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CHAPTER V

Meaningful Learning and Retention: Intrapersonal Cognitive Variables

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MOST OF the discussion in this chapter will be confined to research in cognitive structure variables and in cognitive style. The influence of individual differences in intellectual ability on learning, problem solving, academic achievement, and creativity has been adequately covered in two previous REVIEW issues, "The Education of Exceptional Children" (December 1959) and "Educational and Psychological Testing" (February 1959). The learner's developmental readiness for different kinds, components, levels of difficulty, and methods of teaching of subject matter, as influenced by age-level differences in cognitive maturity, is obviously relevant in the context of intrapersonal cognitive variables and has been considered in Chapter I of this issue.

Cognitive Structure Variables

By cognitive structure is meant an individual's organization, stability, and clarity of knowledge in a particular subject-matter field relative to meaningful new learning tasks in this field (Ausubel, 1961). In the more general and long-term sense, cognitive structure variables refer to the influence of significant organizational properties of the learner's *total* knowledge in this subject-matter field on his future academic performance in the same area. In the more specific and short-term sense, cognitive structure variables refer to the effects of the organizational properties of just the *immediately* (or proximately) relevant concepts within a particular subject-matter field on the learning and retention of *small units* of related subject matter.

The importance of cognitive structure variables has been generally underestimated in the past because preoccupation with noncognitive, rote, and motor types of learning has tended to focus attention on such current situational and intrapersonal factors as task, practice, drive, incentive, and reinforcement variables. It is true that the influence of prior experience on current learning tasks is conventionally considered under the heading of positive and negative transfer (or proactive facilitation and inhibition), but such transfer is generally interpreted in terms of the *direct* interaction between the stimulus and response attributes of the two overlapping but essentially discrete learning tasks (i.e., the recently experienced and the current).

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Theoretical Formulations of Cognitive Structure

Much more saliently than in experimental laboratory types of learning situations, typical school learning requires the incorporation of new concepts and information into an established cognitive framework with particular organizational properties. The transfer paradigm still applies here, and transfer still refers to the impact of prior experience upon current learning. But prior experience in this case is conceptualized as a cumulatively acquired, hierarchically organized, and established body of knowledge which is organically relatable to the new learning task, rather than as a recently experienced constellation of stimulus-response connections influencing the learning of another discrete set of such connections. Furthermore, the relevant aspects of past experience in this type of transfer paradigm are such organizational properties of the learner's subject-matter knowledge as clarity, stability, generalizability, inclusiveness, cohesiveness, and discriminability (i.e., cognitive structure variables)—*not* the degree of similarity between stimuli and responses in the two learning tasks. Further, recent prior experience is not regarded as influencing current learning by interacting *directly* with the stimulus-response components of the new learning task, except insofar as it modifies significant relevant attributes of cognitive structure. In an empirical test of this theoretical orientation, Ausubel and Blake (1958), using a proactive inhibition research design, demonstrated that meaningful learning and retention of a passage on Buddhism was not adversely affected by recent prior learning of interfering materials, for example, on Christianity.

Bruner's (1960) concept of "structure," in which he elaborated in a school learning context his previously published views on "going beyond the information given," was related to the concepts of cognitive structure and transfer as defined above. Mastery of the fundamental ideas of a discipline (its structure), he claimed, both makes the subject matter more comprehensible and easier to retain and facilitates transfer. Although these propositions, in their general form, had considerable face validity, Bruner's particular formulation was vulnerable on two counts. In the first place, he asserted that most specific memories can be forgotten with impunity as long as they are derivable or can be "reconstructed" when needed from those "generic" concepts or formulas which *are* worth remembering. Actually, however, relatively little school knowledge conforms to this derivative or "regenerative" model of memory in which the loss of specifics constitutes no great disadvantage in terms of academic achievement. New learning materials more frequently bear a *correlative* than a derivative relationship to established concepts in cognitive structure, and the forgetting of meaningful learned material, according to Ausubel (1960a), is largely a disadvantageous process of "obliterative subsumption" in which the identity of newly incorporated specific items is no longer dissociable from the more inclusive and generalized meaning

