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# THE ROLE OF VERBAL MEDIATION IN MENTAL DEVELOPMENT* [1]

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## A. The Nature of Mental Development

The importance of current theory and research pertaining to verbal mediation is highlighted mainly by two factors: (*a*) conceptions of the nature of mental development, and (*b*) social concern with the educational problems of children called "culturally disadvantaged."

Historically and currently, ideas about mental development may be characterized in terms of the relative degree of emphasis given to (*a*) growth or developmental factors, and to (*b*) learning or experiential factors.

Until about the last decade, child psychology, preschool education, and primary education were dominated by a developmental or growth-oriented approach to the study of changes in mental ability as a function of age. The same developmental factors were invoked to explain individual differences and even social class and ethnic group differences in scholastic achievement and in performance on mental tests. This *growth-readiness* view of mental development, associated with such eminent psychologists as G. Stanley Hall and Arnold Gesell, holds that certain organized patterns of growth of neural structures must occur before certain experiential factors can effectively contribute to development. Rate of intellectual development is seen as related primarily to internal biological mechanisms and their orderly, sequential growth, rather than to inputs from the environment.

The opposite viewpoint emphasizes learning as a major causal factor in development. The most elemental and radical statement of this position is simply that humans, like all mammals, possess the neural structures for the formation of associations between the sensory inputs from receptors and the output mechanisms of the effectors—in short, the capacity for acquiring S-R habits. The sets of habits which we identify as intelligent behavior are seen as being built up through the acquisition of habits and chains of habits which interact to pro-

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duce complex behavior. Mental development is thus viewed as the learning of an ordered set of capabilities in some hierarchical or progressive fashion, making for increasing skills in stimulus differentiation, recall of previous learned responses, and generalization and transfer of learning. In recent years this viewpoint has been most vigorously espoused by Robert M. Gagné (10). He refers to it as the *cumulative learning* model of mental development.

My own view of these contrasting theories is that when each is stated in an extreme form, they serve as a useful set of coordinates in terms of which what is probably the true nature of mental development may be represented. One can represent the importance of developmental factors on the X axis and the importance of experiential factors on the Y axis. Various types of performance can be represented by their locations in this space, and for many types of performance the location will depend upon the age of the individual. For example, developmental factors may be relatively important in vocabulary acquisition in early childhood, while experiential factors may be of much greater importance for vocabulary acquisition in teenagers. Also, vocabulary acquisition in early childhood may depend less on developmental factors than, say, ability to cope geometric forms of varying complexity (16). As will be pointed out shortly, there is increasing reason to believe that both the growth and cumulative learning models are necessary to comprehend all the results of recent research. It is when we attempt to force either of the two extreme interpretations on the data that we must either strain credulity or severely restrict the range of phenomena that can be explained.

### 1. *The Recent Importance of Mediation Theory and Research*

In recent years the cumulative learning model seems to be most in tune with hopes for improving the educability of children from poor families, now called the culturally disadvantaged. The *growth-readiness* model has perhaps seemed too pessimistic to many educators and social scientists concerned with this problem. Those aspects of behavioristic learning theory which come closest to dealing with what we think of as the mental processes involved in intelligence have been seized upon as a means for explaining social-class differences in manifest intelligence and scholastic performance. Also, since the learning model makes explicit the processes that characterize intelligence, it offers the possibility that these may be changed through behavioral techniques to the advantage of many children whose chances of succeeding in school would ordinarily be poor.

Mediation theory was developed by behavior theorists specifically to comprehend those forms of behavior classed as "thinking," the abstract attitude, etc.

Disadvantaged children are especially characterized by deficiencies in those behaviors for which mediation processes are invoked as explanatory concepts. It is apparent that cognitive proficiency depends upon covert, self-initiated intellectual processes, and the only formulations of these processes which seem to present distinct possibilities for manipulating them by strictly behavioral means have been the S-R mediation theories. We know little or nothing about manipulating the rate of cognitive development on the biological level. Behavior theories of mediation based on the acquisition of verbal mediators through S-R associations, on the other hand, offer both a means of explaining mental development and of influencing its course through environmental intervention. Hence the attraction of this approach for those who wish to change behavior, and particularly for those who seek to improve the intellectual capabilities of disadvantaged children. The guiding hypotheses of such workers is that the main disadvantage of the "disadvantaged child" is inadequate exposure to the particular stimulus inputs which, for most children, are responsible for the learned forms of behavior we call "intelligence."

### 2. *Formulation of the Principal Research Problem*

The enthusiasm for seeking behavioral means for improving intelligence and educability has probably led to a too exclusive emphasis on those aspects of cognitive behavior that can be experimentally manipulated by the traditional techniques of the experimental psychology of conditioning and learning. Some theorists have cast nearly all aspects of mental development into a rather simple learning-theory framework. For a time, the idea of developmental factors—the growth of neural structures independently of experience, although perhaps requiring specific experiences for their activation—was eclipsed by an almost exclusive emphasis on the importance of learning *per se*.

There is now a growing disillusionment with an exclusive learning approach to cognitive development. Since it would be undesirable for the pendulum to swing to the other extreme, the problem should be reformulated as that of determining the relative importance of developmental and learning factors and their interaction for various cognitive skills. There is evidence that some of the cognitive skills needed for educability (i.e., the ability to learn school subjects under ordinary conditions of classroom instruction) are normally acquired through experience afforded by a good home environment, and they can be learned under special conditions by children whose environment has failed to provide the appropriate experiences. On the other hand, there are other cognitive skills, also an essential part of "intelligence" and educability, which cannot be explained easily without reference to developmental factors, the matu-

ration of brain structures, and the like, and which are relatively unsusceptible to training. One of the key problems is to determine the extent to which some cognitive behaviors achieved through special training merely *simulate* the same behaviors achieved through development (i.e., when there is no evidence of direct training) and the extent to which the trained behavior is actually the same as that achieved by "growth" rather than by specific training.

## B. Recent History of Research on Mediation Processes

### 1. *Russian Work*

Although the concept of verbal mediation may be traced in its various forms back to antiquity, it was probably not until Pavlov that the concept emerged from philosophical discourse into the realm of experimental science. The philosopher Cassirer stated the notion in the most general terms: "Man has, as it were, discovered a new method of adapting himself to his environment. Between the receptor system and the effector system, which are to be found in all animal species, we find in man a third link which we may describe as the symbolic system" (4, p. 43).

Pavlov translated this idea into a form permitting experimental investigation. He referred to speech (or other symbolic behavior) as a second signaling system, as distinguished from the first signaling system consisting of responses conditioned to the impingement of physical stimuli on the sensorium. It was apparent that as individuals grow from early childhood to adulthood, their overt responses to stimuli are increasingly mediated through the second signal system.

The stages through which this development occurs have been intensively studied by students of Pavlov and by later Russian psychologists, most notably A. R. Luria (30). Both developmental and learning factors are clearly evident in Luria's research on the verbal control of motor responses in children. There is a rather definite progression between the ages of 1½ to 6 years in the capability of subjugating motor responses to verbal control. At first, external commands act like any other conditioned stimuli as signals for some overt behavior. This stage is followed by the semantic meaning of utterances evoking or inhibiting responses, such that, for example, a child conditioned to press a bulb on the command "Press!" can be inhibited from pressing by the new command "Don't press!" At an earlier age the command "Don't press!" since it contained the signal "press," would cause the child to press the bulb. Luria views this transition as a developmental process and not as solely the result of cumulative learning. It is not until much later that the child's own speech is capable of regulating his overt behavior, somewhere between 4½ and 6 years of age.

