Mastery of Memory and Thinking

In the light of what my collaborators and I had learned about the functions of speech in reorganizing perception and creating new relations among psychological functions, we undertook a broad study of other forms of sign-using activity 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 had discovered when analyzing practical intellect.

Several series of experiments carried out by my colleagues and myself dealt with these problems, 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 nonmediated 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.[1] 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,[2] the beginnings of writing and simple memory aids all demonstrate that even at early stages of historical development humans 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.

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 of 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 beings, 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 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 S———→R 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:

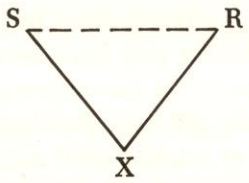


Figure 1

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.

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 intermediate link in this formula is not simply a method of improving the previously existing operation, nor is it 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 permits humans, by the aid of extrinsic stimuli, *to control their behavior from the 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 following experiments, conducted under A. N. Leontiev in our laboratories, demonstrate with particular clarity the role of signs in voluntary attention and memory.[3]

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 colors 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 fourth 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 1, which contains the average number of errors on tasks 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 tasks 2 and 3 is small for both

Table 1. Errors on forbidden colors task.

Age	*Number of subjects*	*Errors (average)*		*Difference*
		Task 2	*Task 3*	
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 preschool children and the adults. The difference is largest for the school-age children.

The processes that give rise to the summary figures are most readily revealed by looking at transcripts representative of children in the differ-

ent 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 colors: blue and red (with cards).

2. What color are houses?	Red [without looking at forbidden colors].
3. Is the sun shining brightly?	Yes.
4. What color is the sky?	White [without looking at card; 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 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, methods 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 named color. Initially, children often do not turn to the cards before they answer the question about color, and only after 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 whether 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.

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

15. And what color were 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 turns 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 mistake].
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 turns one over.]
16. Have you any books?	Yes.
17. What colors are their covers?	Lilac [turning over card].
18. When does it get dark?	At night.

Our results as reflected in the transcripts and 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 (among adults) the difference between their performance in the two tasks decreases and their 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 school children 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 operations is an essential feature of higher mental processes, it would be a great mistake, as I pointed out with respect to the beginnings 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's 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 processes, which are of biological origin, on the one hand, and the higher psychological functions, of sociocultural origin, on the other. *The history of child 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 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.[4] 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:

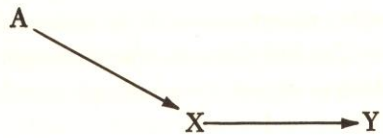


Figure 2

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:

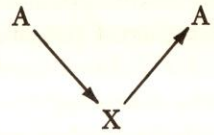
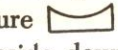


Figure 3

During the process represented by 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 work of my students. L. V. 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.[5] If meaningless figures were presented as memory aids, the children would often refuse to make use of them; they would make no attempt to make up connections between the picture cue and the word they were supposed to remember. Rather, 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 on 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). The 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 laws describing the role of sign operations at this stage of development are completely different from the laws describing how the child links up a word with a sign in fully developed sign operations. Children in the experiments just described illustrate a stage of development between the elementary and the completely instrumental process from which fully mediated operations will later develop.

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.[6] 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 age) 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 perfectly 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 of 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.

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 reply, "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.

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 the world are based on the recall of concrete instances and do not yet possess the character of an abstraction.[7]

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 definitive

characteristic of the early stages of cognitive development. However, in the course of development a transformation occurs, especially in adolescence. 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.* Her 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.

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 complexes, although the processes are compatible with each other.[8] 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.

4

Internalization of Higher Psychological Functions

When comparing the principles regulating unconditioned and conditioned reflexes, Pavlov uses the example of a telephone call. One possibility is for the call to connect two points directly via a special line. This corresponds to an unconditioned reflex. The other possibility is for the phone call to be relayed through a special, central station with the help of temporary and limitlessly variable connections. This corresponds to a conditioned reflex. The cerebral cortex, as the organ that closes the conditioned reflex circuit, plays the role of such a central station.

The fundamental message of our analysis of the processes that underlie the creation of signs (signalization) may be expressed by a more generalized form of the same metaphor. Let us take the case of tying a knot as a reminder or drawing lots as a means of decision making. There is no doubt that in both cases a temporary conditioned connection is formed, that is, a connection of Pavlov's second type. But if we wish to grasp the essentials of what is happening here, we are forced to take into consideration not only the function of the telephone mechanism but also of the operator who plugged in and thus connected the line. In our example, the connection was established by the person who tied the knot. This feature distinguishes the higher forms of behavior from the lower.