represented by the established concept under which they are subsumed. Second, in accordance with traditional usage, Bruner restricted the use of the term "transfer" to those instances in which "a general idea . . . can be used as a basis for recognizing subsequent problems as special cases of the idea originally mastered." However, Ausubel (1961) observed that in the vast majority of classroom learning situations where cognitive structure variables play a significant role, the transfer paradigm was more frequently applicable to the incorporation and retention of presented verbal material (i.e., "reception learning") than to "discovery learning" or problem solving.

Long-Term Studies: Improvement of Thinking

Despite their self-evident significance for school learning, long-term studies of cognitive structure variables involving subject-matter achievement were extremely sparse. Very little research in this area conformed to the minimal necessary research design (i.e., the transfer paradigm), which requires that a single attribute of cognitive structure first be deliberately manipulated, using adequate experimental and/or statistical control procedures, and that this altered cognitive structure then be related to long-term achievement outcomes in an extended program of new studies in the same field.

Promising attempts to enhance critical thinking ability by influencing cognitive structure in particular subject-matter areas were made by Abercrombie (1960), Suchman (1959, 1960), and Smith (1960). Abercrombie tried to improve medical students' ability to reason effectively by providing them with opportunities for "therapeutic" group discussion in an unstructured, nonauthoritarian atmosphere. Ability to analyze X rays was used as the criterion for assessing the effects of this training. Abercrombie's findings were generally in the predicted direction but were vulnerable on the grounds of failure to control for the Hawthorne effect.

Suchman (1960) experimented with the teaching of strategies and tactics of scientific inquiry to children to help them to learn to apply them in question-and-answer investigations. Preliminary findings by Suchman (1959) indicated that although such training increased the number of valid questions children asked in the test (criterion) situation, it did not significantly enhance the quality of the questions or facilitate grasp of concepts. Hence, more definitive evidence of the transfer value of such training to new situations was being sought, and the new criteria of transfer being employed were not only more independent of the particular training procedures used but also more reflective of the ultimate purpose of such training, i.e., greater knowledge of the content and/or the method of science.

Smith (1960), with Henderson's assistance, developed instructional materials designed to develop critical thinking abilities, and then helped teachers to learn how to handle these materials in the classroom. They

found wide differences among students of different teachers with respect to improvement in critical thinking, but refrained from drawing definitive conclusions because they had not yet devised a technique for describing and measuring what teachers were *actually* doing in this situation. Their next step, therefore, was to devise a method of categorizing the logical operations in thinking. The great value of this approach is twofold: First, it involves an attempt to influence critical thinking through the simultaneous teaching of both the logic of a particular subject-matter field and its content, rather than through general principles of logic; second, this category system promises to do much to place long-term classroom studies of cognitive structure variables on a sound experimental basis because of its attempt to quantify the crucially important but elusive teaching variable. Aschner's (1961) useful category system for classifying the thought processes reflected in verbal behavior was based on Guilford's conception of the structure of intellect.

Long-Term Studies: Influence of Existing Knowledge on Achievement

Studies in which the degree of existing knowledge of subject matter at one level of educational attainment was related to performance at subsequent educational levels also conformed to the long-term transfer paradigm. Constancy of academic attainment was, of course, attributable in part to constancy of academic aptitude and motivation. But, especially when these latter factors were controlled, it was reasonable to attribute some of the obtained relationship between earlier and later educational levels to the cumulative effects of cognitive structure variables.

Automated teaching and other forms of programed instruction appeared to exert a leveling influence on the relationship between the degree of existing knowledge and that of new learning in the same subject-matter area. Meyer (1960) obtained a correlation of —.52 between pretest scores on knowledge of English prefixes and gain in such knowledge after 10 days of self-instruction with a programed workbook. Little (1960) similarly found that drill machines giving immediate knowledge of results of practice tests in an educational psychology course, as well as opportunity to correct mistakes by drill, benefited those students most who usually scored in the lower half of the distribution. As a result of such teaching both the more and the less knowledgeable subjects moved upward in attainment, but the terminal achievement of the two groups tended to converge.