It is the internalization of speech and its capability of governing behavior that Russian psychologists, such as Luria and Vygotsky (45), see as the basis for abstract and symbolic thought. The child's speech becomes not only an instrument of expression and social interaction but an instrument for the self-regulation of behavior and for increased control over the environment—through self-initiated planning, recall of past relevant experiences in new problem situations, self-instruction and rehearsal of newly acquired experience, and fantasies that lend coherence and continuity to play activities. The overt aspects of speech diminish as the child grows older and they become manifest from time to time when the child faces a new or difficult problem. Even as adults we begin "thinking out loud" when confronted with complex problems.

The recent Russian research on the developmental characteristics of the second signal system and some of the American research in this line have been reviewed by Thomas F. Hartman (14). The techniques developed by the Russians are powerful tools for exploring covert thought processes. The technique consists essentially of conditioning various autonomic responses, such as GSR, to either nonverbal (objects or pictures) or verbal stimuli (words, phrases, and sentences) and measuring the amount of semantic generalization of transfer of the conditioned response to other related verbal stimuli. Probably no more refined technique has been devised for studying the development of meaning, concepts, semantic equivalence, and covert verbal processes involved in problem solving.

### 2. *American Research on Mediation*

The idea of verbal mediation as covert *behavior* was an essential part of John B. Watson's behaviorism (46). Watson's formulation of thinking as subvocal speech, obeying simple laws of S-R association, was the precursor of later attempts at more detailed behavioristic accounts of thinking.

Clark L. Hull postulated the existence of "pure stimulus acts" to account for behavior in animals and men which did not follow directly from the stimuli to which the behavior had been originally conditioned and which could not be accounted for in terms of primary stimulus generalization (15).

In Hull's system "pure stimulus acts" are responses which serve only as cues or self-produced stimuli to which other responses can be conditioned. They make for generalization or transfer of responses beyond the confines of primary stimulus generalization, which is limited to relatively small variations of the physical stimulus situation.

This Hullian notion that behavior itself serves a stimulus or cue function to which still other responses may be conditioned was greatly elaborated upon in the 1940's and '50's by Cofer (5), and Osgood (32). The most sophisticated

and far-reaching extension of this earlier work is the cumulative learning model of Gagné, which has been most succinctly explicated in an article in the *Psychological Review* (11). In this article Gagné makes a case for interpreting the development of complex and abstract behavior entirely in terms of learning, including such cognitive activities as conservation of volume, which, following Piaget, most developmental psychologists have regarded as depending largely on biologically determined developmental factors.

### C. Types of Mediation Processes

In studies of human learning, mediation nearly always refers to *verbal* mediation. In the most general terms mediation refers to all mental processes that intervene between stimuli and responses when the relationship between these two sets of events cannot be attributed to simple associative processes. In most cases the intervening processes are conceived of as covert verbal responses to external stimulus situations; the verbalizations act in turn as stimuli for other responses.

Most mediational processes may be classified according to their effects into one of two broad categories—(*a*) those that make for stimulus *reduction* or *selection,* and (*b*) those that consist of stimulus *elaboration.*

Learning is facilitated in complex stimulus situations when the learner pays attention to only limited aspects of the stimuli and ignores those aspects which are irrelevant to mastery of the responses to be learned, the concept to be attained, or the problem to be solved. Learning or problem situations can elicit previously acquired mediators or "sets" in the learner which permit him to reduce the problem to its essentials. This is a form of mediation in that the subject is not responding to the entire stimulus complex, but rather to his self-initiated restructuring or abstraction of it. It is the difference between acquiring an S-R association and an S-r-s-R association, where the mediating links, r-s-R, have been previously acquired by the subject.

On the other hand, in relating *simple* stimulus situations, such as learning paired-associates, it is to the learner's advantage to *elaborate* on the stimulus elements, as by recalling other associations to these elements, thereby imbedding them in a larger associative framework, investing them with meaning, etc.

Most, but perhaps not all, forms of verbal mediation depend upon an active, self-initiated, conscious process in the learner. Relatively passive or automatic responding in the learning situation is generally incompatible with mediational processes, which depend upon the subject's activity, usually covert verbalization.

A number of different mediation phenomena and paradigms have been sub-

jected to experimental study. The most prominent phenomena are listed below. They all share in common the important fact that they are forms of verbal mediation which occur "naturally" (that is, they are not just experimentally contrived), and yet they also lend themselves to being manipulated experimentally. Most important is the fact that these forms of mediation can be learned or at least enhanced by training and practice, and all are known to facilitate learning, concept formation, and problem-solving.

### 1. *Labeling*

Labeling or assigning names to things is perhaps the simplest instance of the "elaboration paradox"—that is, the fact that in some situations it is easier to learn more than less. A classic demonstration of the phenomenon is that by Marjorie Honzik Pyles (33). She found that children learned much more quickly to respond to (i.e., pick up) the rewarded three-dimensional nonsense form among a number of such forms if children first learned nonsense syllable names for the objects. This may seem paradoxical, since it involves learning *two* things—the "names" of the objects *and* which object contained the reward. Yet children who were instructed to learn the names of the objects learned the main point of the task—to find the reward—more quickly than children who were not instructed to learn names for the objects. Older children tend to assign names to the objects spontaneously, and if this is made easier by using familiar objects rather than nonsense shapes, learning to pick up the object that conceals a reward is greatly facilitated.

A number of studies have shown that free recall of a number of familiar objects or pictures presented only once is facilitated in preschool children and in primary grade disadvantaged children if the children name the items while they are being presented. Older children (beyond 6 years of age) show little or no increase in amount recalled when they are told to name the items on presentation. Presumably the majority of children beyond 6 years of age spontaneously make some overt or covert naming response to the items, so that being instructed to do so adds little to the facilitation of recall.

One of the important differences we find between middle-class children and culturally disadvantaged children is not in their ability to name things but in the strength of their tendency to do so spontaneously without being asked, in situations in which learning is markedly facilitated by naming the items to be recalled or the elements of the problem to be solved.

In a study comparing trial-and-error selective learning in gifted, average, and retarded school children, Jensen (18) found that gifted and average children were quite active verbally during learning, while retarded (*IQ*s 50 to

75) children showed little evidence of spontaneous verbal activity. However, when the retarded children were instructed to verbalize in relevant ways (e.g., naming the stimuli), their learning rate was often markedly facilitated.

Flavell, Beach, and Chinsky (9) noted these verbalization tendencies in children learning discrimination and transfer problems, by noting speech, lip movements, etc. It was found that children who failed to learn did not produce verbal mediators at the appropriate points during learning trials.

### 2. *Mediated and Semantic Generalization*

Mediated generalization is the learned equivalence of stimulus elements that are physically unrelated: i.e., they do not lie on the same stimulus dimension, as in the case of primary stimulus generalization. This form of mediation has been most intensively studied by Russian psychologists by means of classical conditioning techniques, in which transfer of usually autonomic conditioned responses (e.g., the galvanic skin response) from objects to words or from one word (or phrase or sentence) to another is measured.

