VII. THE DEVELOPMENT OF PERCEPTION IN THE PRESCHOOL CHILD

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During the first years of life perception follows a very complicated pattern of development. The followers of Gestalt theory support the view that a newly born child possesses the basic specific features of perception in ready-made forms. Contrary to their views, however, more and more experimental data are being accumulated testifying to the fact that sensory processes become more complicated gradually, as a result of which perceptive images, appearing at different ontogenetic stages, become more and more orthoscopic, that is, reflect the environments more fully and adequately. We shall try to show here that the increasing effectiveness of solving various sensory problems depends upon the development of children's perceptive activity, that is, upon the degree to which they acquire more perfect means of acquainting themselves with the objects they perceive.

This concept of sensory processes is based on investigation by Soviet researchers (A. N. Leontiev, B. L. Ananiev, P. Y. Galperin, A. V. Zaporozhets, V. P. Zinchenko, and others) who reject (on the basis of Pavlov's reflex theory) the receptory concept of the process of perception, which dominated psychology for a long time. We look upon this process as a certain perceptive action. Important roles in such perceptive actions are played by their effectory components, that is, movements of the hand touching the object or movements of the eye following the outline of the perceived figure. The function of these orienting-exploratory movements is to investigate the object and form a copy—an adequate image of the object—by reproducing its features or forming a "likeness" (A. Leontiev) of it. Motor correction, which is achieved through the movements of the sense organs, probably plays a role in the perception processes analogous to that of sensory correction in the control of complex movements. As we tried to show in another work, making a model of an object with the help of external movements and, in particular, with the movements of receptory apparatus makes it possible for the subject to superimpose, so to say, the created model on the perceived object and, thus, to compare them. The reciprocal afferentation (feedback) from this comparison—the signals of differences—enable the subject to make necessary corrections in the model and to make the copy more precise.

In other words, perceptive actions probably perform not only exploratory and modeling functions but corrective functions as well, providing for an orthoscopic sensory image that is adequate to the object perceived.

I am going to tell you about some experiments that were done by my colleagues and me at the Laboratory of the Psychology of Preschool Children of the Institute of Psychology and the Laboratory of Psychophysiology at the Institute of Preschool Education of the Academy of Pedagogical Sciences in Moscow.

The main aim of the experiments was to investigate the process of the development of perceptive actions and to trace the influence of this development on the formation of sensory images in the child during different periods of his early and preschool childhood.

As is known, the child is born with relatively well developed analyzer systems that are manifested in different general and specific unconditioned reflexes which can be evoked by stimulating the sense organs of the newborn baby. The most important among them, for subsequent sensory development, are orienting-exploratory responses that appear in the form of the child's movements of receptory organs toward the stimuli, fixing these stimuli, tracing their movements, etc. Such orienting responses of a newborn baby are rather imperfect, but the experiments done in our laboratory (M. I. Lisins and L. A. Venger) show that the responses become very sharply differentiated during the first months of life and lead to relatively complicated sensory effects.

L. A. Venger's experiments proved that it is possible to elicit orienting differentiation to complex stimuli, such as geometric figures, in babies 3 or 4 months old. During preliminary experiments, the children were shown two three-dimensional objects (a tetrahedral prism and a ball). It appeared that the duration of eye fixation on each object was approximately the same for all children. Next, one of the objects (the prism) was hung above the cradle in which the child stayed most of the time so that the orienting response to that object would disappear. In conclusion, control experiments were done. Again, the children were shown pairs of objects. In each pair one object was the prism and the other was new (a ball, a cylinder, or a cone). In the control experiments, the children directed their eyes toward the new object and fixed on it for a longer period of time than on the old, familiar object, thus indicating that they had differentiated the objects.

TABLE 1

AVERAGE TIME OF VISUAL FIXATION ON FAMILIAR AND ON NEW FIGURES BY 2- TO 4-MONTH-OLD BABIES[a]

Figure	Time (sec.)
Familiar	17.4
New	37.8

[a]Experiments of L. A. Venger.

But Venger's observations testify to the fact that the movements of receptory organs in a three month old baby are of an executive (the child controls—i.e., executes—the movements), fixing, and not exploratory, modeling character. The function of the movements is to put the receptor into an optimal position for the observation of that or another stimulus, and not to copy or model the features of the stimulus. Our experiments show that the transition from executive movements of receptors to properly exploratory, modeling movements that are necessary for the formation of complex orthoscopic images of perception occurs gradually during the whole preschool period.

