



# THE RESEARCH PAGE

The intensive study of learning in children has been one of the most significant developments in child psychology during the last decade. Slowly, a body of scientifically rigorous studies on factors affecting concept formation and problem solving in young children has been accumulating. In the review which follows, Dr. Jensen describes portions of this material, pointing up the far-reaching implications these studies have for those who plan educational programs for children of pre-school age. Dr. Jensen also provides a bibliography which should be useful to readers who are interested in exploring this important area more fully.

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Research Editor

## LEARNING IN THE PRESCHOOL YEARS\*

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Our present knowledge of the development of learning abilities indicates that the preschool years are the most important years of learning in the child's life. A tremendous amount of learning takes place during these years; and this learning is the foundation for all further learning.

### Early Learning—Perceiving the World

Psychologically the child's main task in the first year or two of life is to gain sensory control over his environment. He has to learn to see, for example. This takes a good deal of learning. There are children who are born blind because of cataracts and who have had the cataracts removed in adolescence or adulthood. We have learned from these cases that nearly everything we perceive, aside from movement, color, and possibly a very rudimentary form perception, has had to be learned (Hebb, 1958). These persons who gain sight for the first time as adults are functionally al-

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most blind. They cannot use what they see.

One such girl, a college graduate by the time she first gained her sight, required months of practice before she could visually distinguish three of her best friends from other persons or even from one another. Common objects that the person learns to recognize when seen in one position appear unfamiliar when they are presented in a new position. One man, for example, could not recognize an automobile when he looked at it for the first time from a second story window. He had to go through quite an elaborate reasoning process to come to the conclusion that what he saw must be an automobile. Perceptual constancy is thus something that must be learned if a particular object is to be always recognized regardless of the conditions under which it is seen.

To get a slight idea of what it is like

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to be handicapped by lack of visual experience you may have noticed how hard it is to tell people apart when they are of a different ethnic group with which you have had no visual experience.

Animal studies have shown the same sort of thing. Even a rat's problem solving ability is increased by appropriate early visual experiences. Rats from the same litter have been reared under two different conditions: Half the rats were kept in a box with all four walls painted plain white. Their littermates were reared in the same kind of box, except that it had designs painted on the walls—black triangles and circles. At two months of age both groups of rats had to learn which of two doors led to food, the door with a triangle on it or the door with a circle on it. The rats that had been visually exposed to triangles and circles learned the problem much faster (Gibson & Walk, 1956).

The experiment was repeated with a new group of rats, but with an interesting feature added (Forgus, 1954). The triangles on the walls of the living cage had the point cut off. When the rats were put into the problem situation, the different appearance of the whole triangle so caught their attention that they learned the discrimination between triangle and circle even faster than did the rats reared with the whole triangles!

Environmental stimulation during the first months of life seems to have beneficial effects of an even more general nature. Krech and Rozenzweig at the University of California have devised a kind of "nursery school" for rats. It is provided with all kinds of environmental "enrichment"—designs painted on the walls, ladders, platforms, and hanging bells that can be jingled by the rats. To insure that the rat takes advantage of all the features of this nursery school, the food is placed in a different location every day so that the rats have to explore. The rats have plenty of playmates in this attractive cage. Rats reared in these conditions are brighter when it comes to learning mazes and solving other rat-type problems than are littermates brought up in the usual drab laboratory cages consisting only of four screen walls, a food cup, and a drinking spout.

And here is what may prove to be one of the most important discoveries ever made in this field: Krech and Rozenzweig have found that certain chemicals in the brain are associated with intelligence in rats (Rosenzweig, Krech, & Bennett, 1960). The balance of these chemical substances that determines intelligence or learning ability is a matter of heredity. But it appears also to be a matter of environment. The most striking finding was that the enriched rat "nursery school" described above caused chemical changes in the rat's brain, changes that are associated with faster learning. These chemical changes were greater in the "school rats" than in the controls reared in a stimulus-deprived environment.

Another task in the early years is sensory integration, that is, learning to inter-connect the information coming in from the various senses. Sight, sound, touch, taste, and so on, become integrated in our experience, so that ice looks cold, rocks look hard, and pillows look soft. These connections have to be acquired by the brain; they are not built-in at birth. As a result of these connections an ice-cube is not just a light-colored patch somewhere out there in the environment, but has an object quality, with hardness, wetness, coldness, slipperiness, and so on. If this is learning—and it most certainly is—the child must acquire more connections in its first couple of years of life than it will ever have to do in its entire formal education!

