DOCUMENT RESUME

ED 045 288 RE 003 063

AUTHOR Frost, Joe L.
TITLE Application of Structure Process Theory to the Teaching of Reading.
PUB DATE 7 Mar 70
NOTE 13p.; Paper presented at the National Conference of Teachers of English, St. Louis, Mo., Mar. 7, 1970

EDRS PRICE EDRS Price MF-$0.25 HC-$0.75
DESCRIPTORS *Cognitive Development, *Educational Theories, Human Development, Individualized Reading, *Models, *Psychoeducational Processes, Reading Diagnosis, *Reading Instruction, Reading Skills

ABSTRACT

Consistent with definitions of theory as offered by Skinner and Bruner, and based on psychological and neurophysiological evidence for a cognitive hierarchy as propounded by eminent psychologists, the structure process theory has validity in constructing a model of reading instruction. The appropriateness of model construction arises from the nature of reading as a cumulative process which can be divided into specific subskills and abilities. A basic concept is the ordinal nature of human development as opposed to normative concepts. Therefore, this theory rejects normative data such as IQ scores and grade level equivalents when diagnosing reading ability. Instruction which is individualized to the extent that it (1) proceeds from diagnosis of what the child can do, (2) observes the hierarchical arrangement of reading skills, (3) matches these two procedures in order to control change, and (4) continues to diagnose in order to obtain optimum match can be said to be based on the structure process theory. A bibliography is included. (DH)

APPLICATION OF STRUCTURE PROCESS THEORY TO THE TEACHING OF READING*

Joe L. Frost
The University of Texas at Austin

The reading systems currently operational in American classrooms rest on undefined foundations. Basal readers, the presumed product of educational research and experimentation, do not reflect any consistent thread of research evidence and the few promising threads of research evidence have not found expression in the basals. Most of the research in reading has been haphazard in nature, contributing minimally to practice, and in the confines of the reading world supportable theory is as rare as moon rocks. The reading world is one of mystics. It is rather unique in this regard for no other educational discipline is so clearly fenced off into cults, each cult maintaining its superiority to all the others; each having the required evidence, a semi-controlled matching of methods with predictable results.

Those who write about reading are saying that we must search for new directions in reading methodology and research; that the typical Method A vs. Method B research is wasteful in terms of time, money, and talent. Tax payers spent $1,000,000. on the U.S.O.E. First Grade Reading Studies to learn that there is no best method for teaching reading to all children and that the teacher is the most important factor. Indictments have persisted over the years. For example, "I have not been able to find the evidence to justify the assertion that the published findings of recent educational research (since 1916) have provided the basis of most of the modern reforms in reading instructions (Fries, 1963, P. 29). "... we are sore put to name even a few trustworthy generalizations or research based guides to educational practice." (Levin, 1966, P. 138). "Research (educational) is voluminous, but of poor quality and non-cumulative," (Barton and Wilder, 1964, P. 397). Chall's (1967) analysis of studies of beginning reading, apparently one of the more carefully designed analyses resulted in several specific conclusions regarding the teaching of reading, all based on studies which Chall herself (P. 88) refers to as "shockingly inconclusive." (my italics) Frost and Rowland (1969, P. 134) believe that a more demanding set of standards must be established for reading

*Presented at the National Conference of Teachers of English
St. Louis, Missouri, March 7, 1970

but they reject the notion that increased precision will necessarily have dehumanizing results.

> The method of science has been only sparingly used in education, and the most frequent reason given is that such a methodology is cold, unconcerned with the human elements in the educational situation. Certainly, this is not the case. The scientist is probably more concerned with the human element than is the random practioner; and because of this deep concern, he wants to obtain all the evidence possible in order to be able to predict the results of intervention... The difference is that the scientist will take the necessary action with all the evidence from research, logic from theory, and results of practice that are at his command, whereas the non-scientist will tend to operate on what he "feels" is the right thing to do. It is simply a question of who will be the most effective with children, and the evidence is strongly in favor of the genuine humanism of science.

