 1966, 67-98.

Beiswenger, H. Luria's model of the verbal control of behavior. _Merrill-Palmer Quart._, child dev., 1968, (in press).

Berlyne, D. E. _Conflict, arousal, and curiosity._ New York: McGraw Hill, 1960.

Beritoff, J. S. _Neural mechanisms of higher vertebrate behavior_. Boston: Little-Brown, 1965.

Birch, D. Verbal control of nonverbal behavior. _J. exp. child psychol._, 1966, _4_, 266-275.

Braine, M. The ontogeny of English phrase structure: the first phase. _Language_, 1963, _39_, 1-13. Reprinted in R. C. Anderson and D. P. Ausubel (Eds.), _Readings in the psychology of cognition_. New York: Holt, Rinehart and Winston, 1966, Pp. 350-363.

Brown, R. and Bellugi, Ursula Three processes in the child's acquisition of syntax. In E. H. Lenneberg (Ed.), _New directions in the study of language_. Cambridge, Mass.: M.I.T. Press, 1966, Pp. 131-161.

Bruner, U., Olver, Rose, and Greenfield, Patricia, _et al._ _Studies in cognitive growth_. New York: Wiley, 1966.

Chase, R. A. Evolutionary aspects of language development and function. In F. Smith and G. A. Miller (Eds.), _The genesis of language: a psycholinguistic approach_, Cambridge, Mass.: M.I.T. Press, 1966, Pp. 253-268.

Chomsky, N. Syntactic structures. The Hague: Mouton, 1957.

Chomsky, N. Aspects of the theory of syntax. Cambridge, Mass.: M.I.T. Press, 1965.

Chomsky, N. Language and the mind. Psychology Today, 1967, 1, 48-69.

DeLaguna, Grace A. Speech: its function and development. Bloomington: Indiana U. Press, 1963. (Paperback ed., original pub., 1927).

Dewey, J. The reflex arc concept in psychology. Psychol. Rev., 1896, 3, 357-370.

Epstein, W. Some conditions of the influence of syntactical structure on learning: grammatical transformation, learning instructions, and "chunking." J. verb. Learn. verb. Behav., 1967, 415-419.

Ervin, Susan M. Imitation and structural change in the child's language. In E. H. Lenneberg (Ed.), New directions in the study of language. Cambridge, Mass.: M.I.T. Press, 1964, Pp. 163-189.

Flavell, J. H. The developmental psychology of Jean Piaget. Princeton, N. J.: Van Nostrand, 1963.

Fraser, C., Bellugi, Ursula and Brown, R. Control of grammar in imitation, comprehension and production. J. verb. Learn. verb. Behav., 1963, 2, 121-135.

Gardner, R. W. The needs of teachers for specialized information on the development of cognitive structures. In W. M. Cruickshank (Ed.), The teacher of brain-injured children. Syracuse Univ. Press, 1966, 139-152.

Gibson, Eleanor J. Perceptual development. In H. W. Stevenson (Ed.), Child psychology. (62nd Yearbk, Nat. Soc. for Study Ed., Part I). Chicago: Univ. of Chicago Press, 1963, Pp. 144-195.

Jarvis, P. E. Verbal control of sensory-motor performance: a test of Luria's hypothesis. Human Dev., 1968, 11, (in press).

Jakobson, R. Linguistic types of aphasia. In E. C. Carterette (Ed.), Brain Function, vol. 3, Speech, language and communication. Berkeley and Los Angeles: Univ. of Calif. Press, 1966, Pp. 67-91.

Karpova, S. N. The preschooler's realization of the lexical structure of speech. Voprosy Psikhol., 1955, 4, 43-55. Abstract in F. Smith and G. A. Miller, The genesis of language. Cambridge, Mass.: M.I.T. Press, 1966, Pp. 370-371.

Katz, J. J. The philosophy of language. New York: Harper and Row, 1966.

Leont'yev, A. N. Problems of mental development. Washington, D.C.: U.S. Dept. of Commerce (OTS), 1964.

Lenneberg, E. H. The importance of Condon's and Ogston's presentation. Dittoed mms., 1968.

Luria, A. R. Language in the formation of temporary connections. In B. Simon, (Ed.), Psychology in the Soviet Union. Palo Alto: Stanford U. Press, 1957, Pp. 115-129.

Luria, A. R. The directive function of speech in development and dissolution. Word, 1959, 15, Pp. 341-352. Reprinted (Part I) in R. C. Anderson and D. P. Ausubel (Eds.), Readings in the psychology of cognition. New York: Holt, Rinehart and Winston, 1966, Pp. 350-363.

Luria, A. R. Verbal regulation of behavior. In Mary A. B. Brazier (Ed.), The central nervous system and behavior (Third Macy Conference). New York: Macy Foundation, 1960a, Pp. 359-423.

Luria, A. R. Speech development and the formation of mental processes. In B. G. Anan'yev (Ed.), Psychological science in the USSR, vol. 1. Moscow: Acad. Pedag. Sci. RSFSR, 1960b. (English translation, pub. by U.S. Joint Publ. Res. Services, Washington, D. C., 1961, Pp. 704-787.)