The invention and use of signs as auxiliary means of solving a given psychological problem (to remember, compare something, report, choose, and so on) is analogous to the invention and use of tools in one psychological respect. The sign acts as an instrument of psychological activity in a manner analogous to the role of a tool in labor. But this analogy, like any other, does not imply the identity of these similar

concepts. We should not expect to find *many* similarities with tools in those means of adaptation we call signs. What's more, in addition to the similar and common feature shared by the two kinds of activity, we see very essential differences.

Here we want to be as precise as possible. Leaning for support on the term's figurative meaning, some psychologists have used the word "tool" when referring to the indirect function of an object as the means for accomplishing some activity. Expressions such as "the tongue is the tool of thought" or "aides de memoire" are usually bereft of any definite content and hardly mean more than what they really are: simple metaphors and more colorful ways of expressing the fact that certain objects or operations play an auxiliary role in psychological activity.

On the other hand, there have been many attempts to invest such expressions with a literal meaning, to equate the sign with the tool. By erasing the fundamental distinction between them, this approach loses the specific characteristics of each type of activity and leaves us with one general psychological form of determination. This is the position adopted by Dewey, one of pragmatism's representatives. He defines the tongue as the tool of tools, transposing Aristotle's definition of the human hand to speech.

I wish it to be clear that the analogy between sign and tool that I propose is different from either of the approaches just discussed. The uncertain, indistinct meaning that is usually read into the figurative use of the word "tool" in no way eases the researcher's task. His task is to uncover the real relationship, not the figurative one, that exists between behavior and its auxiliary means. Should we conceive of thought or memory as being analogous to external activity? Do the "means of activity" simply play the indefinite role of supporting the psychological process that leans on them? What is the nature of this support? What in general does it mean to be a "means" of thought or of memory? Psychologists who so enjoy using these fuzzy expressions furnish us with no answer to these questions.

But the position of those psychologists who treat such expressions literally turns out to be even fuzzier. Concepts that have a psychological aspect but do not actually belong to psychology—such as "technique"—are psychologized without any grounds whatsoever. Equating psychological and nonpsychological phenomena is possible only if one ignores the essence of each form of activity, as well as the differences between their historic roles and nature. Distinctions between tools as a means of labor of mastering nature, and language as a means of social intercourse

become dissolved in the general concept of artifacts or artificial adaptations.

We seek to understand the behavioral role of the sign in all its uniqueness. This goal has motivated our empirical studies of how both tool and sign use are mutually linked and yet separate in the child's cultural development. We have adopted three conditions as a starting point for this work. The first pertains to the analogy and common points of the two types of activity, the second clarifies their basic differences, and the third attempts to demonstrate the real psychological link existing between the one and the other, or at least to hint at its existence.

As we have already noted, the basic analogy between sign and tool rests on the mediating function that characterizes each of them. They may, therefore, from the psychological perspective, be subsumed under the same category. We can express the logical relationship between the use of signs and of tools using the schema in figure 4, which shows each concept subsumed under the more general concept of indirect (mediated) activity.

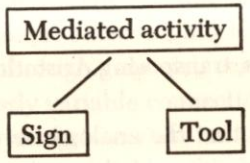


Figure 4

That concept, quite justly, was invested with the broadest general meaning by Hegel, who saw in it a characteristic feature of human reason: "Reason," he wrote, "is just as cunning as she is powerful. Her cunning consists principally in her mediating activity which, by causing objects to act and react on each other in accordance with their own nature, in this way, without any direct interference in the process, carries out reasons' intentions."[1] Marx cites that definition when speaking of working tools, to show that man "uses the mechanical, physical, and chemical properties of objects so as to make them act as forces that affect other objects in order to fulfill his personal goals."[2]

This analysis provides a sound basis for assigning the use of signs to the category of mediated activity, for the essence of sign use consists in man's affecting behavior through signs. In both cases the indirect (mediated) function comes to the forefront. I shall not define further the relation of these jointly subsumed concepts to each other, or their relation to the more generic concept of mediated activity. I should only

like to note that neither can, under any circumstance, be considered isomorphic with respect to the functions they perform, nor can they be seen as *fully* exhausting the concept of mediated activity. A host of other mediated activities might be named; cognitive activity is not limited to the use of tools or signs.

On the purely logical plane of the relation between the two concepts, our schema represents the two means of adaptation as diverging lines of mediated activity. This divergence is the basis for our second point. A most essential difference between sign and tool, and the basis for the real divergence of the two lines, is the different ways that they orient human behavior. The tool's function is to serve as the conductor of human influence on the object of activity; it is *externally* oriented; it must lead to changes in objects. It is a means by which human external activity is aimed at mastering, and triumphing over, nature. The sign, on the other hand, changes nothing in the object of a psychological operation. It is a means of internal activity aimed at mastering oneself; the sign is *internally* oriented. These activities are so different from each other that the nature of the means they use cannot be the same in both cases.