Today's teacher must be a model for imitation, a diagnostician, a setter of expectations, in other words, a behavioral scientist. Our schools are accused of social obsolescense, particularly in ghetto areas, a context in which American education now faces the acid test. The teacher in middle-class schools of the past was allowed to teach according to her "feelings" or to follow rigidly a set of standarized materials, for her students achieved literacy and they caused little trouble. But such compliancy among students is no longer the rule and may soon be the exception. The great silent majority are joining their disadvantaged peers in crying out for relevancy in education. They are rejecting the subtly discriminating, fantisized middle-class norms - grade level standards, basals, letter grades, promotion-retention, just as surely as the ghetto student rejected the more overt but equally perveraive practices of the ghetto school. Good feelings and intentions are nice but they are no substitute for the skillful, scientific teacher; for skillful, scientific teachers can also be nice.

The development of education as a behavioral science need no longer be science fiction. Many of the previously misunderstood variables of human learning can now be controlled and their effects can be determined. The development of alternate, workable theories of instruction is sorely needed in the reading field. Reading is essentially a cognitive process not yet amenable to the physical manipulation of the neuro-physiologists but well within the domain of neuro-physiological theory. Unfortunately, to this day,

only etremely limited application of available learning theory has been applied to the teaching and learning of reading.

TOWARD A THEORY OF READING INSTRUCTION

A great deal depends upon definitions of theory. Skinner (Evan, 1968) offered two definitions: The first, ... "an effort to explain behavior in terms of something going on in another universe, such as the mind or the nervous system." He does not believe that this type of definition is essential or helpful for the psychologist or the educator since the mind can hardly be probed directly by practitioners. Skinner, however, would be quite interested in promoting an overall theory of human behavior which will bring together a lot of facts and express them in a more general way" (P. 88). I believe that both types of definitions are fair game for psychologists and educators; it is quite clear that researchers in related disciplines, notably chemistry and biology, are approaching a genuine understanding of the nature of the chemical and electrical activity of the cerebral cortex and the function of the brain stem (Pribham, 1969) (Krech, 1968). The most fruitful approaches for educators at present deal with observable behaviors or expressions that infer codified mental schema.

"A theory of instruction is a normative theory. It sets up criteria and states the conditions for meeting them" (Bruner, 1966, P. 40). But the conditions for application may be, in fact, should be, powerfully individualistic and ordinal in nature. Theories of learing and of development are descriptive, telling us what happened after treatment. A theory of instruction is prescriptive, telling us what should happen to result in learning and development. A theory of instruction should be congruent with the theories of learning and development to which it subscribes.

Bruner gives four major features of theory of instruction (Pp. 40-41):

1. A theory of instruction should specify the experiences which most effectively implant in the individual a predisposition (motivation) toward learning...

2. A theory of instruction must specify the ways in which a body of knowledge should be structured so that it can be most readily grasped by the learner.

3. A theory of instruction should specify the most effective sequences in which to present the materials to be learned.

4. A theory of instruction should specify the nature and pacing of rewards and punishments in the process of learning and teaching.

The structure process approach to cognition (Rowland, 1967; Frost and Rowland, 1968-69) and instruction is an emerging effort to bridge two related but oft-isolated behavioral disciplines, education and psychology. The approach is consistent with Bruner's criteria for a theory of instruction and it cuts across both of Skinner's definitions of theory. The SP approach synthesized from a conglomerate of descriptive learning theories relating both to observable behavior and to neuro-physiology. The applications to instruction are prescriptive.

The theory is conceptualized from the works of eminent psychologists; a concept having communality, though expressed in different ways, is accepted as having validity in the construction of a model for the instruction of children. The SP approach has wide applicability. Both the instructional process and the content field may be accommodated within its framework (Frost, 1970).