Mediated generalization, especially semantic generalization, is of interest in that it indicates that certain subject-generated stimuli (covert verbal responses) are elicited by the external stimulus situation and become conditioned to it as well. More interesting is the fact that there are gradients of semantic generalization, as well as of primary stimulus generalization. For example, if a galvanic skin response (GSR) is conditioned to a blue light, the word "blue" will also elicit the conditioned response (CR), and to a lesser degree the word "sky" will elicit the CR, as will other semantic associates of the word "blue."

Semantic generalization is of special interest to developmental psychologists because young children do not show it and its appearance and increasing strength in the age range from 5 to 7 are indicative of the development of the verbal mediational system, a system which is of great importance to school learning. Children with higher *IQ*s (and higher mental age) show a greater tendency for mediated generalization than lower *IQ* children (1).

Mediated generalization is also the basis for categorizing, an important intellectual ability on which great emphasis is placed in early childhood programs aimed at facilitating cognitive development.

### 3. *Far Transposition*

In the transposition paradigm the subject learns a discrimination between two stimuli which have values at two different points on some stimulus dimension (e.g., size or brightness). After the discrimination is learned, two new stimuli are presented, representing different points on the stimulus continuum, and the nature of the subject's transfer is noted.

In *near* transposition the subject learns the discrimination $1^-$ *vs.* $2^+$ (1 is unrewarded and 2 is rewarded stimulus; the numbers represent values on some stimulus continuum), then is given stimuli 2 *vs.* 4. In *far* transposition, the learned discrimination $1^-$ *vs.* $2^+$ is followed by, say, 4 *vs.* 8.

In far transposition, rats, monkeys, and young children generally respond to value 4 as the positive stimulus in the transfer situation, while older children and adults will choose value 8. (Results for near transposition are usually ambiguous, so that discussion is limited here to far transposition.) The predicted response would be made to value 4 if the subject's transfer were based only on primary stimulus generalization. Response to value 8 is interpreted as an instance of verbally mediated transfer. That is, the subject had not learned to associate a response to the physical stimulus, but to his verbal representation of some aspect of its relationship to the negative stimulus—e.g., "the larger (or brighter) is correct." In short, the physical stimulus elicits some verbal response and it is this verbal response (mediator), supplied by the subject himself, to which the overt response (selecting one or another stimulus object) becomes conditioned.

Classic experiments support this interpretation of transposition as verbally mediated transfer which overrides primary stimulus generalization, and they show a positive relationship between this phenomenon and age, intelligence, tendency to verbalize in the learning situation, and ability to state the basis for mediated transfer (28, 41).

### 4. *Reversal-Nonreversal Shift*

The reversal and nonreversal shift paradigm has been used extensively by Howard and Tracy Kendler to study the development of verbal mediation as a function of age (e.g., 27). The paradigm is based on the subject's learning discriminations between two sets of stimuli which differ simultaneously on two stimulus dimensions, such as size and brightness. The learned discrimination involves only one dimension, the other being irrelevant. After the discrimination has been learned up to some criterion, the discrimination task is changed in either one of the two ways: (*a*) the positive (rewarded) stimuli on the previously relevant dimension are made consistently negative (unrewarded) and the previously negative instances are made consistently positive—this is the *reversal* shift; or (*b*) the previously irrelevant stimulus dimension is made the basis for the discrimination and the previously relevant dimension becomes irrelevant—this is the *nonreversal* shift.

The Kendlers and others have reported age differences in the relative difficulty of learning the reversal and nonreversal shift discriminations. Younger children (under 6) do better on the nonreversal shift than on the

reversal; older children (over 6) do better on the reversal than on the nonreversal shift. The performance of the younger children is in this respect characteristic of lower animals. At kindergarten age children are divided about 50-50 in superiority of the reversal shift.

The change in case of learning reversal or nonreversal is interpreted in terms of mediated *versus* nonmediated learning, and the Kendlers have shown that instructions to verbalize relevant or irrelevant dimensions of the discrimination influence performance markedly and in ways that are consistent with the Kendler's mediation interpretation of the phenomenon (27). Much of the recent theoretical development of mediation theory has involved extensive research on the reversal-nonreversal shift difference (48).

### 5. *Experimentally Acquired Mediation*

Experimental psychologists in verbal learning have studied mediation by providing conditions under which subjects learn verbal mediators and then obtain measures of transfer to new learning. Much of this work has been reviewed by Jenkins (17).

The most common paradigm is that of three-stage mediated association in paired-associate (PA) learning. The subject learns a list of PAs designated as A-B, then learns list B-C, and then A-C. The A-C list can be learned in the same way that A-B was learned, or it can be learned by mediation through the A-B, B-C common link that B provides between A and C. The degree of facilitation afforded by the use of the mediator is assessed against the control condition of A-B, D-C, A-C.

An appreciable degree of facilitation due to mediation is generally found. In view of this, therefore, it is of considerable interest that four-stage mediation is almost never found, even when the conditions for it are made ideal and when the same kinds of subjects show a high degree of mediated facilitation in the three-stage paradigm. (The four-stage paradigm consists of A-B, B-C, C-D, A-D, with the speed of learning A-D measured against an appropriate nonmediated control condition.)

Lee and Jensen (29) hypothesized that the reason for the sharp discontinuity between the facilitation yielded by the three- and four-stage paradigms was due to the need for subjects to perform one other mediational act for the mediation paradigm to become effective in facilitating learning. That additional act is for the subject to perceive or become aware of the nature of the paradigm: that is, to "see" the connections between A-B, B-C, and A-C and B is the common link. This is relatively easy to see in the three-stage paradigm (as testimony of the subject's shows) and very difficult in the four-stage

paradigm. An experiment was designed to test the hypothesis that "awareness" of the paradigm and a conscious effort by the subject to use this knowledge in learning the A-C list is necessary for mediated facilitation to occur (29). The hypothesis was borne out by the experiment. The finding indicates that mediation, at least of the type found in this experiment, does not occur passively just as a result of having previously acquired the necessary primary associations on which mediation is based. The subject must perform still another mediating act ("awareness" or verbalizing to himself the nature of the paradigm and the conscious effort to use this information) in order for the other elements needed for mediation to be manifested as facilitation of learning. Some subjects gain this awareness spontaneously. Others can be made aware by instructions, and their performance is facilitated. Still others can be made aware and yet do not use the possibility for mediation and consequently do not show facilitation. There appear to be individual differences not only in the spontaneity of mediation, but in the ability to use mediators even when they are explicitly provided for the subject.

6. *Extraexperimentally Acquired Mediators: Implicit Chaining Paradigm*

The phenomenon of apparent implicit verbal chaining as a facilitator of PA learning was first demonstrated in an experiment by Russell and Storms (40). Their experiment showed that verbal mediators that are never explicitly introduced into the learning situation, but which had been acquired at some previous time, can facilitate PA learning. It is still not certain whether such mediation can take place without the subject's awareness of using a mediational process, although Russell and Storms believed that the process was unconscious and automatic. It appears that previously formed associations were capable of mediating and facilitating PA learning of list A-D in the following paradigm: A-B, B-C, C-D, A-D. The subject learns A-B pairs, then A-D pairs. The B-C and C-D pairs are never brought into the situation; but the whole sequence above is constructed in such a way that B-C and C-D are high frequency associates in word association norms. That is, there is high probability that these associations already exist in the subject, who thus can "use" these connections to mediate the learning of the A-D list.

