3

Mastery of Memory and Thinking

The very essence of human memory consists in the fact that human beings actively remember with the help of signs. It may be said that the basic characteristic of human behavior in general is that humans personally influence their relations with the environment and through that environment personally change their behavior, subjugating it to their control.

(*Vygotdky)*

In the light of what my collaborators and I learned about the function of speech in reorganizing perception and creating new relations among psychological functions, we undertook a broad study of other forms of sign-using activities in children in all its concrete manifestations (drawing pictures, writing, reading, using number systems, and so on). We also considered whether other operations not related to practical intellect would show the same laws of development we have discovered when analyzing practical intellect.

Several series of experiments carried out by my colleagues and myself dealt with this problem, and now, based on the data we obtained from them, we are able to describe in schematic form the basic laws that characterize the structure and development of the child's sign operations. These will be presented through a discussion of memory, which is exceptionally appropriate for study of the changes that signs introduce into basic psychological functions because it clearly reveals the social origin of signs as well as their crucial role in the individual's development.

►Social origins of indirect (mediated) memory

♦ A comparative investigation of human memory reveals that, even at the earliest stages of social development, there are two, principally different, types of memory. One, dominating in the behavior of nonliterate peoples, is characterized by the non mediated impression of materials, by the retention of actual experiences as the basis of mnemonic (memory) traces. We call this *natural memory*, and it is clearly illustrated in E.R. Jaensch's studies of eidetic imagery.

• This kind of memory is very close to perception, because it arises out of the direct influence of external stimuli upon human beings.

From the point of view of structure, the entire process is characterized by a quality of immediacy.

♦ Natural memory is not the only kind, however, even in the case of nonliterate men and women. On the contrary, other types of memory belonging to a completely different developmental line coexist with natural memory.

• The use of notched sticks and knots, the beginnings of writing and simple memory aids all demonstrate that even at early stages of historical development human went beyond the limits of the psychological functions given to them by nature and proceeded to a new culturally-elaborated organization of their behavior.

Comparative analysis shows that such activity is absent in even the highest species of animals; we believe that these sign operations are the product of specific conditions of social development.

OPERATIONS THAT CHANGE THE PSYCHOLOGICAL STRUCTURE OF THE MEMORY PROCESS

♦ Even such comparatively simple operations as tying a knot or marking a stick as a reminder change the psychological structure of the memory process.

• They extend the operation memory beyond the biological dimensions of the human nervous system and permit it to incorporate artificial, or self-generated, stimuli, which we call signs.

This merger, unique to human being, signifies an entirely new form of behavior [higher psychological functions]. The essential difference between it and the elementary functions is to be found in the structure of the stimulus-response relations of each. The central characteristic of elementary functions is that they are totally and directly determined by stimulation from the environment. For higher functions, the central feature is the self-generated stimulation, that is, the creation and use of artificial stimuli which become the immediate causes of behavior.

▶ Structure of sign operations

♦ Every elementary form of behavior presupposes a direct reaction to the task set before the organism, which can be expressed by the simple formula:

S ⟹ R.

• But the structure of sign operations requires an intermediate link between the stimulus and the response. This intermediate link is a second order stimulus (sign) that is drawn into the operation where it fulfills a special function; it creates a new relation between S and R.

The term "drawn into" indicates that an individual must be actively engaged in establishing such a link. This sign also possesses the important characteristic of reverse action (that is, it operates on the individual, not the environment).

♦ Consequently, the simple stimulus-response process is replaced by a complex, mediated act, which we picture as:

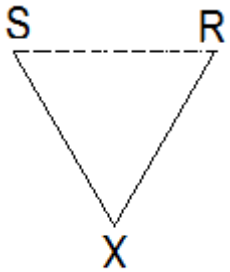


Figure 1

• In this new process of the direct impulse to react is inhibited, and an auxiliary stimulus that facilitates the completion operation by indirect means is incorporated.

Careful studies demonstrate that this type of organization is basic to all higher psychological processes, although in much more sophisticated forms than that shown above.

THE TRANSFER OF A PSYCHOLOGICAL OPERATION TO HIGHER AND QUALITATIVELY NEW FORMS PERMITING HUMANS TO CONTROL THEIR BEHAVIOR FROM OUTSIDE

The intermediate link in this formula is not a simple method of improving the previously existing operation, nor is a mere additional link in an S—R chain. Because this auxiliary stimulus possesses the specific function of reverse action, it transfers the psychological operation to higher and qualitatively new forms and permit human, by the aid of extrinsic stimuli, *to control their behavior from outside***.**

• The use of signs leads humans to a specific structure of behavior that breaks away from biological development and creates new forms of a culturally-based psychological process.