DEFINITION

There is no magic in the terminology, structure-process. The terms are used merely for convenience. Structure refers to the presumed existence of a cognitive hierarchy and the cumulative nature of knowledge acquisition. Process is viewed as a duality: (1) the invariant processes of the development of intelligent behavior, and (2) the teaching processes which relate distinctively to the accurate assessment of accumulated cognitive structure through establishment of techniques, procedures, and materials that build sequentially upon these structures (analogical to the "solution of the match," Hunt, 1964).

PSYCHOLOGICAL EVIDENCE FOR A COGNITIVE HIERARCHY: STRUCTURE

Gagne (1962) presented evidence for a ordered hierarchy of types of learning which he termed "abilities." Abilities are acquired through changes in human behavior permitting successful performance on certain tasks. The two major variables involved are knowledge and instruction. Gagne constructs an ordered hierarchy of subordinate knowledges (capabilities) called learning sets. Productive learning is the transfer of training from component (subordinates) learning sets to a new activity which incorporates these previously acquired capabilities. The fundamental factor arising from these studies is that of individual differences and the recurring problem is that of undependability of current measures of proficiency in determining capabilities already established in the child's cognitive structure. This work stands in contradiction to the well-known Gesellian assumption that training for a desired performance might as well, and

probably should, wait until a child is "maturationally ready," Gagne (1968), on the other hand, emphasized learning as a major causal factor in development.

Piaget (1947) also recognizes that development is enhanced by the interaction of the child with his environment. As new experiences are assimilated into existing cognitive structures, newly acquired structures make it possible for the organism to accommodate to the demands of the environment. The constant building of experiences results in increasingly complex structures or schemas. Experience, however, operates with other factors -- maturation, social transmission, and equilibration in influencing intellectual growth. Four major stages characterize the development of intelligent behavior -- sensory motor, preconceptual, concrete and formal. The developmental sequence through these stages is invariant for normal humans but the rate and timing of development is highly variant. Time, per se, has no legitimate function in the sequence, serving only as a backdrop against which events transpire. The attainment of lower-order tasks is prerequisite to the attainment of higher-order tasks. For example, the child must grasp the principles of conservation of quantity before he can develop the concept of number (Piaget, 1965).

Bruner (1964) postulates three processes by which people come to know: (1) enactive -- through habitual actions; (2) iconic -- through imagery that is relatively free of action; and (3) symbolic -- the translation of action and image into language. Olson (1966), an associate of Bruner describes processes and strategies emerging from their work. In order for the child to deal with advanced information selection he must be able to deal with several images simultaneously and construct a hierarchy of distinctive features. Strategies employed in finding and using information change dramatically as development proceeds. Conceptualization of alternative information selection strategies are necessarily hierarchical for information leading to the acceptance and rejection of subsets leads to the ability to distinguish among remaining alternatives.

Ferguson (1954, 1956) is the fourth major psychologist whose approach to cognition influences the development of the structure-process rationale. He maintains that the abilities of men are among those certain aspects of the state of the organism that attain a crude stability of invariance. Thus behavior becomes organized, or structured, and to some extent predictable. The discovery of these invariants in human behavior, then, might becomes a primary objective of psychological and educational research. But the task is complicated by Ferguson's statements, "Everything we know suggests that different environmental demands lead to the

development of different ability patterns (particularly crucial in minority group contexts)." The concept of a culture-free test is a misconception because the abilities of men are themselves not culture-free (1956, P. 129).

These eminent psychologists appear to support a common element or factor in cognitive development: Gagne's capabilities; Piaget's principles; Bruner and Olson's strategies; and Ferguson's abilities. Certain neuro-physiological theorizing adds additional strength to these psychological bases.