In T. O. Ginevskaya's experiments, preschool children were asked to acquaint themselves with some objects on the table by closing their eyes and only touching them. It was found that the character of the tactile movements of the hand changed with age. The younger preschool children (3–4½ years of age) used primitive movements that were not differentiated from working, executive movements. On first touching the object, the children tried to manipulate it (rolling, pulling, and pushing it, knocking with it, etc.) and to acquaint themselves with the objects in the process of such practical and playing actions. Later, the palping actions of the hand are separated from its practical executive actions, but the palping actions are mainly of a fixing character, not exploratory. Trying to find out what kind of an object it is, the child catches it with his hand without using any examining, palping movements (Plate 1*A*). Children of 6–7½years of age use, along with the actions described above, more perfect methods of palping the object. You can see delicate palping movements of the hand tracing the outline of the object, determining how solid it is, and examining the material of which it is made. As a result, the tactile images of the child become more diverse in content and correspond to the features of the perceived objects more precisely (see Plate 1*B*, Table 2).

TABLE 2

Methods and Results of Tactile Examination of Objects in Different Age Groups by Percentages of Cases[a]

		Method of Examination			
Age of Children	No. Reaction	Practical Manipulations	Fixation in Hand	Palpitation	Mistakes
3 to 4–6...	9	82	9	—	36
4–6 to 6...	—	48	44	8	41
6 to 7–6...	4	29	26	41	8

[a]Experiments of L. A. Ginevskaya.

Analogous data were found by Z. M. Boguslavskaya, who studied how children of different preschool age groups achieved visual acquaintance with a new object and how they later recognized it among other objects. Under such conditions, younger preschool children cast a very short glance at the object, trying to catch it with the hands as soon as possible and to begin to manipulate it. At the same time, in older children the phase of practical operations was usually preceded by a detailed visual examination of the object, as a result of which they solved sensory problems more effectively.

In the projects of Boguslavskaya and Ginevskaya, the orienting movements of the hand and eye were observed only visually, preventing the investigators from discovering the most general and approximate characteristics of the development of such movements in preschool children.

Later, V. P. Zinchenko, together with A. G. Ruzskaya and others, undertook a more detailed study of this problem using movie films to record manual and eye movements of the children. At the same time, Zinchenko found that there is a great difference in the perceptive actions of children when they recognize a more or less familiar object and when they see quite new, unfamiliar ones. Consequently, we should speak about two different types of perceptive actions: actions of recognition and actions of "acquaintance." In this paper I will speak of the "acquaintance actions" of children.

The palping actions were studied experimentally in the following way: A big, flat figure of an irregular form was fixed behind a screen and the child was asked to examine it tactually for 60 sec. so that afterward he could find it visually among other objects. The experiments were filmed.

A comparison of the actions of children in different age groups permitted us to characterize the stages of development in the tactile movements of the child's hands. The movements of the 3-year-old child were more like catching than like touching. Often small children played with the figure instead of examining it. For example, the child placed his palms on the edge of the figure and pushed it with his fingers. The palm was motionless during the whole period of filming (Plate 2*A*).

The movements of the 4- to 5-year-old children considerably reminded one of those of the 3-year-olds, but you could see some new elements here. The same catching of the edge of the object with four fingers and the palm was observed, but the hands did not stay in this position for long. Rather quickly, the 4-year-old children started to acquaint themselves with the object more actively by using the palms and the surfaces of the fingers. Fingertips were almost absolutely passive in the tactile process. Usually, the palping was done with one hand only.

In the children 5 to 6 years of age, you could see the simultaneous touching of the figure, the two hands moving toward each other or in opposite directions. But the systematic tracing of the outline of the whole figure was not yet observed. Usually, children confined themselves to careful examination of some specific features of the figure, for example, of some hollow part or some projection, without correlating them or locating their position on the whole figure (Plate 2*B*). And it was with 6-year-old children that you could observe the systematic tracing of the whole outline of the figure with the fingertips, as if the children were reproducing the form of the figure with their tactile movements by modeling its form (Plate 2*C*, 2*D*).

The transition to such more perfect methods of acquainting themselves with an object leads to a considerable increase in the effectiveness of perception. This was revealed in the control experiments with visual recognition of the objects, previously presented for a tactile examination (Table 3). The

TABLE 3

MISTAKES OF RECOGNITION (PERCENTAGES) BY PRESCHOOL CHILDREN AFTER USING DIFFERENT METHODS OF EXAMINING OBJECTS[a]

METHOD OF EXAMINATION	AGE OF CHILDREN			
	3–4	4–5	5–6	6–7
Looking only	50.0	28.5	0.0	2.5
Touching only	47.7	42.3	25.0	23.1
Looking and touching	30.8	21.0	11.5	1.9
Practically operating	15.4	10.5	0.0	0.0

[a]Experiments of V. P. Zinchenko and A. C. Ruzskaya

children under 5 years of age made many mistakes in recognizing figures while 6-year-olds, who had traced the outline of the figure in detail with the palping hand, could distinguish it later unmistakably, in the majority of cases.