Finally, the third point pertains to the real tie between these activities and, hence, to the real tie of their development in phylo- and ontogenesis. The mastering of nature and the mastering of behavior are mutually linked, just as man's alteration of nature alters man's own nature. In phylogenesis we can reconstruct this link through fragmentary but convincing documentary evidence, while in ontogenesis we can trace it experimentally.

One thing is already certain. Just as the first use of tools refutes the notion that development represents the mere unfolding of the child's organically predetermined system of activity, so the first use of signs demonstrates that there cannot be a single organically predetermined internal system of activity that exists for each psychological function. The use of artificial means, the transition to mediated activity, fundamentally changes all psychological operations just as the use of tools limitlessly broadens the range of activities within which the new psychological functions may operate. In this context, we can use the term *higher* psychological function, or *higher behavior* as referring to the combination of tool and sign in psychological activity.

Several phases in the use of sign operations have been described thus far. In the initial phase reliance upon external signs is crucial to the child's effort. But through development these operations undergo radical changes: the entire operation of mediated activity (for example,

memorizing) begins to take place as a purely internal process. Paradoxically, late stages of the child's behavior appear to be the same as early stages of memorizing, which were characterized by a direct process. The very young child does not rely upon external means; rather he uses a "natural," "eidetic" approach. Judging only from external appearances, it seems that the older child has simply begun to memorize more and better; that she has somehow perfected and developed her old methods of memorizing. At the highest levels she appears to have abandoned any reliance upon signs. However, this appearance is only illusory. Development, as often happens, proceeds here not in a circle but in a spiral, passing through the same point at each new revolution while advancing to a higher level.

We call the internal reconstruction of an external operation *internalization.* A good example of this process may be found in the development of pointing. Initially, this gesture is nothing more than an unsuccessful attempt to grasp something, a movement aimed at a certain object which designates forthcoming activity. The child attempts to grasp an object placed beyond his reach; his hands, stretched toward that object, remain poised in the air. His fingers make grasping movements. At this initial stage pointing is represented by the child's movement, which seems to be pointing to an object—that and nothing more.

When the mother comes to the child's aid and realizes his movement indicates something, the situation changes fundamentally. Pointing becomes a gesture for others. The child's unsuccessful attempt engenders a reaction not from the object he seeks but *from another person.* Consequently, the primary meaning of that unsuccessful grasping movement is established by others. Only later, when the child can link his unsuccessful grasping movement to the objective situation as a whole, does he begin to understand this movement as pointing. At this juncture there occurs a change in that movement's function: from an object-oriented movement it becomes a movement aimed at another person, a means of establishing relations. *The grasping movement changes to the act of pointing.* As a result of this change, the movement itself is then physically simplified, and what results is the form of pointing that we may call a true gesture. It becomes a true gesture only after it objectively manifests all the functions of pointing for others and is understood by others as such a gesture. Its meaning and functions are created at first by an objective situation and then by people who surround the child.

As the above description of pointing illustrates, the process of internalization consists of a series of transformations:

(a) *An operation that initially represents an external activity is reconstructed and begins to occur internally.* Of particular importance to the development of higher mental processes is the transformation of sign-using activity, the history and characteristics of which are illustrated by the development of practical intelligence, voluntary attention, and memory.

(b) *An interpersonal process is transformed into an intrapersonal one.* Every function in the child's cultural development appears twice: first, on the social level, and later, on the individual level; first, *between* people (*interpsychological*), and then *inside* the child (*intrapsychological*). This applies equally to voluntary attention, to logical memory, and to the formation of concepts. All the higher functions originate as actual relations between human individuals.

(c) *The transformation of an interpersonal process into an intrapersonal one is the result of a long series of developmental events.* The process being transformed continues to exist and to change as an external form of activity for a long time before definitively turning inward. For many functions, the stage of external signs lasts forever, that is, it is their final stage of development. Other functions develop further and gradually become inner functions. However, they take on the character of inner processes only as a result of a prolonged development. Their transfer inward is linked with changes in the laws governing their activity; they are incorporated into a new system with its own laws.

The internalization of cultural forms of behavior involves the reconstruction of psychological activity on the basis of sign operations. Psychological processes as they appear in animals actually cease to exist; they are incorporated into this system of behavior and are culturally reconstituted and developed to form a new psychological entity. The use of external signs is also radically reconstructed. The developmental changes in sign operations are akin to those that occur in language. Aspects of external or communicative speech as well as egocentric speech turn "inward" to become the basis of inner speech.