NEURO-PHYSIOLOGICAL EVIDENCE FOR A COGNITIVE HIERARCHY

Hebb (1949) builds a substantial theoretical basis for perfect correlation of behavior and neural function (viewing correlation as causal rather than related). Not unlike previously cited psychologists be argues for predictability in psychology (this writer would argue for predictability in education). "One cannot logically be a determinist in physics and chemistry and biology, and a mystic in psychology (P. xiii)." Hebb stands in direct contrast to Skinner by regarding the problem of understanding behavior as a problem of understanding the action of the neural system, and vice versa. He believes that stimulation leads to the development of a diffuse structure of "cell-assemblies" capable of brief independent action but facilitative to other such systems. The level of intelligence at any given time is a function of previously developed concepts. Perception is a summative process depending upon consistent central action of a repeated stimulus. Gordon (1966) joins with Hebb in rejecting the telephone switchboard theory of cortical transmission, emphasizing intervening processes and presenting a trans-actional modal man characterized by a computer brain. Both see intelligence and potential as creatable through environmental transactions. Usage stimulates brain structure and all areas participate, though in differing amounts, in input coding and response activities. Krech (1962) and his associates demonstrated that rats reared in environmentally complex environments and subjected to intensive training differ from their litter-mates in the weight of the cerebral cortex; furthermore, timing and extent of experience were important variables. George Ungar (December, 1968) reported at the American Association for the Advancement of Science (Dallas, Texas) that he and his associates found learning to be transferrable from the brain of one animal to another through an extract of brain tissue. Ungar concluded, "It is highly probable that the extracts contain some highly specific information encoded in molecular structure."

Many additional studies in neurology and physiological psychology stress the inherent activity of the brain as an information-processing system. Pribham's (1964)

work resulted in a test-operation-retest-exit of T.O.T.E. mechanism theory of neurological functioning. TOTE's are conceived to be arranged hierarchically into plans, and structurally plans are no more than Rx programs, similar to those that guide the operation of computers -- well-worked-out outlines such as those used in programmed texts and teaching machines. Bloom's (1956) logically derived taxonomy of the cognitive domain,and Guilford's (1967) statistically derived factors of intellect may be examined for practical implications of these studies.

IMPLICATIONS OF STRUCTURAL THEORY FOR AN INSTRUCTIONAL MODEL

The evidence presented in support of a cognitive hierarchy suggests that certain prerequisite abilities are necessary for concept attainment. Since the development of intelligent behavior, in this context the ability to read, is a cumulative process, the educator should be able to subdivide a specific task into its subordinate or fractional concepts or units necessary for mastery of a prescribed goal. The cognitive structure desired for mastery may be identified as terminal behavior and all ultimate conceptual goal behaviors are supported by subordinate concepts. Based on these assumptions, the teaching of reading may proceed in a controlled and planned manner of successive, cumulative mastery of subordinate concepts or skills. For hypothetical purposes or for purposes of developing reading curricula one may identify such major reading skills as power and speed of reading as "program goals." The elemental components of phonics or comprehension, e.g., the identification of short vowel sounds, then, would be the behavioral change the educator seeks to effect through direct or indirect instruction. Successful mastery of each behavioral goal would in turn contribute to the attainment of the ultimate or "terminal" program goal. The challenge to reading specialists is to apply increasing research rigor in their efforts to bring order and clarity to the hierarchical ordering of reading goals.

One promising exception to the flood of unprofitable reading research is the work of the late Jack Holmes (1960), work which appears to have been summarily dismissed with the publication of criticism of his statistical, not his theoretical, techniques. Holmes' Substrata-Factor Theory of Reading held that reading is sustained by the inter-facilitations of an intricate hierarchy of substrata factors. The theory provides an excellent framework in which to view the relationships between sequential, logical, presentation of information and the success of the child in accommodation and assimilation of that information into his working system. Of great relevance are implications for meaningful material, logical explanations, and continuity of themes in the teaching-learning encounter. A more recent factor analytic

study of critical reading tests (Wolf and Mehrotra, 1969) demonstrates the applicability of the computer in bringing increased precision to the determination of objectives in reading.