The experiments in which the eye movements of children of different age groups in the process of perceiving were filmed, also showed considerable changes in the character of perceiving actions in the course of the child's development. For these experiments, Zinchenko and Ruzskaya used the same figures of an irregular form (30 × 40 cm.). The figures were projected for 20 sec. on a screen that had a hole for a camera in the center. The children were asked to look at the screen attentively so that they could recognize the figures among other figures later (in the control experiments).

In 3- and 4-year-old children, under the conditions of this sensory problem, the movements of the eye were not numerous. The periods of fixation between movements were much longer than in older children. The movements were within the figure and sometimes they followed the central line

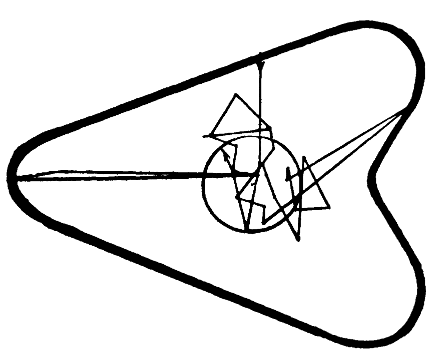


FIG. 1

PLATE 1A

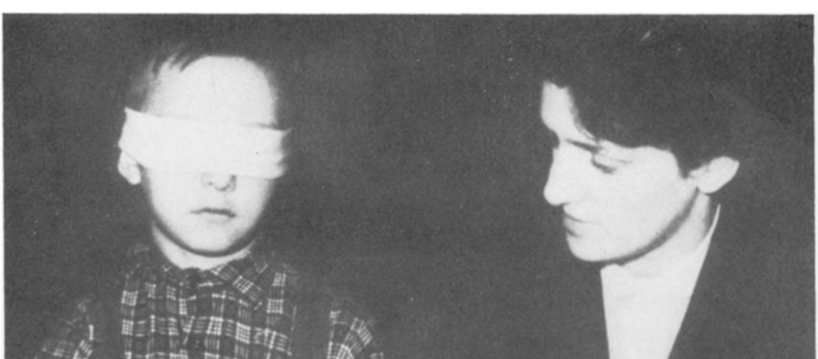


PLATE 1B

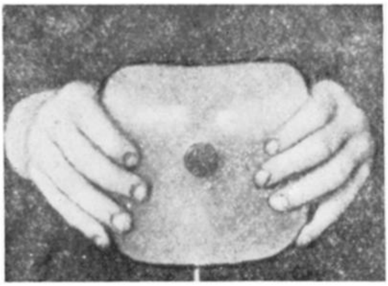


PLATE 2A

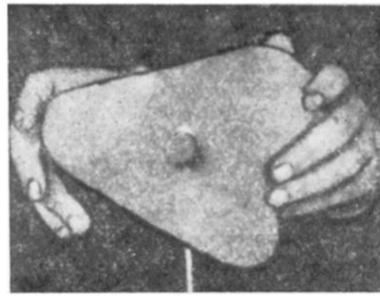


PLATE 2B

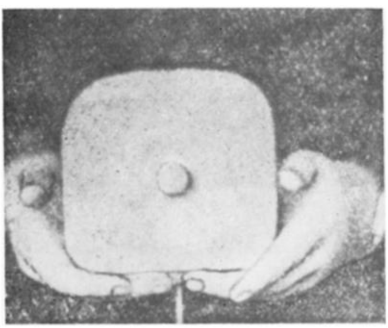


PLATE 2C

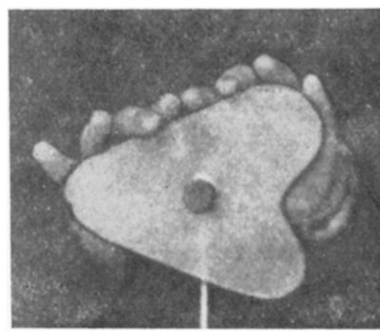


PLATE 2D

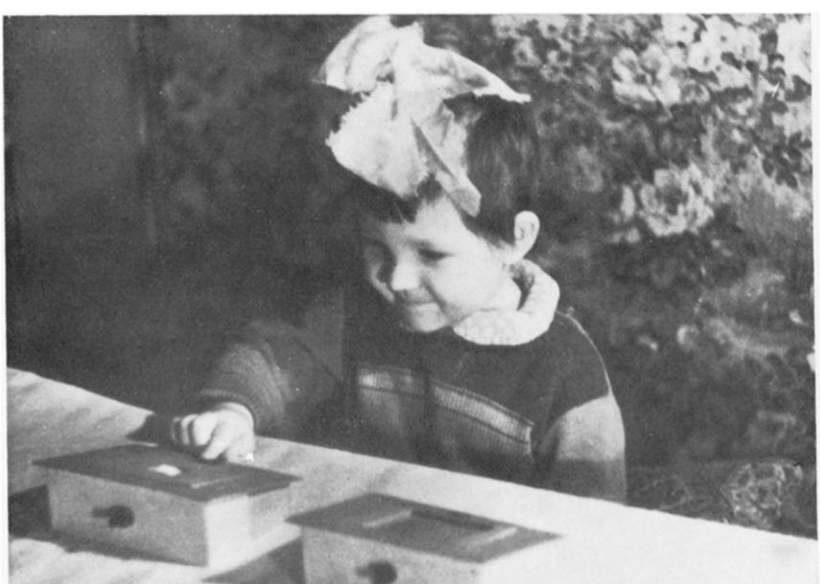


PLATE 2E

of the figure once. Often the subject's attention was distracted by the camera. The movement of the eye following the outline of the figure was not registered at all (Fig. 1). The child's technique of studying is very primitive here, and recognition is very low. Half the answers were wrong, and the children mixed up figures that were quite different in form.

In children of 4 to 5 years of age, the eye movements were also mainly within the figure (Fig. 2). The number of movements was twice as great as

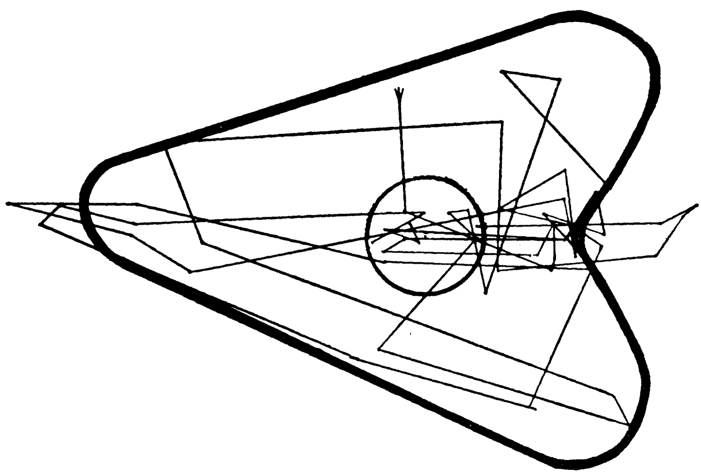


FIG. 2

in the previous group and the time of fixation was correspondingly less. Judging by direction, we think that the movements were oriented to the size and the length of the figure. There were many long movements that were aimed, probably, at measuring the object. Although we did not see movements tracing the outline of the object, in this age group, we did find some groups of fixing points that were close to each other and related to the most specific features of the object. This method gave better results in recognizing the object during control experiments than it did with 3-year-old children.