►Early sign operations in children

♦ The role of signs in voluntary attention and memory

The following experiments, conducted under A.N. Leontiev in our laboratories, demonstrate with particular clarity the role of signs in voluntary attention and memory.

• *Children were asked to play a game in which they were to answer a set of questions without using certain words in their answers*.

As a rule, each child was presented three or four tasks differing in the constraints placed upon answers and the kinds of potential stimulus aids the child could use. In each task the child was asked eighteen questions, seven of which had to do with color (for example, "What color is …?"). The child was asked to answer each question promptly using a single word. The *initial task* was conducted in exactly this fashion. With the *second task*, we began to introduce additional rules that the child had to follow in order to succeed. For example, there were two color names the child was forbidden to use, and no color name could be used twice. *The third task* had the same rules as the second, but the child was given nine colored cards as aids to playing the game ("these cards can help you to win"). *The fourth task* was like the third and was used in cases where the child either failed to use the color cards or began to do so only late in the third task. Before and after each task we asked the child questions to determine if she remembered and understood the instructions.

• *A set of questions for a typical task is the following (in this case green and yellow are the forbidden colors):*

(1) Have you a playmate? (2) What color is your shirt? (3) Did you ever go in a train? (4) What color are the railway-carriages? (5) Do you want to be big (6) Were you ever at the theater? (7) Do you like to play in the room? (8) What color is the floor? (9) And the walls? (10) Can you write? (11) Have you seen lilac? (12) What color is lilac? (13) Do you like sweet things? (14) Were you ever in the country? (15) What color can leaves be? (16) Can you swim? (17) What is your favorite color? (18) What does one do with a pencil?

For the third and four tasks the following color cards were provided as aids: black, white, red, blue, yellow, green, lilac, brown, and gray.

The results for thirty subjects ranging in age from five to twenty-seven years are summarized in table I, which contains the average number of errors on task 2 and 3 and the difference between the two tasks. Looking first at the data from task 2, we see a slight decrease in errors from ages five to thirteen and a

sharp drop in adulthood. For task 3 the sharpest drop occurs between the five-to-six and eight-to-nine-year-old groups. The difference between task 2 and 3 is small for both the preschool children and the adults. The difference is largest for the school-age children.

Table I. Errors on forbidden colors task

Age	Number of Subjects	Errors (average) Task 2	Task 3	Difference
5-6	7	3,9	3,6	0,3
8-9	7	3,3	1,5	1,8
10-13	8	3,1	0,3	2,8
22-27	8	1,4	0,6	0,8

• *The processes that give rise to the summary figures are most readily revealed by looking at transcripts representative of children in the different groups.*

The preschool children (age five to six years) were generally unable to discover how to use the auxiliary color cards and had a great deal of trouble with both tasks. Even when we tried to explain to them how the color cards could help them, children at this age were incapable of using these external stimuli in order to organize their own behavior.

• *The following transcript is from a five-year-old boy:*

Task 4. Forbidden color: blue and red (with cards)

2. What color are houses? Red [without looking at forbidden color].
3. Is the sun shining brightly? Yes.
4. What color is the sky? White [without looking at cards; but after replying, searches for white card]. Here it is! [Picks it up and keeps it in his hand.]
8. What colors are tomatoes? Red. [Glances at cards.].
9. And what color are exercise books? White—like this! [pointing to white card].
12. What color are balls? White [looking at card].
13. Do you live in the town? No.
. . . . . .
Do you think you have won? Don't know—yes.
What must you not do if you want to win? Mustn't say red or blue.
And what else? Mustn't say the same word twice.

• *This transcript suggests that the "aids" actually hindered this child.*

His repeated use of "white" as a response occurred when his attention was fixed on the white card. The aids are only an accidental feature of the situation for him.

• *Still, there is no doubt that preschool children sometimes demonstrate precursors of the use of the external signs.*

From this point of view certain cases are of special interest. For example, after we suggested to a child that he use the cards to carry out his task ("take the cards, they will help you to win"), he searched for the forbidden colors and put all such cards out of his sight, as if trying to prevent himself from naming them.