### **The Verbal Control of Learning**

With the development of speech we enter upon a most crucial stage: the development of the verbal control of learning. This is characteristically human and clearly sets man apart from the lower animal.

What is meant by the verbal control of learning? Let me begin with some simple examples. Two little boxes, one black and one white are placed in front of a child who is still in a preverbal stage, a child who does not use words. Under the black box is a piece of candy; there is nothing under the white box. The child is allowed to pick up each box. He gets the candy under the black box. But if he picks up the white box,

both boxes are immediately removed for a short time. We do this over and over again, alternating randomly whether the black box appears on the right or the left. We see that the child gradually learns; with each trial there is a greater probability that he will pick up the black box to get the candy. But it is a rather slow process and takes many trials before the child consistently picks up only the black box every time we put the two boxes before him. This is preverbal learning. This is the way very young children and most of the lower animals learn.

In contrast we find some older children who can already speak well enough to say such words as black, white, pick-up, and candy, and perhaps other words associated with candy, such as good or yum-yum. But in the early stages of language acquisition, the child does not use these words in learning. He may say the words, but they do not facilitate the learning, and his performance will be about the same as that of the first, preverbal child mentioned earlier. The learning will be slow and gradual, very much like that of a rat, a dog, or a monkey. Even when we see to it that these children verbalize what they are doing while learning, it makes little difference. They still learn slowly and gradually, in the fashion characteristic of animals and small children. In short, the verbal responses at this stage do not control the learning process.

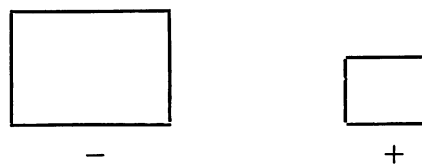
Now let us look at some children a little further along in their learning development. We find that they learn this task almost instantly. One or two trials are sufficient to establish a completely consistent performance of always picking up the black box to get the candy. Some children at this stage, however, do not always spontaneously use their verbal facilities, and so their learning is still slow and gradual like that of younger children. Unlike the younger children, however, if we ask these slightly older children to name every element in the learning situation (black box, white box, pick-up, don't pick-up, and candy), we find that they learn quickly. The verbal labels facilitate the learning.

In short, what the child has to learn is to connect together a number of al-

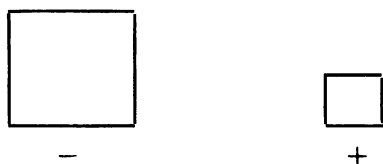
ready-learned verbal responses, which may be linked up as follows: "Black box, pick it up, that's right." The child may even say, "The candy is always under the black box." The verbal labels are not all merely incidental to the learning. They actually make rapid learning possible. Even more important, they make possible much greater generalization or transfer of what has been learned. It is also well known that verbal mnemonics can make for greater retention of what has been learned, and verbally learned habits seem to be less subject to extinction in the absence of reward or reinforcement. Apparently, as long as the subject can confidently tell himself that he is making the "correct" response, he is not dependent upon external confirmation, such as the reward of getting the candy under the black box.

Human learning characteristically consists of the linking up of verbal responses, while animal learning (and the learning of young children) consists of linking stimuli or sensations with overt motor reactions. These various effects of verbalization in learning have been found in a number of studies of learning in young children (Cantor, 1955; Norcross, 1958; Shepard, 1956). The most comprehensive review of literature on this topic is by Spiker (1960, pp. 401-407). Luria and Yudovich (1956) have illustrated many of these points in their interesting case study of the intimate relationship between verbal and mental development in a pair of twins.

Another experiment recently carried out by the writer will illustrate how this kind of verbal mediation can make a big difference in the child's behavior in a learning situation. We hide candy under the smaller of two boxes and present the two boxes side-by-side repeatedly, randomly varying the side on which the small box appears, until the child learns to pick up consistently only the small box in order to get the reward. Here are the boxes:



When the child has learned this task, we give him a new set of boxes to learn, with the candy again under the smaller of the boxes, thus:



The child who has learned the first problem on a non-verbal basis will now choose the larger of the two boxes in the second problem, because it more closely resembles the box that always had the candy in the previous problem. The child whose learning is verbally mediated, on the other hand, will select the smaller of the two boxes in the second problem, because he has learned to respond, not to the physical object itself, but to his verbal reaction to it.