The internalization of socially rooted and historically developed activities is the distinguishing feature of human psychology, the basis of the qualitative leap from animal to human psychology. As yet, the barest outline of this process is known.

6

Interaction between Learning and Development

The problems encountered in the psychological analysis of teaching cannot be correctly resolved or even formulated without addressing the relation between learning and development in school-age children. Yet it is the most unclear of all the basic issues on which the application of child development theories to educational processes depends. Needless to say, the lack of theoretical clarity does not mean that the issue is removed altogether from current research efforts into learning; not one study can avoid this central theoretical issue. But the relation between learning and development remains methodologically unclear because concrete research studies have embodied theoretically vague, critically unevaluated, and sometimes internally contradictory postulates, premises, and peculiar solutions to the problem of this fundamental relationship; and these, of course, result in a variety of errors.

Essentially, all current conceptions of the relation between development and learning in children can be reduced to three major theoretical positions.

The first centers on the assumption that processes of child development are independent of learning. Learning is considered a purely external process that is not actively involved in development. It merely utilizes the achievements of development rather than providing an impetus for modifying its course.

In experimental investigations of the development of thinking in school children, it has been assumed that processes such as deduction and understanding, evolution of notions about the world, interpretation of physical causality, and mastery of logical forms of thought and abstract logic all occur by themselves, without any influence from school

learning. An example of such a theory is Piaget's extremely complex and interesting theoretical principles, which also shape the experimental methodology he employs. The questions Piaget uses in the course of his "clinical conversations" with children clearly illustrate his approach. When a five-year-old is asked "why doesn't the sun fall?" it is assumed that the child has neither a ready answer for such a question nor the general capabilities for generating one. The point of asking questions that are so far beyond the reach of the child's intellectual skills is to eliminate the influence of previous experience and knowledge. The experimenter seeks to obtain the tendencies of children's thinking in "pure" form, entirely independent of learning.[1]

Similarly, the classics of psychological literature, such as the works by Binet and others, assume that development is always a prerequisite for learning and that if a child's mental functions (intellectual operations) have not matured to the extent that he is capable of learning a particular subject, then no instruction will prove useful. They especially feared premature instruction, the teaching of a subject before the child was ready for it. All effort was concentrated on finding the lower threshold of learning ability, the age at which a particular kind of learning first becomes possible.

Because this approach is based on the premise that learning trails behind development, that development always outruns learning, it precludes the notion that learning may play a role in the course of the development or maturation of those functions activated in the course of learning. Development or maturation is viewed as a precondition of learning but never the result of it. To summarize this position: Learning forms a superstructure over development, leaving the latter essentially unaltered.

The second major theoretical position is that learning *is* development. This identity is the essence of a group of theories that are quite diverse in origin.

One such theory is based on the concept of reflex, an essentially old notion that has been extensively revived recently. Whether reading, writing, or arithmetic is being considered, development is viewed as the mastery of conditioned reflexes; that is, the process of learning is completely and inseparably blended with the process of development. This notion was elaborated by James, who reduced the learning process to habit formation and identified the learning process with development.

Reflex theories have at least one thing in common with theories such as Piaget's: in both, development is conceived of as the elaboration and substitution of innate responses. As James expressed it, "Education,

in short, cannot be better described than by calling it the organization of acquired habits of conduct and tendencies to behavior."[2] Development itself is reduced primarily to the accumulation of all possible responses. Any acquired response is considered either a more complex form of or a substitute for the innate response.

But despite the similarity between the first and second theoretical positions, there is a major difference in their assumptions about the temporal relationship between learning and developmental processes. Theorists who hold the first view assert that developmental cycles precede learning cycles; maturation precedes learning and instruction must lag behind mental growth. For the second group of theorists, both processes occur simultaneously; learning and development coincide at all points in the same way that two identical geometrical figures coincide when superimposed.

The third theoretical position on the relation between learning and development attempts to overcome the extremes of the other two by simply combining them. A clear example of this approach is Koffka's theory, in which development is based on two inherently different but related processes, each of which influences the other.[3] On the one hand is maturation, which depends directly on the development of the nervous system; on the other hand is learning, which itself is also a developmental process.

Three aspects of this theory are new. First, as we already noted, is the combination of two seemingly opposite viewpoints, each of which has been encountered separately in the history of science. The very fact that these two viewpoints can be combined into one theory indicates that they are not opposing and mutually exclusive but have something essential in common. Also new is the idea that the two processes that make up development are mutually dependent and interactive. Of course, the nature of the interaction is left virtually unexplored in Koffka's work, which is limited solely to very general remarks regarding the relation between these two processes. It is clear that for Koffka the process of maturation prepares and makes possible a specific process of learning. The learning process then stimulates and pushes forward the maturation process. The third and most important new aspect of this theory is the expanded role it ascribes to learning in child development. This emphasis leads us directly to an old pedagogical problem, that of formal discipline and the problem of transfer.