A real problem is why the four-stage paradigm is so unsuccessful when all the elements have to be acquired in the laboratory and why it works in the Russell and Storms situation in which the mediating links (B-C, C-D) have been acquired in the subject's natural environment. The facilitating effect is weak, in any case. Its chief theoretical significance is that it shows the influence of previously acquired verbal associations on the learning of new associations which are not explicitly or directly related to the new associations. It suggests

that a person's richness of verbal associations may provide a general enhancing and facilitating basis for new learning and thus may constitute a part of what we mean by "intelligence" and "learning ability."

Consistent with this notion is the finding that simple PA learning is faster in subjects who can give more free associations per minute to nonsense syllables than for subjects who have difficulty producing free associations (31).

### 7. *Associative Clustering*

This phenomenon is observed when a list of words which can be classified into several categories (e.g., professions, vegetables, animals, clothing, etc.) are presented in a random order, and subjects are then asked to recall as many of the words as possible (3). It is generally found that the words are recalled as "clusters" corresponding to the categories and that subjects are able to recall more words when clustering is possible than when it is not, as in the case of lists of unrelated words.

The occurrence of associative clustering means (*a*) that the input has been actively reorganized by the subject before it is recalled, and (*b*) that the reorganization is verbally mediated by superordinate category labels which are apparently elicited by the presentation of the single instances of the categories. This implies a hierarchical arrangement of the verbal associative network, an important requirement for categorization, concept attainment, and related skills that are closely identified with cognitive development and intelligence.

### 8. *Verbal Self-Reinforcement*

If all of the immediate environmental consequences of the human learner's responses were biologically rewarding or nonrewarding, learning could proceed without the need for secondary reinforcement. In human learners the secondary reinforcement usually takes the form of an overt or covert verbal response, which I shall designate a verbal confirmatory response, $V_c$. It is a form of self-initiated feedback which tells the learner he is or is not on the right track in his attempt to learn something or to solve a problem. In other words, the immediate results of the subject's response (e.g., getting the "right" or "wrong" answer), if it is not a primary reinforcer, must elicit some mediated reinforcer which will shape the learner's performance much as do primary reinforcers. The subject utters to himself "Good," "Correct," "Right," "Wrong," etc.

So-called "informative feedback" in the learning situation seems to be powerless as a reinforcer unless it simultaneously elicits some verbal acknowledgement of its meaning in the subject. And there is some evidence that

low socioeconomic status children are relatively deficient in this type of verbal confirming response as compared with middle-class children (42, 43).

In a trial-and-error selective learning task in which the responses (pressing one of a number of pushbuttons) had to be paired with colored geometric forms projected on a screen and the informative feedback indicating correct responses was a green light going "on" for one second, Jensen (18) found that the learning rate of some educationally retarded children could be markedly improved when they were instructed to say aloud "good!" or "right!" whenever their button-pushing response caused the green light to go "on." Some showed absolutely no learning at all until they began making this verbal response to the informative feedback. It was found that average and, especially, "gifted" (*IQ* over 135) children make the $V_c$ spontaneously in this situation without having to be explicitly instructed to do so. Some children in the retarded group needed a good deal of practice and urging by the experimenter before the $V_c$ became more or less habitual.

Merely being told at the beginning of a session that the green light means "right" is apparently without any appreciable reinforcing effect unless the subject says aloud or to himself "right" (or some equivalent thereof) each time he sees the green light.

Why some children do this so spontaneously—even if they are not told that the green light means anything—and why some children have such a high threshold for spontaneous verbal utterance in what outwardly appears to be a nonverbal problem situation is the key question. In social and verbal contexts one type of child is as verbal as the other. In fact, many of the nonverbalizers in the problem situation are highly verbal in a social context, if by verbal one means sheer amount of speech production accompanying social interactions.

It is worth entertaining the hypothesis that acquiring strong habits of verbalizing elements in certain learning situations can be a powerful facilitator of learning. The facilitating effects of such verbalization have already been demonstrated in situations where the verbalization helps to reduce the seeming complexity of the input and to focus the subject's attention on the most relevant aspects. It is not yet known how broadly such verbalization training will transfer.

### 9. *Syntactical Mediation and Mnemonic Elaboration*

This form of verbal mediation was first described by Jensen and Rohwer (19, 23, 24, 25). It has since been extensively studied by Rohwer and his co-workers (3, 4, 35, 36, 37, 38, 39). Syntactical mediation, which Rohwer regards as just a special case of a whole class of mediators he calls *mnemonic*

*elaboration*, is by far the most powerful mediational process we have worked with in terms of its facilitating effects on associated learning.

The basic paradigm is simple. The subject is presented with a list of paired-associates to learn by the standard method of anticipation. (The paired items are usually words or pictures of familiar objects.) On the first presentation of the pairs (our studies used from eight to 24 pairs), the subject is instructed to make up a simple sentence which relates the two items in each pair, or, in some experiments, the experimenter says aloud a sentence which serves this purpose. This is done *only* on the first presentation trial. It is found that subjects learning under such conditions learn the list in fewer trials than a control group which has been instructed only to *name* the two items in each pair on their first presentation.

An example of a syntactical mediator for the pair HAT-CHAIR is "The HAT is on the CHAIR."

The amount of facilitation of learning achieved by syntactical mediation depends upon the age and intelligence of the learner. In general, the amount of facilitation decreases from about age 7 to age 17, presumably because with increasing age an increasing proportion of children spontaneously provide their own mediation. They report this on questioning. Second-grade children learn as fast as twelfth-graders (matched for *IQ*) when they are told to form syntactical mediators. Twelfth-graders show no appreciable gain in performance. Retarded adults (*IQ*s 40-60), however, can learn a list of paired associates approximately five times as fast under mediation instructions (19). Kindergarten children (ages 5-6), however, seem to benefit little if at all. This absence of facilitation below about age 6 raises the question whether children of this age are developmentally incapable of deriving benefit from this form of elaboration or if they simply have difficulty in carrying out the elaboration instructions to generate sentences under the constraints of the PA task. Many do, in fact, generate what would be adequate sentences for facilitation in slightly older age groups. The fact that learning is not facilitated in the younger children is consistent with other findings to the effect that under 6 years of age the child's verbalizations have little influence on his learning and problem-solving behavior.

Rohwer has further investigated the degree of facilitation of learning as a function of the linguistic form classes of the elaborations employed by the subject or manipulated by the experimenter's instructions. For example, conjunctions, prepositions, and verbs differ in their potency as mediators, conjunctions being least effective and verbs the most. A series of studies by Rohwer, designed to pinpoint the locus of syntactical mediation, leads to the following conclusions:

(*a*) The difference in facilitatory power between conjunctions, prepositions, and verbs is not attributable to the fact that the degree of formal intralist similarity is lower in a list of verb strings than in a list of conjunction or preposition strings.

(*b*) The form-class effect is not attributable to the greater degree of semantic constraint exerted on subsequent string components by verb than by conjunction connectives.

(*c*) Normal sentences facilitate the learning of the constituent noun pairs, whereas anomalous sentences (i.e., abnormal syntax) do not.

(*d*) As connectives, verbs implying relatively little overt action facilitate learning as much as verbs implying considerable overt action.

(*e*) Even though matched for number and identity of words, sentences in which two nouns are connected by a conjunction produce less efficient learning than sentences in which the nouns are connected by a verb.

(*f*) The presence or absence of adjective modifiers appears to have no effect on the learning of noun pairs presented in sentences.

(*g*) The principal locus of the effect of sentence elaboration appears to be at the time of input rather than at the time of retrieval.