• *In spite of their apparent variety, method for using the cards can be reduced to two basic types.*

First the child may put forbidden colors out of sight, display the remainder, and, as he answers the questions, place the colors already named to one side. This is the less effective but the earliest method used. The card in this case serves only to register the name color. Initially, children often do not turn to the cards before they answer the question about color, and only as it is named do they search among the cards, turn over, move, or put away the one named. This is undoubtedly the simplest act of memorization with the help of external means. It is only later that the conditions of the experiment bestow a new, second function on the cards. Before naming a color the child makes a selection with the help of the cards. It makes no difference if the child looks at the cards so far unused or whether she attends to the colors she has already named. In either case the cards are interposed in the process and serve as a means of regulating her activity. The preliminary hiding of forbidden colors, which is a distinguishing characteristic of the first method for using the cards, does not yet lead to the complete substitution of a less mature operation by a more complex one; it represents merely a step in that direction. Its occurrence is explained partly by the greater simplicity of this operation in mastering memory and partly by a "magical" attitude toward various potential problem-solving aids that children frequently display.

• *The following examples from a thirteen-year-old schoolgirl illustrate these points:*

Task 2. Forbidden colors: green and yellow (without cards)

1. have you playmates?	Yes.
2. What color is your blouse?	Gray
3, have you been in a train?	Yes.
4. What color are railway carriages?	Gray [notices that she has repeated the same color twice, laughs.]
5. Do you want to be a big girl?	Yes.
6. Were you ever in a theater?	Yes.
7. Do you like to play in the room?	Yes.
8. What color is the floor?	Gray. [Hesitates.] Again – I repeated it.
9. And the walls?	White.
10. Can you write?	Yes.
11. Have you seen lilac?	Yes.
12. What color is lilac?	Lilac color.
13. do you like sweets?	Yes.
14. Were you ever in the country?	Yes.
15. And what color are the leaves?	Green-no, shouldn't have

	said green- brown, red sometimes.
16. Can you swim?	Yes
17. What is your favorite color?	Yellow! I can't! [Throws up hands behind head.].
18. What do you do with a pencil?	Write.
What do you think, did you win or lose?	Lost.
What should you not have said?	Green and yellow.
And what else?	Shouldn't repeat.

Task 3. Forbidden colors: blue and red (with cards)

The subject puts forbidden colors to one side and spreads out the remainder in a row before her.

1. Do you go for walks in the street?	Yes.
2. What color are the houses?	Gray. [after answering, looks at the cards and turned over the gray one.]
3. Is the sun shining brightly?	Brightly.
4. What color is the sky?	White. [First looks at card and then turn it over.]
5. Do you like candy?	Yes.
6. Have you seen a rose?	Yes.
7. Do you like vegetables?	Yes.
8. What color are tomatoes?	Green. [turns over card.]
9.And exercise books?	Yellow. [turns over card.]
10. Have you any toys?	No.
11. Do you play ball?	Yes.
12. And what color are balls?	Gray [without glancing at cards; after answering, glances and notices mistakes].
13. Do you live in the town?	Yes.
14. Did you see the demonstration?	Yes.
15. What color are flags?	Black. [First looks at cards and then turn one over.]
16. Have you any books?	Yes.
17. What color are their covers?	Lilac [turning over card]
18. When does it get dark?	At night.

♦ Our results as reflected in the transcripts and the table 1 indicate three basic stages in the development of mediated remembering.

• ***At the first stage*** *(preschool age) the child is not capable of mastering his behavior by organizing special stimuli.*

The colored cards that, might help the child in his task do not increase to any considerable extent the effectiveness of this operation. Although they act as stimuli, they do not acquire an instrumental function.

• ***The second stage*** *of development is characterized by a sharp difference in the indices in both of the main tasks.*

The introduction of cards as a system of auxiliary, external stimuli raises the effectiveness of the child's activity considerably. At this stage the external sign predominates. The auxiliary stimulus is a psychological instrument acting from the outside.

• ***At the third stage*** *(adults) the difference between their performance in the two tasks decreases and the coefficients become more nearly equal, but now on a new and higher basis.*

This does not mean that the behavior of adults again becomes direct and natural. At this higher stage of development behavior remains mediated. But now we see that in the third task the auxiliary stimuli are emancipated from primary external forms. What takes place is what we have called internalization; the external sign that schoolchildren require has been transformed into an internal sign produced by the adult as a means of remembering.