The application of complex machinery in structuring reading is not an exercise in rigidity. Just as medicine is increasingly turning to computers to analyze thousands of isolated elements contributing to asthma, to eventually arrive at a cure, so reading teachers can expect that such application may eventually help to make reading relevant and to open up rather than to close possibilities for flexible teaching. Machines, per se, are neither flexible or rigid, people make them so. Similarly, structure is neither flexible or rigid, inherently, teachers make this decision. The prevailing notion among teachers of reading that structure is bad and machines are worse is sheer sophistry and the movement of industry into education may very soon make this point crystal clear.

PROCESS AND ORDINALITY IN HUMAN DEVELOPMENT AND INSTRUCTION

The structure of knowledge and the invariant processes of the development of intelligent behavior are intimately linked together. How are they linked and why? The answer to this question, at least on a theoretical level, appears to be the ordinal nature of human development. The emphasis here is on the term ordinal, and is deliberately posed in opposition to normative concepts of human development.

The normative concept of human development is most often associated with the name of Arnold Gesell, and proposes that there are specific achievements which are age-related. In other words, a child at age X would be able to perform task Y. If he cannot, it is a matter of maturation or unfolding, or it is a matter of heredity. Both of these notions are largely discredited today (See J. McV. Hunt's Intelligence and Experience, 1961). Nonetheless, there is still widespread acceptance of the normative approach in spite of the evidence. These notions are particularly noxious in education, for they allow the school system and the teacher to hide behind a theory as an excuse for their own ineptitude and inflexibility to the needs of children. The ordinalist would never say that a child should make a certain score on a certain test at a certain age, and would find the judgmental nature of normative testing unacceptable no matter how well it is disguised in psychometrics. There is an inherent and invariant sequence of behaviors preliminary to any developmental objective. The task of the educator is conceived to be that of determining at what point in the continuum of development the child is functioning, and then to move from there to the predetermined objective. There

is no judgment implicit or explicit that a child is above or below any artificial norm (Frost and Rowland, 1969).

In 1961, Piaget asserted the invariance of developmental stages saying "only the order of succession is constant." This is a notion which is intimately related to the rejection of time as a factor of primary signifiaance in human development. The work of Flavel (1963) and Kohlberg (1966) also supports the invariance of stages. The result of this thinking is that stages constitute an ordinal measure of human development. In the past, where the approach has been from a normative frame of reference, the age at which a behavior appeared was considered to be not only significant but the determining factor.

IMPLICATIONS OF ORDINAL PROCESS THEORY FOR AN INSTRUCTIONAL MODEL

From the concept of the ordinality of human development, Hunt (1964) has proposed that planned experiences may well be the answer to the problems of disadvantaged or deprived children. This makes a great deal of sense, when the educator understands that development is not tied to time, and yet development is invariant and sequential. Therefore, if a child does not function appropriately it may well be the product of an environment which did not encourage or support his experiments which would have produced the central processes appropriate to the task. In such an event, the educator intervenes and provides the appropriate experiences, which should then re-establish the ordinal continuum.

Hunt (1964) provides a portion of the stimulus for this emerging effort to develop a model for instruction, the Structure-Process Approach, within the context of his statement:

> The danger of attempting to prescribe materials and models... is that the prescriptions may well fail to provide a proper match (italics mine) with what the child already has in his storage. The fact that most teachers have their expectations based on experience with culturally privileged children makes this problem of the match especially dangerous and vexing in work with culturally deprived.

We seek skill in instructional prescription. Currently education is failing to base instruction on antecedent conditions. This establishes a profound challenge for educators to reject the notions of fixed intelligence and predetermined development which underlie normative instruction and to build from existing structures in a controlled, ordinal, individualistic fashion.

The concepts of structure and process elaborated thus far stand in direct opposition to the prevailing methodology for teaching reading. SP theory rejects

the use of grade level equivalents, I.Q. scores and any other normative considerations for instructional diagnosis and assessment. Normative scores have no instructional significance for the teacher attempting to match instruction to a particular child's developmental level. They are sometimes useful to the researcher or the administrator who is dealing with global considerations. The content of standardized instruments, on the other hand, can be quite useful to the teacher in making instructional decisions. The specific content of diagnostic instruments indicates what a particular child can do and what he cannot do and this is the starting point for instruction. The teacher, then, is first of all, a diagnostician. This critical diagnostic process is the base from which the teacher measures the success or the failure of instruction. Each new cognitive structure is dependent upon structures that developed earlier. Understanding and resulting changes in behavior are not possible without a structural base and that base is built from existing materials.