(*h*) Entire verb strings or sentences are easier to learn than entire conjunction strings or phrases when matched for number of words to be recalled.

Another form of mnemonic elaboration being studied by Rohwer is pictorial in nature. Pairs of objects are shown in motion pictures; the objects briefly interact with one another (e.g., a ball rolls toward a candle and knocks it over). The rate of learning such picture pairs (one object is shown and the subject must name the other object that had been paired with it) is assessed against a control condition in which the same pairs of objects are shown in still pictures for the same duration.

Rohwer was led to this procedure by the hypothesis that verbal-mediation of paired associate learnings may act through the verbal evocation of imagery. If so, it may be the variations in properties of the evoked images that determine learning efficiency directly, rather than properties of the verbal units that constitute the nominal learning materials in the usual PA task. Consequently, Rohwer has been investigating the degree of equivalence of verbal and pictorial mediation of paired-associate learning.

The rated capability of words for evoking representational images determines a substantial proportion of the variance in difficulty of learning of verbal paired-associates, even when these are controlled for frequency, meaningfulness, and pronounceability.

For elementary school children, a list of paired associates is easier to learn when the items are shown pictorially than when represented verbally by their

names. Acquisition is most efficient when the two objects in each pair are shown in some action episode (e.g., a ball dropping into a glass), less efficient when the two are static but in a particular spatial juxtaposition (e.g., a ball in a glass), and least efficient when static and represented independently (e.g., a ball and a glass, merely side by side). These relationships hold up over the age range from 6 to 12.

One may wonder whether individual differences in rate of PA learning are related to individual differences in verbalization *per se* or in differences in the degree to which verbalization evokes images or otherwise causes some kind of "associative arousal" which speeds learning.

### 10. *Learning Set Formation*

Learning sets ("learning-how-to-learn") are forms of mediated transfer which may or may not depend upon verbal or symbolic processes. It is known that there is a phylogenetic gradient for speed of acquiring learning sets, and there are individual differences within species. Zeaman and House, for example, report a higher relationship between measured intelligence and rate of acquisition of learning sets than between intelligence and simple learning (49).

Learning set formation apparently involves higher-order processes than conditioning or simple associative learning. Harlow's error factor theory (13) accounts for learning set formation in terms of the extinction or inhibition of irrelevant response tendencies for certain classes of problems. At the human level additional mechanisms probably also play a part. The most important of these are attentional and problem-solving strategies which subjects learn to summon when confronted with problem situations they can classify, such classification being, in part, the mediational stimulus for evoking the appropriate strategy.

The theory of knowledge acquisition as learning which is mediated by positive transfer from a hierarchy of subordinate learning sets has been espoused chiefly by Gagné (10, 11). The importance of his theory is that it focuses attention on task analysis—the discovery of the set of subskills that are necessary prerequisites for the acquisition of new skills or knowledge. It specifies the conditions of prior learning necessary for transfer to some new learning. Learning difficulties at "higher" levels of knowledge acquisition are interpreted as due to a failure (for whatever reason) to learn certain subordinate skills. This basic premise of the Gagné model is questioned in a later section of this paper.

### 11. *Cross-Modal Transfer*

Cross-modal transfer is not yet well understood. But it has implications for mediation theories, and measures of cross-modal transfer may provide an important index of mental development.

The procedure for measuring cross-modal transfer consists of presenting a stimulus in one sensory modality and having the subject identify it in a recognition multiple-choice test in a different modality. The most commonly used modalities are visual and haptic. The subject, for example, puts his hand behind a screen and feels an object of a particular shape, then is shown several different objects (or pictorial representations of several objects) and is asked to point out the one which he had handled. The importance of the subject's ability to transfer the knowledge gained in one modality to recognition in another is the fact that there is no direct connection or neural isomorphism between the sensory "information" from the two modalities. The sensory information must arouse a central mediating process which represents the object in some abstract way and reference to which permits recognition of the object in some other sense modality. Lower animals, including the great apes, are apparently incapable of learning cross-modal transfer. It is unique to man, as far as we know. It is absent in young children and the capability for it does not develop much before other forms of mediation processes are manifest, between ages 5 and 7. Also, temporal lobe damage impairs haptic-visual transfer in adults; the same patients have inordinate difficulties with other learning tasks thought to involve mediational processes in normal subjects.

## D. Current Research Problems

As was pointed out in the first section of this paper, much of the current interest in verbal mediation processes has been stimulated by the facts that (*a*) these processes seem to be the stuff of which abstract and conceptual intelligence is made, (*b*) these aspects of intelligence play a crucial role in educability: that is, the ability to achieve scholastically under ordinary conditions of instruction, and (*c*) a segment of our population called culturally disadvantaged does poorly in school and on the average scores low on measures of abstract intelligence.

Consequently, there has been great emphasis in recent years on stimulating, training, and developing educationally relevant cognitive processes in children whose deficiencies in these processes are hypothesized to be due to certain cultural or environmental lacks during the preschool years. This environmental interpretation of poor scholastic performance and slow rate and low asymptote

of cognitive development is not proved and still has the status of a working hypothesis.

A number of independent current research findings are beginning to suggest that the views of acquired mediational skills or of a cumulative learning model á la Gagné as the basis for abstract intelligence, and of cultural enrichment or even specific training as a means of inculcating or enhancing the desired cognitive process in disadvantaged children, will have to be supplemented and modified by taking into greater account biological development factors.

A view that seems consistent with all the research evidence in this area is that the verbal mediation mechanisms, learning sets, and cumulative learning hierarchies, as described in the previous section, are all involved in cognitive development and are of crucial importance for school learning. Also, it is evident that these processes must be acquired through environmental influences. But the evidence is becoming increasingly convincing that the acquisition of hierarchically ordered cognitive processes also depends, not solely on appropriate inputs from the environment, but upon the maturation of a hierarchically ordered neural substrate. This view holds that certain patterns of neural growth or organization, determined by constitutional factors, must occur before the effects of learning can be manifest in the cognitive processes we identify as intelligence—reasoning ability, abstract and conceptual abilities, the ability to transform the world of the concrete into symbolic representations.

This view does not deny that certain cognitive skills at some level in the developmental hierarchy cannot be specifically trained in the absence of the development of the neural mechanisms normally involved in the acquisition of these skills. But there are differences: (*a*) the training requires much more time, effort, precision and control of the conditions of learning; (*b*) though the specific skill may be acquired, it shows much narrower transfer and in a factor analysis of a variety of cognitive tests the specifically acquired skill would probably contribute little if any variance to the *g* factor on which normally most cognitive skills are highly loaded; (*c*) without further specific training or practice, the specially acquired skill shows no continued growth or transfer to other new skills, and may even deteriorate; and (*d*) it does not seem to constitute a "quantum jump" in the cognitive hierarchy such as to support the acquisition of skills at a higher level.