This series of tasks applied to people of different ages shows how the external forms of mediated behavior develop.

►The natural history of sign operations

♦ **Although the indirect (or mediated) aspect of psychological operation is an essential feature of higher mental processes, it would be a great mistake, as I pointed out with respect to the beginning of speech, to believe that indirect operations appear as the result of a pure logic. They are not invented or discovered by the child in the form of a sudden insight or lightning-quick guess (the so-called "aha" reaction). The child does not suddenly and irrevocably deduce the relation between the sign and the method for using it. Nor does she intuitively develop an abstract attitude derived, so to speak, from "the depths of the child own mind."**

• *This metaphysical view, according to which inherent psychological schemata exist prior to any experience, leads inevitably to an a priori conception of higher psychological functions.*

Our research has led us to quite different conclusions. We have found that

♦ **Sign operations appear as a result of a complex and prolonged process subject to all the basic laws of psychological evolution.**

• This *means that sign-using activity in children is neither simply invented nor passed down by adults; rather it arises from something that is originally not a sign operation and becomes one only after a series of qualitative transformations.*

Each of these transformations provides the conditions for the next stage and is itself conditioned by the preceding one; thus, transformations are linked like stages of a single process, and are historical in nature. In this respect, the higher psychological functions are no exception to the general rule that applies to elementary processes; they, too, are subject to the fundamental law of development which knows no exceptions, and appear in the general course of the child's psychological development as the outcome of the same dialectical process, not as something introduced from without or from within.

If we include this history of higher psychological functions as a factor in psychological development, we must arrive at a new concept of development itself.

♦ Within a general process of development, two qualitatively different lines of development, differing in origin, can be distinguished: the elementary process, which are of biological origin, on the one hand, and the higher psychological functions, of sociocultural origin, on the other.

• The history of child's behavior is born from the interweaving of these two lines.

The history of the development of the higher psychological functions is impossible without a study of their prehistory, their biological roots, and their organic disposition.

• The developmental roots of two fundamental, cultural forms of behavior arise during the infancy: the use of tools and human speech. This alone places infancy at the center of the prehistory of cultural development.

♦ The potential for complex sign operations is embedded in the earliest stages of individual development.

• However, observations show that between the initial level (elementary behavior) and the higher levels (mediated forms of behavior) many transitional psychological systems occur.

In the history of behavior these transitional systems lie between the biologically given and the culturally acquired. We refer to this process *as the natural history of the sign.*

♦ Another experimental paradigm designed to study mediated memorizing provides the opportunity to observe this natural history of the sign.

• N.G. Morozova presented children with words to remember and auxiliary pictures that could be used as mediators. She found that during the preschool years the idea of purposefully using the auxiliary picture (sign) as a means of memorizing is still foreign to the child. Even if the child did turn to the auxiliary picture in order to memorize a given word, it was not necessarily easy for him to execute the reverse operation.

At this stage the learner does not usually recall the primary stimulus when being shown the auxiliary stimulus. Rather, the sign evokes a new associative or syncretic series represented by the following scheme:

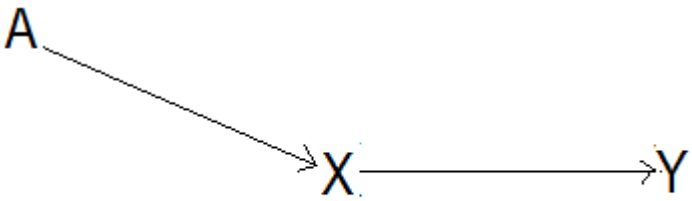


Figure 2

The operation has not yet progressed to the more advanced level which is mediated in form using culturally elaborated features. In contrast with figure 2,

♦ **The usual scheme for mediated memorizing can be represented by the following scheme:**

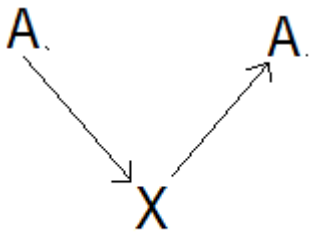
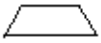
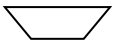


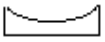
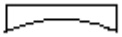
Figure 3