Five- and six-year-old children began tracing the outline of the perceived figure, but usually they looked at a part of the outline (the most specific one) while the rest was left unexamined. The number of eye movements during the exposure time was approximately the same in the group of 5-year-old children as in the group of 4-year-olds. Many such movements yielded little information to help solve the given problem. These were movements within the figure, for example. Nevertheless, the method was adequate for the child to recognize the perceived object later and the majority of 5-year-old children gave correct answers during control experiments.

With 6- to 7-year-old children, the eye movements followed, in the main, the outline of the fiure, as if reproducing or modeling its form (Fig. 3). At the same time, we could observe the movements across the figure.

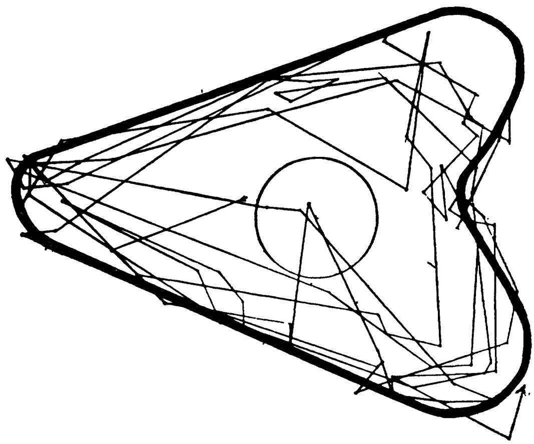


FIG. 3

Probably, these movements also solved an important orienting problem, measuring the area of the figure. The number of movements during the exposure time was greater than that of younger children, and the duration of fixations was shorter.

Using such active and perfect methods of examination, the children gave 100 per cent correct answers during control experiments. But not only this: experiments of Boguslavskaya and others showed that this age group could also solve more difficult sensory problems connected with adequate reproduction of perceived figures in the process of drawing, constructing, modeling, etc.

Although we could have studied the development of perception actions in detail in the spheres of vision and touch only, the results of some of our experiments, as well as some works by other psychologists, gave us the right to think that changes of the same kind could be found in other sensory spheres. Experiments by Y. Z. Neverovich show, for example, that the formation of some probing, orienting movements, clarifying the inner, proprioceptive picture of a motor act, play an important role in the development of kinesthetic perceptions. Investigations by A. N. Leontiev and research workers of our laboratory (Endovitskaya, Repina) testify that the development of methods of active reproduction of sounds will make an important contribution to the genesis of pitch-discrimination in children. The same phenomena were observed by Elkonin and Zhurova in the development of the ability to perceive phonemes, as the modeling of specific features of the stressed sounds, in verbal speech by means of "sounding out" plays an important part in acoustic analysis of a word.