### 1. *Hierarchical Arrangement of Learning Processes*

Sheldon H. White (47) put forth an argument, supported by a diversity of data, that adult mental organization is hierarchical, consisting of two main "layers": (*a*) an associative level laid down early in development and follow-

ing conventional associative principles, and (*b*) a "cognitive layer" laid down in later childhood. The formation of the cognitive layer either begins or is most marked between the ages of 5 and 7, a period during which many signs of a change in mode of cognitive functioning are evident. Between these ages children show a transition from a type of performance in learning situations characteristic of lower animals in similar situations to a type of performance characteristic of adult humans. Some of the experimental paradigms which reveal this transition and are discussed in detail by White are the following:

1. Narrow to broad transposition.
2. Easier nonreversal shifts to easier reversal shifts.
3. Onset of resistance to classical conditioning.
4. Change in the effect of a "varying-position" condition in discrimination learning.
5. Growth of inference in a problem-solving task.
6. Possible interference of complex hypotheses in discrimination learning.
7. Shift from "near receptors" (tactual, kinesthetic, etc.) to "distance receptors" (visual and auditory) in attending to environmental events.
8. Shift from color to form-dominance in classifying objects.
9. Development of personal left-right sense.
10. Decrease in form, word, and letter reversals.
11. Ability to hold spatial information through disorientation.
12. Change in face-hand test—children under 6 do not indicate awareness of a touch on the hand if the face is touched simultaneously but report only the touch on the face. After about age 6 the child can report both.
13. Increasing predictability of adult *IQ*.
14. Internalization of speech.
15. Shift from syntagmatic (associations having a meaningful connection but not grammatical likeness) to paradigmatic (associations having the same grammatical form class) word associations.
16. Increased disruptive influence of delayed auditory feedback.
17. Shift of verbalization toward a planning function in the child's activity.
18. Transition from social to abstract reinforcement.
19. A number of transitions involving conservation of number, length, space, volume, etc., shown in Piaget-type studies.

The fact that so many diverse forms of cognitive behavior change rather rapidly during the years from 5 to 7 in general and probably over a much shorter time-span in individual children suggests the maturation of some common underlying mechanisms. To Sheldon White's list of behaviors may be

added increased susceptibility to certain perceptual illusions (e.g., the spiral after-effect) and the fact that the ability to copy certain geometric figures conforms to an almost perfectly unidimensional age scale: e.g., the 10 figures in Ilg and Ames' *School Readiness* (16).

The shifts from the associative level to a predominantly cognitive level of mental functioning can be summarized in terms of four general transitions: (*a*) from direct responses to stimuli to responses produced by mediated stimuli; (*b*) emergence of the ability to induce invariance on the welter of phenomenal variability; (*c*) the capacity to organize past experience to permit inference and prediction; and (*d*) increased sensitivity to information yielded by distance as against near receptors.

An important question is: can these cognitive functions be trained in children who do not manifest them normally?

### 2. *Training Cognitive Skills*

Within the normal range of environmental variation on just about any index of any dimension of the sociocultural environment one wishes to consider, it seems obvious that other factors are also needed to account for differences in the rate and asymptote of mental development. A verbally rich environment is certainly not sufficient to produce superior intelligence, and it may not even be a necessary condition, since some intellectually superior children come from impoverished homes; and an impoverished environment is certainly neither necessary nor sufficient to cause mental retardation, since some retardates (*IQ*s under 75) come from good homes and the majority of children reared in the poorest circumstances are not mentally retarded. The evidence clearly indicates that a major share of the variance in mental abilities must be attributable to genetically determined biological factors in development and a minor share to experiential inputs for the majority (say, 95 percent) of the population (8, 21).

The crucial question concerning the culturally disadvantaged is the extent to which their environmental disadvantages are responsible for their generally lower scholastic achievement and their performance on mental ability tests. To the extent that their deficiencies are not just cultural but also involve biological developmental factors, something different from merely providing the amenities of middle-class culture will be needed in order to improve the educability of such children. Thus, the real problem of the disadvantaged may be not whether an ordinary middle-class type of environment will boost their intellectual performance up to the general average, but whether one can improve

their cognitive structures by special forms of training and cumulative learning experiences which may be quite different from what is needed for normal mental development by most children.

The meager gains in intelligence and scholastic performance made by general enrichment preschool programs suggests that something more and something different than providing the usual accouterments of middle-class nursery education, even in intensified form, is necessary.

Almost any enrichment experience, including ordinary kindergarten, causes a slight boost in *IQ* (5 to 10 points) in the majority of disadvantaged children (21). This is clearly due to the fact that the test had a certain small cultural loading and the child's cultural-information lacks are quickly made up by the school environment. But the rapid initial rate of gain does not persist, and by the second or third year of school, children called disadvantaged average about one standard deviation below the general population average in just about all areas of measurable intellectual and scholastic performance. This one standard deviation deficit persists quite uniformly throughout the school years, right up to the twelfth grade. There is no compelling evidence for a "cumulative deficit." The achievement gap is consistently close to one standard deviation throughout all the school years (6).

The preschool programs which show some promise of improving the educability of disadvantaged children, but which have not yet been adequately evaluated for long-term (more than one year) effects, have one characteristic in common: the intensiveness and specificity of training. The Bereiter-Engelmann program at the University of Illinois and University of Toronto and the tutorial language program of Marion Blank at the Albert Einstein College of Medicine, Yeshiva University, are good examples of this approach. Certain specific lacks in cognitive skills are identified and are then explicitly trained.

Blank and Solomon express the common observation made by most workers in the field that the behavior of children called culturally or socially disadvantaged "reflects a lack of a symbolic system by which to organize the plentiful stimulation surrounding them" (2, p. 379). Blank and Solomon have analyzed the "abstract attitude" into the behavioral components and specific skills of which it seems to be comprised and which presumably can be taught by one-to-one tutorial techniques.

The specific skills that are taught in the Blank program are (*a*) Selective attention, (*b*) Categories of exclusion, (*c*) Imagery of future events, (*d*) Relevant inner verbalization, (*e*) Separation of the word from its referent, (*f*) Models for cause and effect reasoning, (*g*) Ability to categorize, (*h*) Awareness of possessing language, (*i*) Sustained sequential thinking.

Nursery school children in a deprived area in New York City were individually tutored five days (15-20 minutes per day) a week over a four-month period. The average Stanford-Binet *IQ* gain was close to one standard deviation and ranged from 4 to 28 points. Untutored control groups showed average gains of less than three *IQ* points. The *IQ* changes were accompanied by other signs of improved adjustment to the school setting.

Studies such as this should be conducted on a larger scale, with more representative samples of the disadvantaged population, and with a follow-up of at least two years. Also, the breadth of transfer of such training should be assessed by using a variety of tests and behavioral criteria. Blank and Solomon found, for example, that a nonverbal intelligence test (Leiter Scale) showed smaller gains than the highly verbal Stanford-Binet. There are other indications in the literature that the magnitude of gains is positively correlated with the amount of cultural loading of the test. It is easy to show gains after training on the Peabody Picture Vocabulary Test and difficult to show them on Raven's Progressive Matrices.

Rohwer (34, 35, 36, 37, 38, 39) has trained disadvantaged kindergarten children in the use of verbal and imagery mediation in paired-associate learning. A systematic training program extending over several months produced complex and ambiguous results which are difficult to interpret. Disadvantaged children benefited from the training in the visual modality but not in the auditory (PAs were presented in both forms). That is, mediation training in both visual and auditory modalities showed learning rate gains only in the visual mode for the disadvantaged. A "control" group of middle-class kindergartners showed larger gains than the disadvantaged as a result of the same training, and the gains were manifested in both visual and auditory modalities. This finding is in line with the general impression of many teachers of the disadvantaged that they are poor auditory learners.