Pedagogical movements that have emphasized formal discipline and urged the teaching of classical languages, ancient civilizations, and mathematics have assumed that regardless of the irrelevance of these

particular subjects for daily living, they were of the greatest value for the pupil's mental development. A variety of studies have called into question the soundness of this idea. It has been shown that learning in one area has very little influence on overall development. For example, reflex theorists Woodworth and Thorndike found that adults who, after special exercises, had achieved considerable success in determining the length of short lines, had made virtually no progress in their ability to determine the length of long lines. These same adults were successfully trained to estimate the size of a given two-dimensional figure, but this training did not make them successful in estimating the size of a series of other two-dimensional figures of various sizes and shapes.

According to Thorndike, theoreticians in psychology and education believe that every particular response acquisition directly enhances overall ability in equal measure.[4] Teachers believed and acted on the basis of the theory that the mind is a complex of abilities—powers of observation, attention, memory, thinking, and so forth—and that any improvement in any specific ability results in a general improvement in all abilities. According to this theory, if the student increased the attention he paid to Latin grammar, he would increase his abilities to focus attention on any task. The words "accuracy," "quick-wittedness," "ability to reason," "memory," "power of observation," "attention," "concentration," and so forth are said to denote actual fundamental capabilities that vary in accordance with the material with which they operate; these basic abilities are substantially modified by studying particular subjects, and they retain these modifications when they turn to other areas. Therefore, if someone learns to do any single thing well, he will also be able to do other entirely unrelated things well as a result of some secret connection. It is assumed that mental capabilities function independently of the material with which they operate, and that the development of one ability entails the development of others.

Thorndike himself opposed this point of view. Through a variety of studies he showed that particular forms of activity, such as spelling, are dependent on the mastery of specific skills and material necessary for the performance of that particular task. The development of one particular capability seldom means the development of others. Thorndike argued that specialization of abilities is even greater than superficial observation may indicate. For example, if, out of a hundred individuals we choose ten who display the ability to detect spelling errors or to measure lengths, it is unlikely that these ten will display better abilities regarding, for example, the estimation of the weight of objects. In the same way, speed and accuracy in adding numbers are entirely unrelated to speed and accuracy in being able to think up antonyms.

This research shows that the mind is not a complex network of *general* capabilities such as observation, attention, memory, judgment, and so forth, but a set of specific capabilities, each of which is, to some extent, independent of the others and is developed independently. Learning is more than the acquisition of the ability to think; it is the acquisition of many specialized abilities for thinking about a variety of things. Learning does not alter our overall ability to focus attention but rather develops various abilities to focus attention on a variety of things. According to this view, special training affects overall development only when its elements, material, and processes are similar across specific domains; habit governs us. This leads to the conclusion that because each activity depends on the material with which it operates, the development of consciousness is the development of a set of particular, independent capabilities or of a set of particular habits. Improvement of one function of consciousness or one aspect of its activity can affect the development of another only to the extent that there are elements common to both functions or activities.

Developmental theorists such as Koffka and the Gestalt School—who hold to the third theoretical position outlined earlier—oppose Thorndike's point of view. They assert that the influence of learning is never specific. From their study of structural principles, they argue that the learning process can never be reduced simply to the formation of skills but embodies an intellectual order that makes it possible to transfer general principles discovered in solving one task to a variety of other tasks. From this point of view, the child, while learning a particular operation, acquires the ability to create structures of a certain type, regardless of the diverse materials with which she is working and regardless of the particular elements involved. Thus, Koffka does not conceive of learning as limited to a process of habit and skill acquisition. The relationship he posits between learning and development is not that of an identity but of a more complex relationship. According to Thorndike, learning and development coincide at all points, but for Koffka, development is always a larger set than learning. Schematically, the relationship between the two processes could be depicted by two concentric circles, the smaller symbolizing the learning process and the larger the developmental process evoked by learning.

Once a child has learned to perform an operation, he thus assimilates some structural principle whose sphere of application is other than just

the operations of the type on whose basis the principle was assimilated. Consequently, in making one step in learning, a child makes two steps in development, that is, learning and development do not coincide. This concept is the essential aspect of the third group of theories we have discussed.