We have given a short description of the formation of perceptive actions in a child, the actions that model the features of the perceived object and provide for the creation of an adequate image of it. What, then, are the conditions and forces that determine the development and improvement of such actions in ontogenesis?

Many Soviet studies show (Leontiev, Ananiev, and Elkin) that the processes of perception are not developed in isolation. Rather, they are developed in the course of the subject's practical activity. In particular, our many years' investigations show that perceptive processes acquire orienting and regulating functions in the activity of a child, and that they develop in connection with the increasing complexity of his activity.

In the early stages of development, more or less correct reflection of reality can only be achieved as the result of practical actions with objects, where sensory processes play dependent, secondary roles. It is in the process of such activity as a whole, including both its sensory and motor components, that an adequate model of an object can be created. This model will be compared with the original object many times, becoming more and more precise and finally leading to an adequate perceptive image. For example, a baby, learning to grasp different things and to take into account their place, size, and form, models (with the movements of his hand) these space characteristics. Later, when he learns to walk, he goes around obstacles and walks in a certain direction, modeling the pattern of his path in his locomotion. The formation of such practical or "sensorimotor" (J. Piaget) models plays, probably, a decisive role in the early ontogenesis of sensory processes which, in the course of modeling, are changed themselves and begin, together with previous signal and starting functions, to perform the functions of reproducing and depicting the reality.

Our experiments show that, where an adequate perceptive image in small children cannot be created by means of visual and tactile acquaintance with an object, such image can be formed in the course of practical manipulations with the object. In the experiments done by Zinchenko and Ruzskaya, children of different preschool age groups were asked to acquaint themselves with flat wooden figures of irregular forms in the following ways: (*a*) looking at them only; (*b*) touching them only; (*c*) both looking at and touching them; (*d*) practically operating them in the process of inserting them into corresponding holes in a board.

Sensory effects of all these different means of acquaintance were checked in control experiments in which children were asked to recognize (visually) the familiar figure from among unknown figures. The data from the experiments (Table 3) testify to the fact that in smaller children (3 to 4 years old), sensory, "theoretical" acquaintance with a new and complex object gave poorer results than practical manipulation of the objects.

In the process of practical operations children not only distinguished various features of the objects, but also discovered some relations between them.

In Venger's experiments children of 2 to 3 years of age were given the task of trailing a three-dimensional figure through a hole in the experimental grating. It was necessary for them to choose a hole that would correspond to the shape of the figure (Fig. 4).

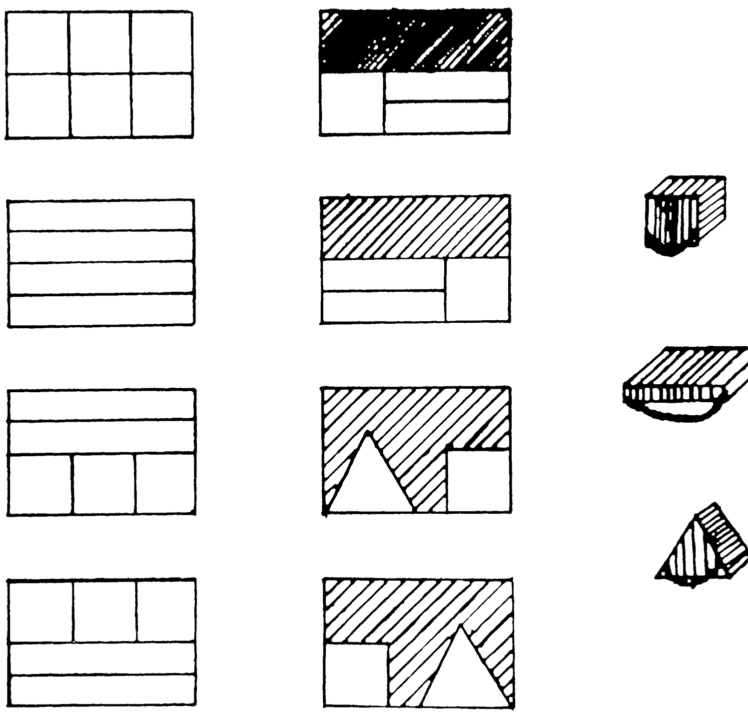


FIG. 4

At first all the children solved the problem only practically by means of trial and error. Two-year-old children stayed at this level even after many exercises. The 3-year-old children often made visual comparisons of the figure and the hole on the basis of practical manipulations. Here the visual perceptive actions "borrowed," so to speak, a method of solution from the practical operations. The child shifted his glance from the figure to the hole several times, as if putting the former on the latter visually, and then gave an unmistakable practical solution, even when the task was quite new and unfamiliar to him.