Luria, A. R. Higher cortical functions in man. New York: Basic Books, 1966a.

Luria, A. R. Brain and mind. Soviet Psychol. and Psychiatry, 1966b, 4, 62-69.

Luria, A. R. The human brain and psychological processes. New York: Harper and Row, 1966c.

Luria, A. R. The regulative function of speech in its development and dissolution. In K. Salzinger, and S. Salzinger (Eds.), Research in verbal behavior and some neurophysiological implications. New York: Academic Press, 1967.

Luria, A. R. and Yudovich, F. Ia. Speech and the development of mental processes in the child. London: Staples Press, 1959. (Orginally published in U.S.S.R. in 1956.)

McNeill, D. Developmental psycholinguistics. In F. Smith and G. A. Miller (Eds.), The genesis of language: a psycholinguistic approach. Cambridge, Mass.: M.I.T. Press, 1966, Pp. 15-84.

Magoun, H. W. The waking brain. Springfield, Ill.: Thomas, 1963, (2nd Ed.).

Marcuse, H. One-dimensional man. Boston: Beacon Press, 1964.

Matthews, P. H. Review of N. Chomsky, Aspects of the theory of syntax. J. of Language, 1967, 3, Pp. 119-152.

Mehler, J. and Carey, P. Role of surface and base structure in the perception of sentences. J. verb. Learn. verb. Behav., 1967, 6, 335-338.

Menyuk, Paula Syntactic structures in the language of children. Child Develpm., 1963a, 34, 407-422.

Menyuk, Paula A preliminary evaluation of grammatical capacity in children. J. verb. Learn. verb. Behav., 1963b, 2, 429-439.

Miller, G. A., Galanter, E., and Pribram, K. H. Plans and the structure of behavior. New York: Holt, 1960.

Neisser, U. Cognitive psychology. New York: Appleton-Century-Crofts, 1967.

Piaget, Jean. The origins of intelligence in children. New York: W. W. Norton, 1962.

Rosvold, H. E. et al. A continuous performance test of brain damage. J. of Consult. Psychol., 1956, 20, 343-351.

Shroder, H. M., Driver, M. J., and Streufert, S. Human information processing. New York: Holt, Rinehart and Winston, 1967.

Sinclair-De Swart, H. Language and thought: a Piagetian point of view. Mimeographed, 1967.

Slobin, D. I. Grammatical transformations and sentence comprehension in childhood and adulthood. J. verb. Learn. verb. Behav., 1966, 5, 219-227.

Smirnov, V. M. and Tsareva, I. S. Studies on the perception of spatial relations by children of pre-school age. In J. Chorobski, (Ed.), Neurological problems. New York: Pergamon, 1967.

Sokolov, A. N. Speech motor affrentation and the problem of brain mechanisms of thought. Voprosy Psikhol., 1967, 13, 41-54. (Translation reprinted in Soviet Psychology, 1967, 6, 3-15.)

Sokolov, Ye. N. Higher nervous functions: the orienting reflex. Ann. Rev. physiol., Palo Alto: Annual Reviews, 1963a.

Sokolov, Ye. N. Perception and the conditioned reflex. New York: Macmillan, 1963b.

Suci, G. J., Ammon, P., and Gamlin, P. The validity of the probe-latency technique for assessing structure in language. Lang. and Speech, 1967, 10, 69-80.

Stolz, W. S. A study of the ability to decode grammatically novel sentences. J. verb. Learn. verb. Behav., 1967, 6, 867-873.

Turner, Elizabeth A. and Rommetveit, R. The acquisition of sentence voice and reversibility. Child Develpm., 1967, 38, 649-660.

Templin, Mildred C. Certain language skills in children: their development and interrelationships. Minneapolis: Univ. of Minn. Press, 1957.

Vygotsky, L. S. Thought and language. New York: Wiley, 1962. (Originally publ. in U.S.S.R. in 1935).

Werner, H. and Kaplan, B. Symbol formation. New York: Wiley, 1963.

White, R. W. Competence and the psychosexual stages of development. In M. R. Jones (Ed.), Nebraska Symposium on Motivation, 1960. Lincoln: Univ. of Nebraska Press, 1960, 97-140.

White, S. H. Evidence for a hierarchical arrangement of learning processes. In L. P. Lipsitt and C. S. Spiker (Eds.), Advances in child development and behavior, Vol. 2. New York: Academic Press, 1965, Pp. 187-220.

Zaporozhets, A. V. The origin and development of the conscious control of movements in man. Voprosy Psikhologii, 1958, 1, 24-36. Reprinted in N. O'Connor, (Ed.) Recent Soviet psychology. Liveright, 1961a, 273-289.

Zaporozhets, A. V. The development of perception in the preschool child. In P. H. Mussen (Ed.), European research in cognitive development (Monographs of the Soc. of Res. in Child Dev.), 1965b, 30, 2, Pp. 82-101.