ZONE OF PROXIMAL DEVELOPMENT: A NEW APPROACH

Although we reject all three theoretical positions discussed above, analyzing them leads us to a more adequate view of the relation between learning and development. The question to be framed in arriving at a solution to this problem is complex. It consists of two separate issues: first, the general relation between learning and development; and second, the specific features of this relationship when children reach school age.

That children's learning begins long before they attend school is the starting point of this discussion. Any learning a child encounters in school always has a previous history. For example, children begin to study arithmetic in school, but long beforehand they have had some experience with quantity—they have had to deal with operations of division, addition, subtraction, and determination of size. Consequently, children have their own preschool arithmetic, which only myopic psychologists could ignore.

It goes without saying that learning as it occurs in the preschool years differs markedly from school learning, which is concerned with the assimilation of the fundamentals of scientific knowledge. But even when, in the period of her first questions, a child assimilates the names of objects in her environment, she is learning. Indeed, can it be doubted that children learn speech from adults; or that, through asking questions and giving answers, children acquire a variety of information; or that, through imitating adults and through being instructed about how to act, children develop an entire repository of skills? Learning and development are interrelated from the child's very first day of life.

Koffka, attempting to clarify the laws of child learning and their relation to mental development, concentrates his attention on the simplest learning processes, those that occur in the preschool years. His error is that, while seeing a similarity between preschool and school learning, he fails to discern the difference—he does not see the specifically new elements that school learning introduces. He and others assume that the difference between preschool and school learning consists of non-

systematic learning in one case and systematic learning in the other. But "systematicness" is not the only issue; there is also the fact that school learning introduces something fundamentally new into the child's development. In order to elaborate the dimensions of school learning, we will describe a new and exceptionally important concept without which the issue cannot be resolved: the zone of proximal development.

A well known and empirically established fact is that learning should be matched in some manner with the child's developmental level. For example, it has been established that the teaching of reading, writing, and arithmetic should be initiated at a specific age level. Only recently, however, has attention been directed to the fact that we cannot limit ourselves merely to determining developmental levels if we wish to discover the actual relations of the developmental process to learning capabilities. We must determine at least two developmental levels.

The first level can be called the *actual developmental level*, that is, the level of development of a child's mental functions that has been established as a result of certain already *completed* developmental cycles. When we determine a child's mental age by using tests, we are almost always dealing with the actual developmental level. In studies of children's mental development it is generally assumed that only those things that children can do on their own are indicative of mental abilities. We give children a battery of tests or a variety of tasks of varying degrees of difficulty, and we judge the extent of their mental development on the basis of how they solve them and at what level of difficulty. On the other hand, if we offer leading questions or show how the problem is to be solved and the child then solves it, or if the teacher initiates the solution and the child completes it or solves it in collaboration with other children—in short, if the child barely misses an independent solution of the problem—the solution is not regarded as indicative of his mental development. This "truth" was familiar and reinforced by common sense. Over a decade even the profoundest thinkers never questioned the assumption; they never entertained the notion that what children can do with the assistance of others might be in some sense even more indicative of their mental development than what they can do alone.

Let us take a simple example. Suppose I investigate two children upon entrance into school, both of whom are ten years old chronologically and eight years old in terms of mental development. Can I say that they are the same age mentally? Of course. What does this mean? It means that they can independently deal with tasks up to the degree of difficulty that has been standardized for the eight-year-old level. If I

stop at this point, people would imagine that the subsequent course of mental development and of school learning for these children will be the same, because it depends on their intellect. Of course, there may be other factors, for example, if one child was sick for half a year while the other was never absent from school; but generally speaking, the fate of these children should be the same. Now imagine that I do not terminate my study at this point, but only begin it. These children seem to be capable of handling problems up to an eight-year-old's level, but not beyond that. Suppose that I show them various ways of dealing with the problem. Different experimenters might employ different modes of demonstration in different cases: some might run through an entire demonstration and ask the children to repeat it, others might initiate the solution and ask the child to finish it, or offer leading questions. In short, in some way or another I propose that the children solve the problem with my assistance. Under these circumstances it turns out that the first child can deal with problems up to a twelve-year-old's level, the second up to a nine-year-old's. Now, are these children mentally the same?