• *During the process represented by the figure 2, Y may lead to a whole series of new associations, among which the subject may arrive at the starting point A. However, this sequence is still devoid of its purposeful and instrumental character. In the second scheme, the word's auxiliary sign, X, possesses the quality of reverse action, so that the subject can reliably retrieve A.*

♦ **The steps leading from the scheme in figure 2 to the scheme in figure 3 can be illustrated by the following examples taken from the works of my students.**

• *L.S. Zankov demonstrated that younger children, particularly between the ages of four and six, must rely on meaningful, ready-made links between the "reminder" sign and the word to be remembered. If meaningless figures were presented as memory aids, the children often refuse to make use of them; they would make no attempt to make up connections between the picture one and the word they were supposed to remember. Rader, they would attempt to turn these figures into direct copies of the to-be-remembered word.*

For example, the figure  , presented as a reminder of the word "bucket," was turned upside down by the children and served to remind them of the word only when the figure  really began to resemble a bucket.

Similarly, the figure  became the sign of the word "bench" only when turned upside down (). In all these cases,

children linked the figures to the word stimuli by changing the meaning of the sign instead of using the mediating link offered by the experimenter. The introduction of these meaningless figures encouraged the children to engage in active mnemonic activity instead of relying in already formed links, but it also led them to treat the sign stimulus as the direct representation of the object to be remembered. When this proved impossible, the child refused to memorize.

A similar phenomenon is apparent in U.C. Yussevich's unpublished study with small children. The auxiliary stimuli, which were pictures that bore no direct relation to the word presented, were rarely used as signs. The child looked at the picture and tried to see in it the object she had to remember. For example, when asked to remember the word "sun" with the help of a picture showing an axe, one child did it very easily; she pointed to a small yellow spot in the drawing and said, "There it is, the sun." This child replaced potentially complex instrumental memorization by a search for a direct representation of the stimulus (akin to an eidetic image). This child sought an eidetic-like representation in the auxiliary sign. *In both the Zankov and Yussevich examples, the child reproduced the required word through a process of direct representation rather than mediated symbolization.*

♦ The development of mediated psychological functions (in this case, mediated memory) represents a special line of development that does not wholly coincide with the development of elementary processes.

• *Leontiev's work on the development of sign operations in memory provides examples supporting the theoretical points discussed above as well as later stages in the development of sign operations in memory.*

He gave a set of twenty words for recall to children of different ages and levels of mental ability. The materials were presented in three ways. First, the words were simply spoken at intervals of about three seconds and the child was told to recall them. In a second task the child was given a set of twenty pictures and told to use them to help recall the words. The pictures were not replicas of the words but were associated with them. In the third series twenty pictures bearing no obvious relation to the to-be-remembered words were used. The basic questions in this research were to what extent can children convert their remembering into a mediated activity using pictures as auxiliary memory aids and how does their success depend upon the different degrees of difficulty represented by the two, potentially mediated, series.

As we might expect, the results differed depending upon the group of children and the difficulty of the recall task. Normal children (ten to twelve years of ages) recalled twice as many words when the pictures were available as memory aids as they did without them. They were able to make use of both picture series equally well. Mildly retarded children of the same age benefited little, if at all, from the presence of the pictures; and for severely retarded children, the auxiliary stimuli actually interfered with performance.

The original transcripts from this study clearly show intermediate levels of functioning in which the child attends to the auxiliary picture stimulus and even associates it with the word to be recalled but cannot integrate the stimulus into his system of remembering. Thus, one child selected a picture of an onion to recall the word "dinner." When asked why she chose the picture, she gave the

perfect satisfactory answer, “Because I eat an onion.” However, she was unable to recall the word “dinner” during the experiment. This example shows that the ability to form elementary associations is not sufficient to ensure that the associative relation will fulfill the *instrumental* function necessary to produce recall. This kind of evidence leads us to conclude that the development of mediated psychological functions (in this case, mediated memory) represents a special line of development that does not wholly coincide with the development of elementary processes.

I should mention also that the addition of pictures as memory aids did not facilitate recall of adults. The reason for the “failure” is directly opposite to the reasons underlying the failure of memory aids to affect the severely retarded children. In the case of adults, the process of mediated memorizing is so fully developed that it occurs even in the absence of special external aids.

► Memory and Thinking

♦ Remembering activities do not simply change as the child grows older; the role of these activities in the system of psychological functions also changes.