Placing groups of children into an instructional sequence with expectations for standard progress is the second major error in current reading methodology. The instructional sequence established for a child or a group of children in advance of diagnosis is always approximate, a reflection on our present stage of knowledge about learning. And the rate and timing of movement through an instructional sequence differs from child to child. The simplest interpretation of perhaps the commonest error in teaching reading is the expectancy that any given group of children will follow an identical time pattern, or skills sequence, and that they will achieve similar proficiency from identical content. SP theory is a mandate for individualization, not the rigidity in disguise of the basals nor the fun and frills of certain other misinterpreted approaches, but a scientific, diagnostically-based approach to breaking the code. I submit that such an approach is a humane one and I present the ghetto children of our nation as living evidence to our present and past ill-fated intuitively oriented efforts.

A third major error in reading instruction is the tendency to focus upon global goals, goals that are not amenable to direct instructional strategy. The SP approach places the teacher in the role of behaviorist. She has no choice regarding this role for she has no influence over genetics. Teachers can operate directly only upon the behaviors of children, what they say, and what they express physically. Teachers listen and they observe. They assess existing behaviors and they prescribe behavioral goals, clear statements of intent designed to increase quality and complexity of behavior.

Thus, an essential instructional process is the introduction of controlled discontinuity or change.

> If input is precisely congruent with established cognitive structure, new learning does not occur; and if the input does not fit into the structure at all, it is simply not assimilated. The optimal difficulty of a task is therefore one in which the complexity of the child's cognitive structure almost, but not quite, matches that of the input pattern. Given those conditions, the structure will change (Phillips, 1969, P. 110).

The specification of behavioral goals may follow diagnosis or the teacher may select a series of behavioral goals from available materials. In either event, the construction or selection begins at a level consistent with diagnosis. Allowable degrees of freedom permit the teacher to group for instruction but the content of the group must continue to be a function of diagnostic teaching.

In sum, the major strategies of a reading program based on SP theory are: (1) the diagnosis of what children can do, (2) the hierarchical arrangement of specific reading skills, (3) the matching of these two strategy outputs to ensure controlled change or novelty, and (4) continued diagnosis to maintain optimum match. The power of these strategies is not in uniqueness but in demonstrable linkage with learning theory.

POSTSCRIPT

Consistent with Bruner's criteria for a theory of instruction the additional elements should be examined at this point. A theory of instruction should specify the experiences which most effectively implant in the individual a predisposition toward learning, and a theory of instruction should specify the nature and pacing of rewards and punishments in the learning process. The time and space limitations necessary for the present paper preclude systematic attention to these important criteria. A second paper has been developed for this purpose (G. Thomas Rowland and Joe L. Frost, "Motivation: A Structure Process Interpretation, 1970, publication pending).

Bruner's four criteria oversimplify the requirements for a theory of instruction and SP theory as currently conceptualized deals only with preliminary requirements. That is, the inference for curriculum and instruction drawn from structural theory are relevant for arranging and sequencing content. Inferences from process theory are relevant to the assessment and/or diagnosis of developmental levels of children and, to lesser extent, with the matching of curriculum content and sequence with developmental levels of children. At this point teaching begins and additional theory is required. In addition to motivational theory the teacher must now have access to organizational theory (see Frost and Rowland, 1969, Ch. 7), teaching methodology theory (Ch. 5).

REFERENCES

Barton, A. H. & D.E. Wilder. Research and practice in the teaching of reading: a progress report. In M. B. Miles, (ed.), Innovations in Education. New York: Teachers College, Columbia University, 1964.