Results of the same kind were obtained by A. Kasianova in our laboratory. She studied perception and transposition of size relations of perceived objects. The children studied were between 18 months and 7 years of age. There were two boxes before the subject with holes of different shapes and sizes into which he could insert pieces of wood. Under the board was an electric bulb, covered with frosted glass. The bulb was operated by a key fixed outside the box. The situation was such that a corresponding bulb

PLATE 3A

PLATE 3B

could be switched on by pushing the button near the big figure (Plate 2*E*). This was reinforcement for the correct action. Contrary to what supporters of Gestalt theory say, it appeared that the effectiveness and transposition of responses to relations is considerably lower in smaller children than in older ones (Table 4).

TABLE 4

TRANSPOSITION OF PERCEIVED-SIZE RELATION IN PRESCHOOL CHILDREN[a]

Experimental Situation	Age of Children						
	1–5 to 2	2 to 2–5	2–5 to 3	3 to 4	4 to 5	5 to 6	6 to 7
Before training...........	36	18	28	18	9	6	11
After training with practical comparisons of objects...	14	1	5	2	1	1	2

[a]Average of reactions on the absolute size of object.

With the help of the experimenter, the child was made to shift his glance from one figure to another again, which considerably improved results in the perception of relations in children of 5 to 7 years of age but made no noticeable difference in the small children. Then we started teaching them to compare objects practically in respect to size, putting one into another, cups, cardboard blocks, and other things of different sizes (Plate 3*A*, 3*B*). After the teaching experiments, the children repeated the original series of experiments. The results in perception and transposition were now higher than those before practical comparison (Table 5).

TABLE 5

DIFFERENTIATION OF GEOMETRICAL FIGURES BY PRESCHOOL CHILDREN (PERCENTAGE OF MISTAKES)

Experimental Situation	Age of Children			
	3–4	4–5	5–6	6–7
Before training....................................	40.0	32.0	17.0	8
After children were taught to examine the outline of the figure....................................	11.0	11.0	11.0	3.0

Concluding the review of data on the role of practical activity in the perception of an object in the early stages of a child's development, I should like to tell you about some experiments by Sokhina, who studied the influence of construction on the development of visual analysis in preschool children. Continuing a well known experiment of A. R. Luria, Sokhina showed that, without special teaching, children of 3 to 7 years could not discriminate purely visual elements of a complex form; they could not, for example, say of what parts a given figure consisted. But, after a series of practical exercises in constructing and creating real structures out of elements of different form and size, the children began making a purely visual analysis of the figure, thus anticipating the organization and results of their practical operations. The results of this teaching were widely transferred to new situations and we can see them, for example, in the location of a given element included in complex figures (as in Gottschaldt's figures).

Analyzing various kinds of a child's practical activity, we found that this activity, as a result of specific conditions of human life, bears, from a very early age onward, an "object" orientation; that is, a child uses certain tools and this activity leads to the creation of certain objects. Consequently, practical modeling of the reality as it takes place in games with dramatizations, constructing, drawing, etc., may have an "object" character at very early genetic stages. In these kinds of activities, the child reproduces features of his environment by means of movements and posturings of his own body and by means of surrounding objects and drawing. Such concrete objective modeling, our experiments show, plays a very important part in the development of cognitive processes in general and perceptive processes in particular. Here are some examples.

Boguslavskaya studied in preschool children the development of the visual perception of pictures of concrete objects (a scoop, a vase, an apple, etc.) and abstract geometrical figures. She found that all the younger children (3 to 5 years of age) and a considerable number of the older group (5 to 7 years) confined themselves to very short visual examinations of the exposed object and the subsequent images they created were very incomplete and fragmentary. Using this manner of observation, the children could recognize the object rather successfully according to one or several typical features, but they could not reproduce it in a drawing, for replication requires a higher level of perceptive processes, that is, more complete and detailed sensory images. In later experiments, the children were taught to model the forms of perceived objects out of matches, sheets of paper, etc. The activity was organized in a certain way: it was especially explained to the children that the work should help to acquaint them better with an object and to draw it more correctly later. In these exercises, the models were not the final goal and final products (as is usual in drawing lessons), but were a means of solving certain cognitive and, then, practical problems. After such exercises the effectiveness of perceptive processes rose considerably in all the children, as seen in more precise drawings of the object perceived, although they did not have any drawing lessons (Figs. 5, 6, 7).