• *Nonmediated memory takes place in the context of psychological operations that may have nothing at all in common with the psychological operations that accompany mediated remembering; consequently, experimental results may make it appear that some psychological functions are replaced by others. In other words, with a change in developmental level there occurs a change not so much in the structure of a single function (which, for example, we may call memory) as in the character in those functions with the aid of which remembering takes place; what changes is the interfunctional relations that connect memory with other functions.*

♦ The memory of older children is not only different from the memory of younger children; it also plays a different role in the older child’s cognitive activity.

• *Memory in early childhood is one of the central psychological functions upon which all the other functions are built.*

Our analyses suggest that thinking in the very young child is in many respects determined by his memory, and is certainly not the same thing as the thinking of the more mature child. For the very young child, to think means to remember; at no time after very early childhood do we see such a close connection between these two psychological functions.

♦ The content of the thinking act in the child when defining such concepts is determined not so much by the logical structure of the concept itself as by the child’s concrete recollections. It is syncretic in character and reflects the fact that the child’s thinking depends first of all on his memory.

I will give three examples. The first is the definition of concepts in children, which are based on their recollections. If you ask a child to tell you what a snail is, he will say that it is little, it slithers, and it sticks out its foot; if you ask him to tell you what a grandmother is, he is likely to replay, “She has a

soft lap." In both cases the child gives a very clear summary of the impressions which the topic has made upon him and which he recollects. The content of the thinking act in the child when defining such concepts is determined not so much by the logical structure of the concept itself as by the child's concrete recollections. It is syncretic in character and reflects the fact that the child's thinking depends first of all on his memory.

♦ Their general representations of their world are based on the recall of concrete instances and do not yet possess the character of an abstraction.

Another example is the development of visual concepts in very young children. Investigations of children's thinking when they are required to transpose a relation learned with one set of stimuli to a similar set have shown that their transfer is nothing more than remembering with respect to isolated instances. Their general representations of their world are based on the recall of concrete instances and do not yet possess the character of an abstraction.

♦ The experience of the child and the "unmediated" influence of the child's experience are documented in his memory and directly determine the entire structure of the young child's thought.

The last example concerns the analysis of word meaning. Investigations in this area show that the connections underlying words are fundamentally different in the young child and in the adult. Children's concepts relate to a series of examples and are constructed in a manner similar to the way we represent family names. To name words for them is not so much to indicate familiar concepts as to name familiar families or whole groups of visual things connected by visual ties. In this way the experience of the child and the "unmediated" influence of the child's experience are documented in his memory and directly determine the entire structure of the young child's thought.

♦ All these facts suggest that, from the point of view of psychological development, memory rather than abstract thought is the definite characteristic of early stages of cognitive development. However, in the course of development a transformation occurs, especially in adolescence.

• *Toward the end of childhood the interfunctional relations involving memory reverse their direction. For the young child, to think means to recall; but for the adolescent, to recall means to think.*

Investigations of memory at this age have shown that toward the end of childhood the interfunctional relations involving memory reverse their direction. *For the young child, to think means to recall; but for the adolescent, to recall means to think.* His memory is so "logicalized" that remembering is reduced to

establishing and finding logical relations; recognizing consists in discovering that element which the task indicates has to be found.

♦ At the transitional age all ideas and concepts, all mental structures, cease to be organized according to family types and become organized as abstract concepts.

This logicalization is indicative of how relations among cognitive functions change in the course of development. At the transitional age all ideas and concepts, all mental structures, cease to be organized according to family types and become organized as abstract concepts.

♦ There can be no doubt that to remember an item when thinking in concepts is a completely different task from thinking in complex, although the processes are compatible with each other.

Therefore, the development of children's memory must be studied not only with respect to changes happening within memory itself, but also with respect to the relation between memory and other functions.

♦ When a human being ties a knot in her handkerchief as a reminder, she is, in essence, constructing the process of memorizing by forcing an external object to remind her of something; she transforms remembering into an external activity. This fact alone is enough to demonstrate the fundamental characteristic of the higher forms of behavior.

• In the elementary form something is remembered; in the higher form humans remember something.

In the first case a temporary link is formed owing to the simultaneous occurrence of two stimuli that affect the organism; in the second case humans personally create a temporary link through an artificial combination of stimuli.

♦ The very essence of human memory consists in the fact that human beings actively remember with the help of signs.