Long-Term Studies: Improvement of Instruction

Many of the curriculum-reform movements attempted to enhance long-term learning and retention by influencing cognitive structure variables. The University of Illinois Committee on School Mathematics (Beberman,

1958), for example, stressed initial self-discovery of generalizations by students, followed by precise, consistent, and unambiguous verbalization of modern concepts. The Secondary School Physics Program of the Physical Science Study Committee (Finlay, 1960) placed great emphasis on the integrative and widely generalizable concepts in modern physics; on inquiry in depth rather than on broad, superficial coverage of the field; on careful, sequential programing of principles; and on conveying to the student something of the spirit and methods of physics as a developing experimental science. Implicit in each program was the assumption that whatever ultimate superiority in academic attainment was achieved by following these pedagogic principles would be attributable to cumulative changes in the organization, stability, and clarity of cognitive structure.

Achievement-test data provided by evaluative studies of such programs offered presumptive evidence regarding the long-term effects of cognitive structure variables. Nevertheless, this type of research did not conform to the transfer paradigm, since the learning of *new* material in the same subject-matter field was not studied as a function of modified cognitive structure. Furthermore, not only was it impossible in such programs to isolate the effects of the individual variables involved, but also only rarely was any effort made to obtain comparable achievement data from control groups or to control for the Hawthorne effect. Measurement also was a difficult problem, because standardized achievement tests both covered various traditional subject-matter units deliberately ignored by these new curriculums and failed to measure knowledge of the more modern concepts which they emphasized. All of these difficulties pointed up the unfeasibility of using curriculum research as a source of rigorous experimental evidence bearing on a single cognitive structure variable.

Similar kinds of presumptive evidence regarding the long-term effects of cognitive structure variables came from studies of automated teaching. Pressey (1960) systematically used a self-instructional (punchboard) device as an integral part of a course in educational psychology. This device both provided immediate feedback and guided the student to the correct answer if he was wrong. Students using the punchboard made higher midterm and final examination scores than did control subjects. Little (1960) and Stephens (1960) reported similar findings. Nevertheless, although control groups were employed in these studies, the transfer paradigm was not followed, the effects of the drill and feedback variables were not isolated from each other, the Hawthorne effect was disregarded, and no attempt was made to equate experimental and control groups with respect to actual degree of exposure to relevant learning material.

Long-term experimental evidence derived from more modern teaching machine procedures is equally sparse. The study conducted by Skinner and Holland (1960) on programed instruction in introductory psychology, for example, was subject to all the methodological criticisms listed above in addition to the fact that control groups were not used. Porter's

(1959) study of programed instruction in spelling and Meyer's (1960) aforementioned vocabulary study were notable for the use of matched control groups, and the latter study also attempted to isolate the effects of single variables.

Despite the paucity of rigorous experimental work in this area, it was evident that, with proper controls, with manipulation of single variables, and with use of the transfer paradigm, automatic teaching devices could provide much valuable evidence on the long-term effects of cognitive structure variables. Programed learning procedures enhanced the stability and clarity of cognitive structure in two important ways: First, by supplying immediate feedback, they corrected wrong choice of alternative meanings, misinterpretations, ambiguities, and misconceptions before they had an opportunity to impair the clarity of cognitive structure and thereby to inhibit the learning of *new* material; second, by deferring the introduction of new material until prior material in the learning sequence was thoroughly consolidated, they maximized the effects of both stability and clarity of cognitive structure on *new* learning.