An analogous technique of concrete modeling was used by Sokhina in teaching children to analyze visually a complex form while constructing it according to a given model. As is shown in the above-mentioned investigation by A. R. Luria, very often preschool children cannot divide (purely visually) a given object into the elements of which it must be constructed. Usually, they solve the problem in a practical way by trying various combinations until they achieve the necessary result. To raise the level of solving such problems, Sokhina changed the problem a little by paying

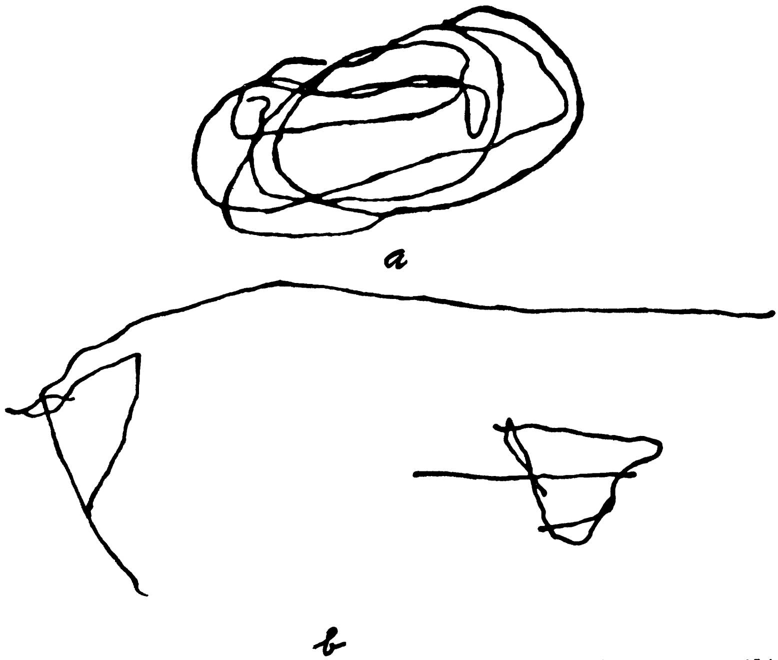


Fig. 5.—Drawings by a 3-6-year-old girl before training; (*a*) is a cup; (*b*), a shovel.

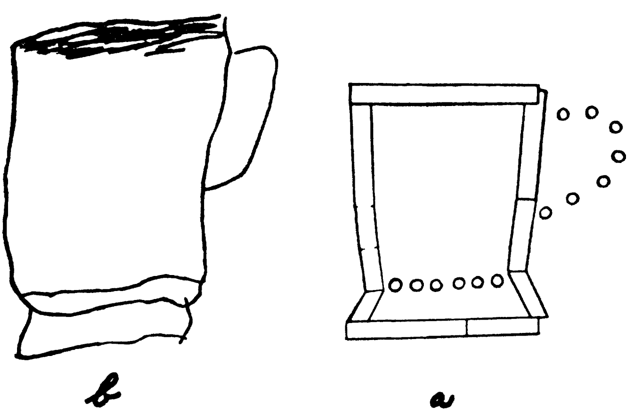


Fig. 6.—Drawing by the same 3-6-year-old-girl after training with concrete modeling; (*a*) is the modeling; (*b*), the drawing.

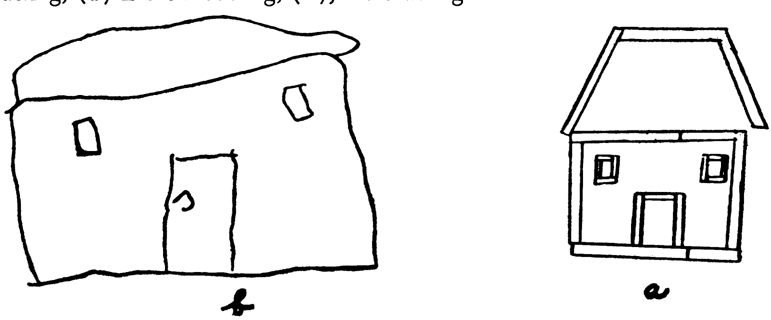


Fig. 7.—Drawing by the same 3-6-year-old girl after training with concrete modeling; (*a*) is the modeling; (*b*), the drawing.

the utmost attention to the preliminary orientation to the manner of solving it and not to the practical result.

The model and the elements (flat figures of different forms) were covered with glass and the child was asked to decide in advance what elements he would need to reproduce the model (Fig. 8). Then the experi-