Interestingly enough, very young children and mentally deficient children, even when taught this verbalization, will still generally select the larger box in the second problem, since it is closer in physical size to the previously rewarded box. Their verbalization does not control their behavior.

The really crucial test now comes when we present two new boxes of equal size, each bearing a picture. The pictures, too, are of equal size, but one picture is of a mouse and the other is of an elephant. Only the child who is verbally mediating will know now which box has the candy. The candy was previously associated with the little box, thus now the little animal, the mouse, should provide a clue. Thus verbalized, it is no trouble at all to learn to pick up the box bearing the picture of the mouse because the child has learned to respond on a conceptual basis; he's got the idea. Obviously he could not do this if he were limited to responding only to the physical stimulus. Other experiments of this type, along with a discussion of mediation theory, are found in an article by the Kendlers (1962).

The development of this sort of verbal mediation is crucial in the growth of the child's intellectual powers. A child who for any reason does not attain the stage of spontaneous verbal mediation

will be mentally retarded in a functional sense.

How do these verbal mediating responses become linked to physical stimuli in the first place? Note that the words verbal mediating responses are used here rather than the words verbal responses. The distinction is important, for even a parrot can develop verbal responses to stimuli. We are here interested in verbal behavior which facilitates further learning, which controls behavior and which permits the development of conceptual thinking. The Russians have done some interesting experiments on the factors that facilitate the development of this kind of human verbal behavior (Razran, 1961).

Here is an example. Children 20 months of age were shown a doll 1,500 times in the course of several months. For some of the children the showing was accompanied by the experimenter's saying only three things: "Here is a doll," "Take the doll," and "Give me the doll." Other children were shown the doll the same number of times, but the showing was accompanied by thirty different sayings, such as "Look for the doll," "Rock the doll," "Seat the doll," and so on. For both groups of children the doll was shown the same number of times and the total amount of verbalization was the same for both groups. But one group had much greater variety of verbal context in which the word "doll" occurred. When the two groups were tested for their understanding of the word "doll" in terms of their ability to pick out dolls from among other objects spread out on a table, the group that had had a greater variety of verbalization associated with "doll" was far superior.

Another experiment suggests that mere visual experience of objects accompanied by verbalization is not sufficient for this kind of learning. Children were merely shown objects repeatedly at the same time they were named. Other children were shown objects and given the objects to handle at the same time that they were named. Though the total time of experience with the objects was the same for both groups, the children who handled the objects learned much more and learned more rapidly. Much more research is

needed along these lines, for the educational implications seem considerable.

### A Hierarchical Matrix of Verbal Associations

The further development of learning ability consists in the main of the elaboration of verbal mediating chains. All these mediational chains have had to be learned, and once learned they facilitate further learning. By adulthood, the brain figurately speaking, is an elaborate hierarchical matrix of verbal connections which mediate between incoming stimuli and outgoing responses in most learning situations.

A couple of examples from laboratory research will illustrate the effects of this verbal matrix on learning. We can make up nonsense syllables by "decomposing" ordinary words in the following manner. Take the word "elephant," for example.

1. ELE
2. LEP
3. PHA
4. HAN  
ant

Here we have four nonsense syllables. (We omit "ant" since it is an actual word). We can make up many nonsense syllables in this way, shuffle them so that the words to which they belong are not readily identified, and then ask persons to memorize a list of, say, twelve such nonsense syllables.

If we make one list in this fashion from words that are common in our language and that one sees frequently in print, and another list from words that are more rare in the language (such as "hydrochloric," for example), we will find that it takes a person longer to learn the list of nonsense syllables made up from the rare words. He recognizes both lists as being merely nonsense syllables. Yet one list is easier to learn than the other. The reason is that the letter combinations in the more common word list are better integrated and are more available in this verbal matrix I have mentioned. A Russian with no knowledge of English, on the other hand, would probably find the two lists equally difficult to learn.