• It may be said that the basic characteristic of human behavior in general is that humans personally influence their relations with the environment and through that environment personally change their behavior, subjugating it to their control.

It has been remarked that the very essence of civilization consists of purposely building monuments so as not to forget. In both the knot and the monument we have manifestations of the most fundamental and characteristic feature distinguishing human from animal memory.

REVIEW

This chapter describes in schematic form the basic laws that characterize the structure and development of the child's sign operations. These will be presented through a discussion of memory, which is exceptionally appropriate for study of the changes that signs introduce into basic psychological functions because it clearly reveals the social origin of signs as well as their crucial role in the individual's development.

Social origins of indirect (mediated) memory

A comparative investigation of human memory reveals that, even at the earliest stages of social development, there are two, principally different, types of memory. One, dominating in the behavior of nonliterate peoples, is characterized by the non mediated impression of materials, by the retention of actual experiences as the basis of mnemonic (memory) traces. We call this *natural memory*. This kind of memory is very close to perception, because it arises out of the direct influence of external stimuli upon human beings. From the point of view of structure, the entire process is characterized by a quality of immediacy.

Natural memory is not the only kind, however, even in the case of nonliterate men and women. On the contrary, other types of memory belonging to a completely different developmental line coexist with natural memory.

The use of notched sticks and knots, the beginnings of writing and simple memory aids all demonstrate that even at early stages of historical development human went beyond the limits of the psychological functions given to them by nature and proceeded to a new culturally-elaborated organization of their behavior.

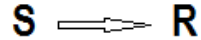
Operations changing the psychological structure of the memory process

Even such comparatively simple operations as tying a knot or marking a stick as a reminder change the psychological structure of the memory process. They extend the operation memory beyond the biological dimensions of the human ne rvous system and permit it to incorporate artificial, or self-generated, stimuli, which we call signs.

This merger, unique to human being, signifies an entirely new form of behavior. The essential difference between it and the elementary functions is to be found in the structure of the stimulus-response relations of each. The central characteristic of elementary functions is that they are totally and directly determined by stimulation from the environment. For higher functions, the central feature is the self-generated stimulation, that is, the creation and use of artificial stimuli which become the immediate causes of behavior.

Structure of sign operations

Every elementary form of behavior presupposes a direct reaction to the task set before the organism, which can be expressed by the simple formula:



But the structure of sign operations requires an intermediate link between the stimulus and the response. This intermediate link is a second order stimulus (sign) that is drawn into the operation where it fulfills a special function; it creates a new relation between S and R.

The term "drawn into" indicates that an individual must be actively engaged in establishing such a link. This sign also possesses the important characteristic of reverse action (that is, it operates on the individual, not the environment).

Consequently, the simple stimulus-response process is replaced by a complex, mediated act, which we picture as:

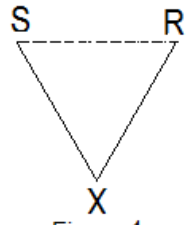


Figure 1

In this new process the direct impulse to react is inhibited, and an auxiliary stimulus that facilitates the completion of the operation by indirect means is incorporated.

Because this auxiliary stimulus possesses the specific function of reverse action, it transfers the psychological operation to higher and qualitatively new forms and permit human, by the aid of extrinsic stimuli, *to control their behavior from outside.*

The use of signs leads humans to a specific structure of behavior that breaks away from biological development and creates new forms of a culturally-based psychological process.

Early sign operations in children

The role of signs in voluntary attention and memory

In experiments conducted under A.N. Leontiev, children were asked to play a game in which they were to answer a set of questions without using certain words in their answers. As a rule, each child was presented three or four tasks differing in the constraints placed upon answers and the kinds of potential stimulus aids the child could use.

The obtained results indicate three basic stages in the development of mediated remembering.

At the first stage (preschool age) the child is not capable of mastering his behavior by organizing special stimuli. The colored cards that, might help the child in his task do not increase to any considerable extent the effectiveness of

this operation. Although they act as stimuli, they do not acquire an instrumental function.

The second stage of development is characterized by a sharp difference in the indices in both of the main tasks. The introduction of cards as a system of auxiliary, external stimuli raises the effectiveness of the child's activity considerably. At this stage the external sign predominates. The auxiliary stimulus is a psychological instrument acting from the outside.