When it was first shown that the capability of children with equal levels of mental development to learn under a teacher's guidance varied to a high degree, it became apparent that those children were not mentally the same age and that the subsequent course of their learning would obviously be different. This difference between twelve and eight, or between nine and eight, is what we call *the zone of proximal development. It is the distance between the actual developmental level as determined by independent problem solving and the level of potential development as determined through problem solving under adult guidance or in collaboration with more capable peers.*

If we naively ask what the actual developmental level is, or, to put it more simply, what more independent problem solving reveals, the most common answer would be that a child's actual developmental level defines functions that have already matured, that is, the end products of development. If a child can do such-and-such independently, it means that the functions for such-and-such have matured in her. What, then, is defined by the zone of proximal development, as determined through problems that children cannot solve independently but only with assistance? The zone of proximal development defines those functions that have not yet matured but are in the process of maturation, functions that will mature tomorrow but are currently in an embryonic state. These functions could be termed the "buds" or "flowers" of development rather than the "fruits" of development. The actual developmental level characterizes mental development retrospectively, while the zone of proximal development characterizes mental development prospectively.

The zone of proximal development furnishes psychologists and educators with a tool through which the internal course of development can be understood. By using this method we can take account of not only the cycles and maturation processes that have already been completed but also those processes that are currently in a state of formation, that are just beginning to mature and develop. Thus, the zone of proximal development permits us to delineate the child's immediate future and his dynamic developmental state, allowing not only for what already has been achieved developmentally but also for what is in the course of maturing. The two children in our example displayed the same mental age from the viewpoint of developmental cycles already completed, but the developmental dynamics of the two were entirely different. The state of a child's mental development can be determined only by clarifying its two levels: the actual developmental level and the zone of proximal development.

I will discuss one study of preschool children to demonstrate that what is in the zone of proximal development today will be the actual developmental level tomorrow—that is, what a child can do with assistance today she will be able to do by herself tomorrow.

The American researcher Dorothea McCarthy showed that among children between the ages of three and five there are two groups of functions: those the children already possess, and those they can perform under guidance, in groups, and in collaboration with one another but which they have not mastered independently. McCarthy's study demonstrated that this second group of functions is at the actual developmental level of five-to-seven-year-olds. What her subjects could do only under guidance, in collaboration, and in groups at the age of three-to-five years they could do independently when they reached the age of five-to-seven years.[5] Thus, if we were to determine only mental age—that is, only functions that have matured—we would have but a summary of completed development, while if we determine the maturing functions, we can predict what will happen to these children between five and seven, provided the same developmental conditions are maintained. The zone of proximal development can become a powerful concept in developmental research, one that can markedly enhance the effectiveness and utility of the application of diagnostics of mental development to educational problems.

A full understanding of the concept of the zone of proximal development must result in reevaluation of the role of imitation in learning. An unshakable tenet of classical psychology is that only the inde-

pendent activity of children, not their imitative activity, indicates their level of mental development. This view is expressed in all current testing systems. In evaluating mental development, consideration is given to only those solutions to test problems which the child reaches without the assistance of others, without demonstrations, and without leading questions. Imitation and learning are thought of as purely mechanical processes. But recently psychologists have shown that a person can imitate only that which is within her developmental level. For example, if a child is having difficulty with a problem in arithmetic and the teacher solves it on the blackboard, the child may grasp the solution in an instant. But if the teacher were to solve a problem in higher mathematics, the child would not be able to understand the solution no matter how many times she imitated it.

Animal psychologists, and in particular Köhler, have dealt with this question of imitation quite well.[6] Köhler's experiments sought to determine whether primates are capable of graphic thought. The principal question was whether primates solved problems independently or whether they merely imitated solutions they had seen performed earlier, for example, watching other animals or humans use sticks and other tools and then imitating them. Köhler's special experiments, designed to determine what primates could imitate, reveal that primates can use imitation to solve only those problems that are of the same degree of difficulty as those they can solve alone. However, Köhler failed to take account of an important fact, namely, that primates cannot be taught (in the human sense of the word) through imitation, nor can their intellect be developed, because they have no zone of proximal development. A primate can learn a great deal through training by using its mechanical and mental skills, but it cannot be made more intelligent, that is, it cannot be taught to solve a variety of more advanced problems independently. For this reason animals are incapable of learning in the human sense of the term; *human learning presupposes a specific social nature and a process by which children grow into the intellectual life of those around them.*

Children can imitate a variety of actions that go well beyond the limits of their own capabilities. Using imitation, children are capable of doing much more in collective activity or under the guidance of adults. This fact, which seems to be of little significance in itself, is of fundamental importance in that it demands a radical alteration of the entire doctrine concerning the relation between learning and development in children. One direct consequence is a change in conclusions that may be drawn from diagnostic tests of development.