They differ, however, from totally deaf children in one very important way: they never catch up. Deaf children are retarded in school learning and various cognitive functions associated with verbalization. However, from early childhood to late adolescence deaf children gradually catch up and, on the average, finally attain a normal level of intellectual functioning. A major study comparing cognitive processes in deaf and hearing adolescents and adults found no differences between the deaf and the hearing by adulthood; such indices as dissociation between words and referents, verbalization adequacy, and level of verbalization were not different for deaf and hearing adult subjects. The investigators concluded that differences found between deaf and hearing children "fall along a normal developmental line and were amenable to the effects

of increased age and experience, and education" (26, p. 32). Such findings may lead one to wonder if the cognitive deficit of the disadvantaged can be adequately explained in terms of inadequate verbal stimulation. Verbal stimulation is increased in the school situation and yet the majority of disadvantaged children do not maintain gains in verbal intelligence which permit them to reach the same asymptote as the average level of the general population.

If general social-cultural deprivation is at fault, then one has to explain why some extremely deprived groups perform better in school and on tests than some less deprived groups. For example, on the 12 environmental indices used in the Coleman study of *Equality of Educational Opportunity* (6), American Indians rated as far below Negroes as Negroes rate below whites, and yet on all the scholastic measures used by Coleman, American Indians performed significantly better than Negroes. Apparently school performance is not related to the quality of the environment in any simple, monotonic way.

### 3. *Associative Clustering in Free Recall*

As was pointed out in a previous section, the phenomenon of associative clustering in verbal free recall is one of the clearest forms of evidence of conceptual, hierarchical processes. For clustering to occur, the subject must actively organize the stimulus input according to certain self-providing superordinate categories.

Two studies of this phenomenon as a function of age and socioeconomic status (confounded with race, since the low-SES group was Negro, the middle-SES group was white) have been made by Glasman (12) and Jensen and Frederiksen (22). Though the two studies were carried out in different school systems and with slight procedural variations, they are in close agreement in their results. First of all, in *random* lists of words which are made up so as not to lend themselves to categorization, there is no significant difference between low and middle-SES groups in amount of recall over five recall trials. In categorized lists (20 words that fall into four categories), on the other hand, middle-SES show better recall than do low-SES children. The degree of clustering in recall increases over the five trials and the amount of recall is highly correlated with degree of clustering—this is true over trials and over subjects. Clustering and amount of recall increase with age. At the kindergarten level the two SES samples do not differ, whereas by fifth grade the middle-class group is substantially superior. Although the low-SES group's output order of recall more closely approximates the input order than is the case for the middle-SES groups, there is evidence that both groups organize the random input in some fashion, but the principles of organization are ap-

parently quite different. The clustering by the middle-class group clearly is correlated with amount of recall. The main research problems now are (*a*) to determine the degree to which disadvantaged and nondisadvantaged children organize items for free recall with different kinds of principles, (*b*) whether the differences in types of organization is responsible for discrepancies in free recall performance, and (*c*) whether it is possible to improve free recall through training in categorization.

Examination of recall protocols from our free recall studies shows that low-SES children produce many two-item clusters according to some functional rather than conceptual relationships. For example, *table* and *bed* are not likely to be clustered (both furniture), while *shoe* (clothing) and *bed* may be a cluster because "you take off your shoes when you go to bed." In interviews with children as to the basis for their clusters in recall, many more such idiosyncratic pair-wise clusters are found in the low-SES group. It suggests a deficiency in hierarchical organization of the verbal associative network.

Since the SES differences in clustering tendency and amount of recall *increases* with age from kindergarten to fifth grade (the total range we have studied), one may wonder why the common school experience for both groups does not produce a convergence, rather than a divergence, in their clustering tendency and recall ability. This finding forces the question as to what extent clustering, and hierarchical and conceptual modes of learning in general, involve developmental, as well as experimental, factors.

### 4. *Psychometrizing Piaget Conservation Tests*

Piaget's various conservation demonstrations would seem to involve some sort of mediation process, though its nature remains obscure. The resistance of conservation to specific training is one of its most remarkable properties and strongly suggests that the sequence of development described by Piaget is largely controlled by developmental rather than by experimental factors, although the latter may well be a necessary but not sufficient ingredient. Factor analyses of performance on a variety of Piaget conservation tests along with various standard psychometric tests, such as the Stanford-Binet and Raven's Progressive Matrices, show that the Piaget tests contain a high *g* loading and introduce no source of variance not found in other developmental tests like the Stanford-Binet (44). Also, Piaget conservation tests show about the same social class and race differences as are found with standard *IQ* tests. If one argues that such differences are due to cultural bias in traditional *IQ* tests, can it be that the Piaget tasks are equally culturally biased? If so, of what, precisely, does the bias consist? Apparently it is in the capacity for some kind

of mediational arousal in the case of a nominally nonverbal problem. Yet supplying verbal mediators to nonconserving children does not alter their performance.

There is an interesting doctoral dissertation on this problem, by De Lemos (7), who studied Piaget conservation problems in Australian aborigines and found marked significant differences in the age of attaining conservation between groups of pure aborigines and those who had one Caucasian grandparent, even though there was no indication of any environmental difference or mode of upbringing between the pure and the mixed aborigines. Many of the pure aborigines never reach the stage of conservation of volume even by adulthood.

### 5. *The Age-Scale Properties of Figure Copying*

Various geometric forms can be scaled according to the age at which, say, 50 percent of children can accurately *copy* the figure. It is possible to make up such scales which seem to be quite invariant in rank order of difficulty across diverse segments of the population. Another striking feature of such scales is the rather discrete quality of the "quantum jumps" that exist from one item in the scale to the next, and the very few reversals of rank order of difficulty even for single subjects. The copying test consists of 10 geometric figures of increasing difficulty. The increasing difficulty of the figures may correspond to some developmental process. Dexterity, drawing ability, etc. are not important factors. A child who can copy any particular figure in the normal manner can do it also with his nondominant hand or with pencil between his toes. It is essentially a conceptual, not a manual, ability that is manifested in this performance.

In brief training sessions with individual subjects we find that it is practically impossible to teach children to copy the figures in the scale beyond the last one in the series they were able to copy without help. The child often acts quite amazed, chagrined, and frustrated by his failure to copy, say, a diamond, even after the experimenter has repeatedly shown him how to do it. The problem is not perceptual, because the child has no difficulty in recognizing the deficiency of his own performance.

Dr. David R. Olson, while at Harvard's Center for Cognitive Studies, performed an elaborate series of experiments on children's ability to copy one such figure—a square or rectangle containing one diagonal.[2] Whereas most 3-

[2] Dr. David Olson's experiments are reported in a monograph to be published by Academic Press in 1971.

and 4-year-old children are able to copy a square, they have to be 5 or 6 before they can copy a square containing a diagonal.

Olson performed experiments which ruled out motor or perceptual inabilities as the basis of the difference between 4- and 6-year-olds. He concluded that the difficulty for the 4-year-old was a *conceptual* difficulty. He then attempted to teach the skill of copying the diagonal to 3- and 4-year-olds who could not do so originally. The training involved a number of methods, such as making the diagonal with rods—first with one rod which simply had to be placed in the right position, etc., and then with peg boards, and checkers. Children were also taught to verbalize definitions of diagonal and other aspects of the figure. The verbalization training was the only technique that facilitated performance, but even this was not uniformly successful. It seemed to work for some children and not for others, as if some were closer to "readiness" than others. This interpretation is supported by the fact that 4-year-olds were able to profit from verbalization while 3-year-olds did not, although originally both were equally unable to copy the diagonal. The ease and spontaneity of the children who can copy the diagonal the first time they try and the great difficulty of teaching such performance to children who cannot do it right off leads Olson to say, "The recalcitrance of the problem of the diagonal strongly suggests a large maturational component in the development of this system."