But the verbal matrix has even more subtle effects than this experiment il-

lustrates. Chains consisting of several links of verbal associations can facilitate learning, and they apparently do so without our conscious effort or awareness. On this point the only clear-cut demonstration is an experiment performed with adult subjects (Russell & Storms, 1955) in whom, of course, verbal associations are much more established than in young children.

Another experiment by Norcross and Spiker (1958), however, suggests that the same sort of phenomenon might be found in children. Russell and Storms have shown that previously acquired connections between words will facilitate the learning of entirely new connections. Persons are asked to learn a list of paired-associates, that is, they have to learn to associate a word with a nonsense syllable. Certainly this is a connection they would not have learned outside the laboratory. One such pair might be:

"cef" ---- "stem"

After the subjects have learned this connection (and many others like it) they are required to learn a new connection:

"cef" ---- "smell"

Another group of subjects learns the connection "cef" ---- "stem" followed by learning "cef" ---- "joy." The group that had to learn "cef" ---- "smell" did so more easily than the group that had to learn "cef" ---- "joy." The reason for the difference is that the connection "cef" ---- "smell" was mediated by previously learned connections, in the following manner:

#### Subject learns    Already knows    Learns

cef-stem    Stem-flower-smell    cef-smell

A ---- B    b ---- c ---- d    A .. b .. c .. d

The connection "cef" ---- "joy" is not as easily learned because most persons have not acquired as strong an associative connection between the words "joy," "flower," and "stem" as between the words "smell," "flower," and "stem." Because of past associations between "stem," "flower" and "smell," the new connection "cef" ---- "smell" is more readily mediated than the connection "cef" ---- "joy."

Some of the author's research indicates that mentally retarded children

have comparatively few such verbal chains to facilitate their learning. Some of these children do not use such chains even when the chain is well established by training in the laboratory. They probably have defective brains.

On the other hand, some children who seem to be retarded are capable of acquiring these mediational chains through training, which they then spontaneously use in acquiring new connections. Jacqueline Rapier (unpublished study) has found that culturally deprived Mexican children with low IQ's can be taught mediating links and will spontaneously make use of them in learning a new set of connections. White children of the same low IQ as the Mexicans can be taught the mediating links, but they do not use them in a new learning situation.

The implication is obvious. This test is now being investigated as a potential diagnostic instrument for distinguishing between retardation due to basically poor neural equipment and retardation due to a verbally impoverished environment which has afforded little opportunity for the acquisition of an adequate matrix of verbal associations.

#### Implications for Nursery Schools

Some of the research we have carried out so far has led us to believe that in certain segments of our society a large proportion of children who appear to be mentally retarded or slow learners in school may not be defective in any basic neurological sense. They are handicapped by the failure of their particular environment to inculcate a sufficiently complex system of verbal mediation to enable the child to profit from school learning or to engage in the complex symbolic behavior known as human thinking.

It seems reasonable to believe that many children of impoverished culture can be influenced for the better during

these early years by spending a certain portion of each day in a verbally stimulating environment. For these children to benefit from nursery education, however, a part of their time in the nursery school must be carefully planned so that it will include the kinds of experience that will aid the child in developing through the various stages of learning ability that I have described. It cannot be a passive experience. It involves mainly the coordination of verbal behavior with other sensory-motor experience. In essence, the child must see, hear, say, and do, all more or less at the same time.

Right now we are developing methods for accurately assessing where a child stands in the development of his learning abilities. Ordinary IQ tests and the like are of little help here. Instead we are using specially devised learning tests which enable us to measure the child's ability to learn new connections right in the test situation itself. Ordinary tests simply measure what the child has already learned outside the test situation. They do not tell us whether his failure is due to a lack of the necessary equipment, the so-called "gray matter," or is due to an environment that has not provided the verbal opportunities for learning the kinds of skills, mostly verbal, that are tapped by the IQ test. If we are successful, these new tests will serve a useful diagnostic purpose in the nursery school and in the assessment of children entering the primary grades.

From this review of some of our present knowledge in this area, it may be concluded that the nursery school years can greatly affect the later educability of the child. His learning experiences during this crucial period of mental development will determine in no small measure how far he will successfully go in school and how far he will go in life.

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