Formerly, it was believed that by using tests, we determine the mental development level with which education should reckon and whose limits it should not exceed. This procedure oriented learning toward yesterday's development, toward developmental stages already completed. The error of this view was discovered earlier in practice than in theory. It is demonstrated most clearly in the teaching of mentally retarded children. Studies have established that mentally retarded children are not very capable of abstract thinking. From this the pedagogy of the special school drew the seemingly correct conclusion that all teaching of such children should be based on the use of concrete, look-and-do methods. And yet a considerable amount of experience with this method resulted in profound disillusionment. It turned out that a teaching system based solely on concreteness—one that eliminated from teaching everything associated with abstract thinking—not only failed to help retarded children overcome their innate handicaps but also reinforced their handicaps by accustoming children exclusively to concrete thinking and thus suppressing the rudiments of any abstract thought that such children still have. Precisely because retarded children, when left to themselves, will never achieve well-elaborated forms of abstract thought, the school should make every effort to push them in that direction and to develop in them what is intrinsically lacking in their own development. In the current practices of special schools for retarded children, we can observe a beneficial shift away from this concept of concreteness, one that restores look-and-do methods to their proper role. Concreteness is now seen as necessary and unavoidable only as a stepping stone for developing abstract thinking—as a means, not as an end in itself.

Similarly, in normal children, learning which is oriented toward developmental levels that have already been reached is ineffective from the viewpoint of a child's overall development. It does not aim for a new stage of the developmental process but rather lags behind this process. Thus, the notion of a zone of proximal development enables us to propound a new formula, namely that the only "good learning" is that which is in advance of development.

The acquisition of language can provide a paradigm for the entire problem of the relation between learning and development. Language arises initially as a means of communication between the child and the people in his environment. Only subsequently, upon conversion to internal speech, does it come to organize the child's thought, that is, become an internal mental function. Piaget and others have shown that reasoning occurs in a children's group as an argument intended

to prove one's own point of view before it occurs as an internal activity whose distinctive feature is that the child begins to perceive and check the basis of his thoughts. Such observations prompted Piaget to conclude that communication produces the need for checking and confirming thoughts, a process that is characteristic of adult thought.[7] In the same way that internal speech and reflective thought arise from the interactions between the child and persons in her environment, these interactions provide the source of development of a child's voluntary behavior. Piaget has shown that cooperation provides the basis for the development of a child's moral judgment. Earlier research established that a child first becomes able to subordinate her behavior to rules in group play and only later does voluntary self-regulation of behavior arise as an internal function.

These individual examples illustrate a general developmental law for the higher mental functions that we feel can be applied in its entirety to children's learning processes. We propose that an essential feature of learning is that it creates the zone of proximal development; that is, learning awakens a variety of internal developmental processes that are able to operate only when the child is interacting with people in his environment and in cooperation with his peers. Once these processes are internalized, they become part of the child's independent developmental achievement.

From this point of view, learning is not development; however, properly organized learning results in mental development and sets in motion a variety of developmental processes that would be impossible apart from learning. Thus, learning is a necessary and universal aspect of the process of developing culturally organized, specifically human, psychological functions.

To summarize, the most essential feature of our hypothesis is the notion that developmental processes do not coincide with learning processes. Rather, the developmental process lags behind the learning process; this sequence then results in zones of proximal development. Our analysis alters the traditional view that at the moment a child assimilates the meaning of a word, or masters an operation such as addition or written language, her developmental processes are basically completed. In fact, they have only just begun at that moment. The major consequence of analyzing the educational process in this manner is to show that the initial mastery of, for example, the four arithmetic operations provides the basis for the subsequent development of a variety of highly complex internal processes in children's thinking.

Our hypothesis establishes the unity but not the identity of learning

processes and internal developmental processes. It presupposes that the one is converted into the other. Therefore, it becomes an important concern of psychological research to show how external knowledge and abilities in children become internalized.

Any investigation explores some sphere of reality. An aim of the psychological analysis of development is to describe the internal relations of the intellectual processes awakened by school learning. In this respect, such analysis will be directed inward and is analogous to the use of x-rays. If successful, it should reveal to the teacher how developmental processes stimulated by the course of school learning are carried through inside the head of each individual child. The revelation of this internal, subterranean developmental network of school subjects is a task of primary importance for psychological and educational analysis.

A second essential feature of our hypothesis is the notion that, although learning is directly related to the course of child development, the two are never accomplished in equal measure or in parallel. Development in children never follows school learning the way a shadow follows the object that casts it. In actuality, there are highly complex dynamic relations between developmental and learning processes that cannot be encompassed by an unchanging hypothetical formulation.

Each school subject has its own specific relation to the course of child development, a relation that varies as the child goes from one stage to another. This leads us directly to a reexamination of the problem of formal discipline, that is, to the significance of each particular subject from the viewpoint of overall mental development. Clearly, the problem cannot be solved by using any one formula; extensive and highly diverse concrete research based on the concept of the zone of proximal development is necessary to resolve the issue.