Short-Term Studies

Ausubel (1960a) proposed the use of organizers (i.e., advance introductory material at a high level of abstraction, generality, and inclusiveness) as a means of investigating programmatically the effects of short-term cognitive structure variables. By systematically manipulating the properties of organizers, it was possible to influence various attributes of cognitive structure (e.g., the availability to the learner of relevant and proximately inclusive subsumers, and the clarity, stability, discriminability, cohesiveness, and integrativeness of these subsumers) and then to ascertain the influence of this manipulation on new learning, retention, and problem solving. Such studies employed control subjects who were exposed to similar introductory materials, except for the particular variable under investigation, and hence followed the transfer paradigm. Ausubel (1960b) showed, for example, that when undergraduates were exposed to organizers presenting relevant and appropriately inclusive subsuming concepts, they were better able to learn and retain unfamiliar ideational material. Where the new learning material was relatable to previously learned concepts, as in the more typical classroom situation, the learner's ability to discriminate between the two bodies of material was obviously an important variable. Ausubel and Fitzgerald (1961) demonstrated that such discriminability was partly a function of the stability and clarity of these previously learned concepts (as measured by an achievement test) and that when discriminability was low because of inadequate prior knowledge, learning and retention could be enhanced by the use of "comparative organizers."

Several investigators used automated teaching devices in short-term studies of learning and retention, but they generally restricted their atten-

tion to the relative effectiveness of these devices compared to conventional classroom instruction. Coulson and Silberman (1960) and Evans, Glaser, and Homme (1960), for example, reported that university students, using simulated teaching machines and programed textbooks, respectively, were better able to learn small units of meaningful material than were control groups employing comparable conventional methods. These studies also isolated the effects of such variables as size of step and mode and overtness of response. But unless the transfer paradigm is followed (i.e., until the effect of prior exposure to such factors was related to the learning of *new* material), the rich potentialities of these devices for increasing our knowledge of cognitive structure variables cannot be realized.

Information about the effects of cognitive structure on learning could be gleaned from many traditional studies of transfer of training. Morrisett and Hovland (1959) showed that transfer in learning set problems was a function both of mastery within a given type of problem and of experience with a variety of problems (i.e., generalization between problems). Goss and Moylan (1958) and Yarczower (1959) also demonstrated that the facilitating effect of verbal pretraining on concept formation was relative to the subjects' mastery of discriminative verbal cues during pretraining. Heterogeneous presentation of stimulus material that did not provide sufficient repetition to allow for mastery not only was less effective than homogeneous presentation in learning a principle but also, according to Sassenrath's (1959) data, did not facilitate during a transfer period the learning of a principle which was the reverse of the original. An incidental finding in this study confirmed the transfer value of furnishing to subjects feedback about the correctness of responses in the training series.

Evidence continued to accumulate regarding the mediating function of implicit verbal processes in concept formation. Liublinskaya (1957) and Kendler and Karasik (1958) showed that the availability of distinctive verbal responses facilitated concept formation and conceptual transfer; also confirming earlier findings in this area, Weir and Stevenson (1959) reported that *explicit* instructions to verbalize enhanced transposition learning in children and that this effect was unrelated to chronological age within the age range of three to nine. Mere ability to verbalize, however, may have constituted no advantage in certain simple transposition problems, inasmuch as "preverbal" preschool children seemed to do as well as "verbal" children (Rudel, 1958; Gonzalez and Ross, 1958). Both Sassenrath (1959) and Bensberg (1958) demonstrated that, even when the transfer task required the learning of a reversal principle, preliminary training on the original form of the principle, when accompanied by mediating symbolic processes, had facilitating rather than inhibitory effects. In support of Judd's classical research on transfer, Ervin (1960) found that verbal instruction in relevant physical principles underlying a given motor performance increased transfer to analogous motor performance in third-grade and fourth-grade children. This effect, however,

did not occur unless the subjects were able to perceive both the similarity between the two motor tasks and the link between verbal principles and performance.