### 6. *Failure in Mediation Arousal*

Some children fail to show signs of verbal mediation in situations where it is facilitating, even though they seem to have all the necessary component behaviors. For example, in our experiments on clustering we find children who do not cluster items in categorized lists and yet who recognize the categories and can clarify the items when told to do so. We find children whose performance in recall of objects is facilitated when they are told to name the objects, but who do not use this technique unless they are told to do so. We have instructed subjects in ways to mediate and facilitate paired-associate learning. Though the technique is part of the subject's repertoire, in that it is fully functional when he is told to use it, he does not use it *spontaneously*. It is as if this is not his "natural" mode of approach to a learning task. This is not true of all children, but seems to be most characteristic among those called disadvantaged. Why some children evince such resistance to verbalizing in effective ways in nonsocial problem situations remains a mystery. Some of these children appear highly fluent in conversation. Their verbal production, however, seems to have little or no functional value when they are privately confronted with a problem. In short, their language does not serve as a tool of thought. One of

the major goals of research should be to try to discover methods of instruction that might give language this particular power for these children.

### 7. *Relationship Between Learning Abilities and Intelligence*

The writer's chief research effort at present involves the study of the relationship between performance in a variety of learning tasks typically used in the experimental psychology of human learning and psychometric intelligence (20). Special attention has been directed to the experimental analysis of learning abilities in children called culturally disadvantaged.

The major finding that has emerged from this research so far is highly relevant to the understanding of the intellectual performance of children called disadvantaged. The basic finding is already well established, although in its details, its theoretical interpretation, and its possible implications for instruction and educational policy, it stills needs much more research and thought.

The basic finding is this: children from a low socioeconomic background who have measured *IQ*s in the below-average range from 60 to 80 perform in general much better on a variety of associative learning tasks than do middle-class children in the same range of *IQ*. On the other hand, low SES children who are above average in *IQ* do not show learning performance that is significantly different from the performance of middle-class children of the same *IQ*. This finding holds in Caucasian, Negro, and Mexican-American groups. Most of the research, along with a theoretical interpretation, is summarized elsewhere (21).

The theoretical interpretation proposed to comprehend these findings is that there is a continuum of ability to perform on mental tests, going from simple associative rote learning to conceptual problem solving. This continuum of test complexity taps two functionally dependent but genotypically independent types of mental processes: associative learning ability, called Level I, and conceptual or abstract reasoning ability, called Level II. Level I processes are best measured by tests of digit span and serial and paired-associative rote learning. Level II processes are best measured at present by nonverbal intelligence tests highly loaded on the *g* factor, such as Raven's Progressive Matrices and Cattell's Culture-Fair Tests. Level II processes are hierarchically related to Level I. That is to say, Level I ability is necessary but not sufficient for the manifestation of Level II ability. For example, short-term memory is necessary for solving the Progressive Matrices problems, but the processes of abstraction and symbolic manipulation needed for the Matrices are not necessary for digit memory. Level I ability appears to be distributed about the same in lower-class and in middle-class populations, while Level II ability is distributed about a

higher mean in middle-class than in lower-class groups. These hypotheses taken together are so far adequate to account for our data. In brief, the three hypotheses are (*a*) the genetic independence of the processes called Level I and Level II, (*b*) the functional hierarchical dependence of Level II upon Level I, and (*c*) the differential distributions of Level I and Level II genotypes in upper and lower social classes.

One of the key questions that needs to be answered is the origin of Level II ability. Is it wholly acquired? Or does it depend upon inherited neural mechanisms which mature at a later age than the mechanisms involved in associative learning? Many psychologists and educators have been acting on the assumption that the "higher" cognitive processes are a result of the cumulative effects of learning, particularly of verbal mediation strategies and the like. This assumption must now be questioned anew.

A number of different research approaches will help to determine the relative roles of developmental and experiential factors in cognitive functioning.

1. The relationship between various physical growth indices and measures of mental development needs to be studied *within* and *between* various SES and racial groups. Within Caucasian groups we know that a fairly substantial multiple correlation exists between a number of indices of physical maturation and performance on various mental tests. Does the same multiple regression equation predict, say, mental age, in other racial groups to the same degree as in Caucasian groups? In short, are the correlations between various indices of maturation, both physical and mental, the same for different social class and ethnic groups?

2. What is the normative distribution of various developmental indices in large representative samples of various segments of our population? How much consistency in status on developmental tests is there among various groups?

3. How well do the rather simple polygenic models that so closely fit the patterns of correlations among blood relations so well for, say, height and fingerprint ridge counts also fit developmental indices? We need methodologically and genetically sophisticated heritability studies of most of the measures we use in developmental research.

4. We need highly focused and long-range attempts to train specific cognitive abilities in children who are *high* in associative learning ability (Level I) and poor in conceptual ability (Level II). One important factor that has vitiated much of the enrichment and cognitive training research is that no distinction has been made between Level I and Level II and the *S*'s initial status on

Level I. A group of lower-class children all with rather low Stanford-Binet *IQ*s, is made up of children who stand at all points on the continuum of Level I learning ability. Those who are low in Level I have little potential for any kind of learning—they are much like middle-class retarded children. Cognitive training should be focused on children with average or superior associative learning ability and short-term memory. Probably more than half of the children called disadvantaged fall into this category. The problem, then, is to see if these children with good associative learning ability can, through intensive, highly focused training, acquire Level II abilities—that is, those abstract cognitive modes of processing information that characterize *g*.

Such research should be aimed, in part, at determining whether *g* can actually be built in through training or if the resultant behavior is only a kind of *simulation* of Level II functions by means of training that really involves only Level I associative ability. Measuring the breadth of transfer of the trained cognitive skills, as compared with control groups who have the skills "naturally," and determining the factorial structure of the trained skills are probably the best methods of investigating this problem.

For the purposes of ordinary school education, merely *simulated* Level II ability may be adequate, so we should not belittle the importance of training cognitive skills even in children who may have some deficiency in the brain mechanisms which normally subserve these functions.

Present day schooling is highly geared to *conceptual* modes of learning and many children whose weakness is in conceptual ability, even though they may be superior associative learners, are frustrated by schooling and therefore learn far less than is warranted by their good Level I learning ability. An important avenue of exploration is the extent to which school subjects can be taught by techniques which depend only on Level I and not upon Level II ability. Much of the work of the world, after all, depends only on Level I ability and it may be that many persons can become functionally educated, employable, and productive by making the most of their Level I ability.

## E. Summary

Various types of verbal and symbolic mediational processes which facilitate learning and comprise much of what is meant by "intelligence" are viewed in terms of both maturation and learning. The relative roles of developmental and experiential factors in the growth of complex cognitive abilities are discussed with reference to recent research on verbal mediation, and current research gaps and directions for future research in this field are indicated. The chief practical significance of research on verbal mediation is that it suggests

some of the mechanisms by means of which instructional techniques might inculcate or train cognitive skills that facilitate learning and problem solving. A hierarchical theory of cognitive development is proposed to explain social-class differences in mediational processes and to suggest further research directed at discovering techniques for strengthening cognitive mediational processes in children typically called disadvantaged.

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