At the third stage (adults) the difference between their performance in the two tasks decreases and the coefficients become more nearly equal, but now on a new and higher basis. This does not mean that the behavior of adults again becomes direct and natural. At this higher stage of development behavior remains mediated. But now we see that in the third task the auxiliary stimuli are emancipated from primary external forms. What takes place is what we have called internalization; the external sign that schoolchildren require has been transformed into an internal sign produced by the adult as a means of remembering.

This series of tasks applied to people of different ages shows how the external forms of mediated behavior develop.

The natural history of sign operations

Although the indirect (or mediated) aspect of psychological operation is an essential feature of higher mental processes, it would be a great mistake, as I pointed out with respect to the beginning of speech, to believe that indirect operations appear as the result of a pure logic. They are not invented or discovered by the child in the form of a sudden insight or lightning-quick guess (the so-called "aha" reaction). The child does not suddenly and irrevocably deduce the relation between the sign and the method for using it. Nor does she intuitively develop an abstract attitude derived, so to speak, from "the depths of the child own mind.

Sign operations appear as a result of a complex and prolonged process subject to all the basic laws of psychological evolution. This means that sign-using activity in children is neither simply invented nor passed down by adults; rather it arises from something that is originally not a sign operation and becomes one only after a series of qualitative transformations. Each of these transformations provides the conditions for the next stage and is itself conditioned by the preceding one; thus, transformations are linked like stages of a single process, and are historical in nature.

Within a general process of development, two qualitatively different lines of development, differing in origin, can be distinguished: the elementary process, which are of biological origin, on the one hand, and the higher psychological functions, of sociocultural origin, on the other. The history of child's behavior is born from the interweaving of these two lines.

The history of the development of the higher psychological functions is impossible without a study of their prehistory, their biological roots, and their organic disposition.

The developmental roots of two fundamental, cultural forms of behavior arise during the infancy: the use of tools and human speech. This alone places infancy at the center of the prehistory of cultural development.

The potential for complex sign operations is embedded in the earliest stages of individual development. However, observations show that between the

initial level (elementary behavior) and the higher levels (mediated forms of behavior) many transitional psychological systems occur. In the history of behavior these transitional systems lie between the biologically given and the culturally acquired. We refer to this process *as the natural history of the sign.*

The development of mediated psychological functions (in this case, mediated memory) represents a special line of development that does not wholly coincide with the development of elementary processes.

Memory and Thinking

Remembering activities do not simply change as the child grows older; the role of these activities in the system of psychological functions also changes.

The memory of older children is not only different from the memory of younger children; it also plays a different role in the older child's cognitive activity. Memory in early childhood is one of the central psychological functions upon which all the other functions are built.

The thinking in the very young child is in many respects determined by his memory, and is certainly not the same thing as the thinking of the more mature child. For the very young child, to think means to remember; at no time after very early childhood do we see such a close connection between these two psychological functions.

The content of the thinking act in the child when defining such concepts is determined not so much by the logical structure of the concept itself as by the child's concrete recollections. It is syncretic in character and reflects the fact that the child's thinking depends first of all on his memory.

In very young children, their general representations of their world are based on the recall of concrete instances and do not yet possess the character of an abstraction.

The experience of the child and the "unmediated" influence of the child's experience are documented in his memory and directly determine the entire structure of the young child's thought.

Memory rather than abstract thought is the definite characteristic of early stages of cognitive development. However, in the course of development a transformation occurs, especially in adolescence. Toward the end of childhood the interfunctional relations involving memory reverse their direction. For the young child, to think means to recall; but for the adolescent, to recall means to think.

At the transitional age all ideas and concepts, all mental structures, cease to be organized according to family types and become organized as abstract concepts.

When a human being ties a knot in her handkerchief as a reminder, she is, in essence, constructing the process of memorizing by forcing an external object to remind her of something; she transforms remembering into an external activity. This fact alone is enough to demonstrate the fundamental characteristic of the higher forms of behavior. In the elementary form something is remembered; in the higher form humans remember something.

The very essence of human memory consists in the fact that human beings actively remember with the help of signs. It may be said that the basic characteristic of human behavior in general is that humans personally influence their relations with the environment and through that environment personally change their behavior, subjugating it to their control.

It has been remarked that the very essence of civilization consists of purposely building monuments so as not to forget. In both the knot and the monument we have manifestations of the most fundamental and characteristic feature distinguishing human from animal memory.