The issue of directed *versus* independent discovery in learning and transferring principles was still very much in doubt, partly because of the difficulty of holding constant such other relevant factors as the rote-meaningful, inductive-deductive, verbalization, and motivational variables. Haslerud and Meyers (1958) concluded from a coding experiment that encoding practice was more transferable when coding principles were independently derived than when they were given. This conclusion was questionable, however, in view of the fact that their subjects exhibited significantly better initial learning on those problems for which the rule was given. Further, the less debatable of the two types of analysis performed showed no significant difference in score on a delayed test of code identification between problems originally learned by these two methods. Kersh (1958) did find significant differences in favor of a "no help" as against a "directed reference" and "rule given" group on a delayed test of ability to infer rules from arithmetic problems, but he also presented evidence suggesting that this superiority was attributable to the greater interest and drive instigated by the independent discovery procedure in the interval between the initial and later test, rather than to superior understanding or meaningfulness.

Cognitive Style

Research interest continued to be active in the area of "cognitive style," i.e., self-consistent and enduring individual differences in cognitive organization and functioning. Cognitive style refers both to individual differences in general principles of cognitive organization (e.g., simplification and consistency trends) and to self-consistent idiosyncratic tendencies that are not reflective of human cognitive functioning in general (e.g., intolerance for ambiguity; memory for particular kinds of experience). It reflects differences in personality organization as well as genetically and experientially determined differences in cognitive capacity and functioning. A serious methodological weakness common to many of the studies in this area was their utilization of measures of cognitive style, its determinants, and its functional consequences for which adequate intratask or intertask generality of function had not been established.

Holzman and Gardner (1960) used the Schematizing Test, with an odd-even reliability coefficient of .84 to .90, to measure leveling-sharpening tendencies. They found that "sharpeners" surpassed "levelers" in ability to recall anecdotal material. Berkowitz (1957) showed that leveling tendencies manifested significant generality of function and that "levelers" tended to prefer simple to complex phenomenal experience. Gardner and others (1959), employing a factor-analytic approach, isolated a limited number of control principles reflective of individual consistencies

in cognitive behavior. These factors differed for men and women subjects. "Retention style" was studied by Paul (1959), who found general and consistent individual differences with respect to importation, amount of material retained, and the use and retention of imagery.

Rokeach (1960) obtained evidence of a generalized "open-closed" dimension of belief systems measured by a Dogmatism Scale and an Opinionation Scale with respective reliability coefficients of approximately .80 and .70. In validating these scales he noted that Catholics made high dogmatism and right-opinionation scores, whereas Communists and religious disbelievers made high dogmatism and left-opinionation scores. Only the right-opinionation groups, however, tended to score high on the Berkeley Fascism and Ethnocentrism Scales.

Luchins and Luchins (1959), in reviewing the literature on rigidity of behavior and the effect of *Einstellung,* asserted that no conclusions were possible at that time as to whether a general and self-consistent factor of rigidity existed. The intratask generality of individual differences in the water-jar *Einstellung* test had not yet been determined, and the validity of this measure, as well as its relationship both to other measures of rigidity and to other personality traits, were highly equivocal. Rokeach (1960), on the other hand, presented evidence which suggests that "closed" and rigid individuals experience difficulty in synthetic and analytic thinking, respectively. In an investigation of intra-individual consistency in "the use of affect labels in describing and categorizing social and ink blot stimuli," Kagan, Moss, and Sigel (1960) were able to demonstrate significantly positive intercorrelations among their four measures.

Broverman (1960a, b) identified "conceptual *versus* perceptual-motor dominance" and "strong *versus* weak automatization" styles on a word-color interference test. He then demonstrated that "conceptually dominant" subjects were less distracted than "perceptual-motor dominant" subjects on a difficult conceptual task and that "strong automatizers" were less distracted than "weak automatizers" both on an automatized conceptual and on an automatized perceptual-motor task (Broverman, 1960b). Parallel kinds of results also were reported for the effects of these same cognitive style variables on intra-individual differences in response strength (Broverman, 1960a). The significance of these findings, however, was diminished by the failure to consider intratask or intertask generality of function either for the measures of cognitive style or for the measures of their effects.

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