Bloom, B.S. (Ed.), Taxonomy of Educational Objectives. Handbook I: Cognitive Domain. New York; Longmans, 1956.

Bruner, J. S. The course of cognitive growth. American Psychologist, 1964, P. 1-15.

Bruner, J.S. Toward a Theory of Instruction. Cambridge, Massachusetts; The Belknap Press, 1966.

Evans, R. I. B. F. Skinner: The Man and His Ideas. New York; E. P. Dutton, 1968.

Ferguson, G. A. On learning and human ability. Canadian Journal of Psychology. 1956, 13, P. 131-137.

Ferguson, G. A. On Transfer and the abilities of men. Canadian Journal of Psychology, 1956, 10, P. 95-112.

Flavell, J. H. The Developmental Psychology of Jean Piaget. Princeton, N.J.; Van Nostrand, 1963.

Fries, C. C. Linguistics and Reading. New York; Holt, Rinehart and Winston, 1963.

Frost, J. L. Application of a structure process approach to inservice teacher education and compensatory programming. In J. L. Frost and G. R. Hawkes (Eds.) The Disadvantaged Child, Issues and Innovations (second edition). Boston; Houghton Mifflin, 1970.

Frost, J. L. and G. T. Rowland. Curricula for the Seventies. Early Childhood Through Early Adolescence. Boston; Houghton Mifflin, 1969.

Frost, J. L. and G. T. Rowland Cognitive development and literacy in disadvantaged children: a structure process approach. In Joe L. Frost (ed.) Early Childhood Education Rediscovered. New York; Holt, Rinehart and Winston, 1968.

Gagne, R. M. Contributions of learning to human development. Psychological Review. 1968, 75, P. 177-190.

Gagne, R. M. The acquisition of knowledge. Psychological Review. 1962, 69, P. 355-356.

Gordon, T. J. New conceptions of children's learning development from W. B. Waetjen et al. Learning and Mental Health in the School. Washington, A. S. C. D., 1966.

Guilford, J. P. The Nature of Human Intelligence. New York; McGraw-Hill, 1967.

Hebb, D. O. Organization of Behavior. New York; John Wiley, 1949.

Holmes, J. A. The substrata-factor theory of reading: some experimental evidence. International Reading Association Conference Proceedings, 1960, 5, P. 115-121.

Hunt, J. McV. The psychological basis for using pre-school enrichment as an antidote for cultural deprivation. Merrill-Palmer Quarterly, 10, July, 1964.

Kohlberg, L. Cognitive stages and preschool education. Human Development, 1966, 9, P. 17.

Krech, D. The chemistry of learning. Saturday Review. January 20, 1968.

Krech, D., et al. Relations between brain chemistry and problem solving among rats raised in enriched and impoverished environments. Journal of Comparative and Physiological Psychology, 1962, 55, P. 801-807.

Levin, H. Reading research: what, why, and for whom? Elementary English, 1966, 43, P. 138-147.

Olson, D. P. On conceptual strategies. from Bruner, J. et al. Studies in Cognitive Growth. New York; John Wiley, 1966.

Piaget, J. How children form mathematical concepts. from Mussen, P. H. et al. Readings in Child Development and Personality. New York; Harper and Row, 1965.

Piaget, J. Psychology of Intelligence. Totowa, N.J.; Littlefield, Adams, 1947 (second edition, 1966)

Pribham, K. H. Neurological notes on the art of educating. Theories of learning and instruction. NSSE 63rd Yearbook, Part I. Chicago: University of Chicago, 1964.

Pribham, K. H. The neurophysiology of remembering. Scientific American, 220, No. 1. (January, 1969), P. 73-86.

Rowland, G.T. Cognitive development in children: a model for intervention. A paper delivered at the 14th annual convention of the Southwestern Psychological association, Developmental Psychology I., Houston, Texas, 1967.

Wolf, W. and C. Mehrotra. A factor analytic study of the Ohio State University critical reading tests. Journal of Research and Development in Education. 1969, 3, P. 100-109.