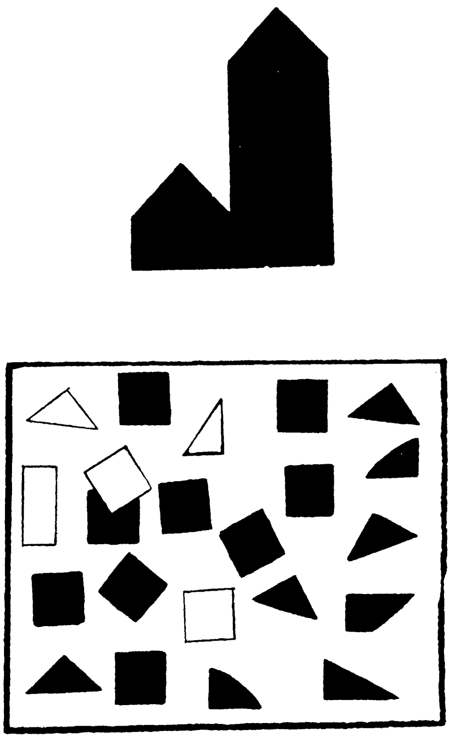


FIG. 8

menter gave the designated figures to the subject and he began solving the problem practically. He learned in the course of the solution whether his previous visual analysis of the complex form had been correct or not. After a number of failures the child usually understood that the problem was difficult and that he had made mistakes in his choice of necessary elements. Then we told him to use the method of concrete modeling to solve the problem and gave him additional elements of white paper corresponding to the figures under the glass; thus, he learned to lay the duplicate elements on the sample and to determine the elements from which the model could be constructed.

Children of different age groups learned to operate with such models in different ways. Three-year-old children could not master the method and the course of instruction did not give any noticeable results. Children of 4 to 5 years of age learned to operate with the paper patterns successfully, but they considered the task and its results to be an independent practical achievement and not a means of solving the next constructive problem. First, they placed paper elements on the sample and, then, quite independently of this problem, began to choose the cardboard figures under the glass that would be needed to construct a new building. In order to induce the subjects to use actual modeling in constructing the building, we had to use some additional methods to increase the value of this problem (constructing a beautiful building by means of parts made of nice, colored cardboard) and to decrease the attractiveness of modeling (using patterns made of simple, soft, white paper). The older children (5–7 years) mastered the method of concrete modeling without any additional exercises and used it adequately to achieve the required practical results.

After this training the level of visual analysis of a complex form was considerably raised in all the children between the ages of 4 and 7. In most cases, they could show correctly the geometrical elements that a given sample could be composed of and where, approximately, those elements should be placed (Table 6).

TABLE 6
INFLUENCE OF "CONCRETE MODELING" ON VISUAL ANALYSIS OF A COMPLEX FORM (PERCENTAGES)

Experimental Situation	Age of Children		
	4–5	5–6	6–7
Before training	23.0	36.0	39.0
After training with concrete modeling	40.0	75.0	80.0

In the described cases, both the object perceived by the child and his reproduction of it were in the same sensory modality. But our studies show that children can start modeling qualities of the specific features of one modality in relation to another modality rather early. Such heterogeneous models are especially important in the formation of an adequate method of analyzing speech and musical sounds. The acoustic sphere is very dynamic and difficult for a child to grasp until he has a model, that is, "materializes" it (as P. Y. Galperin says) in the acoustic characteristics of the space around him and in relation to the objects present.

We had two research projects in our laboratory (T. V. Endovitskaya and I. A. Repina) that showed that discriminating the pitch of pure sounds was extremely difficult for preschool children. The differential thresholds found in these experiments, therefore, are very high. During the teaching experiments, we introduced objects that, by their space relations, created a model correlating tones with objects. Thus, Repina prepared dramatizations in which the heroes were a big Father Bear that emitted low sounds, a smaller Mother Bear with a little higher voice, and a little Son Bear with a still higher voice.

At first, the experimenter and the children presented various stories about the life of this family; then the bears hid themselves in different places and the child was instructed to find them by their voices. It appeared that, after such training, even the younger children (2 to 4 years of age) could easily discriminate the voices according to the tone and, later, to differentiate more successfully other sounds they heard for the first time although they were not connected with any familiar objects (Table 7).

TABLE 7

THRESHOLD OF PITCH DISCRIMINATION IN PRESCHOOL CHILDREN (DIFFERENCE IN TONE)

Experimental Situation	Age of Children			
	3–4	4–5	5–6	6–7
Before training	4.8	3.4	2.4	1.7
After training with concrete modeling	2.0	1.0	0.85	0.6

I. V. Endovitskaya used a more complicated but more universal model of the correlations between sounds and different heights. She gave to a child a rectangular ruler that was divided into equal squares. The child received a doll, too, which was to jump from one square to another according to the sounds that the child heard (Plate 4A). If the difference between sounds was small, the doll was to jump from the first square to the second. If the difference was bigger, it jumped from the first square to the third, and so on. At first the child did the exercises together with the experimenter and then independently.

The training of children to make such models leads to a considerable increase in the effectiveness of tone discrimination. The use of "heterogeneous" models for such training probably exerts some influence on both sensory and intellectual development.

Logical and psychological studies, carried on by L. P. Shchedrovitsky in our laboratory, show that the transition from object-like models to models that resemble real objects less and less, will prepare the child to replace perceived objects with symbols; this is of great importance for the formation of thinking processes at the preschool age. But the very complicated problem of the formation of thinking that is based on certain sensory impressions, as well as the changes in relations between perceptive and intellectual processes at different stages, will require special analysis, and I shall not deal with it in the present paper.

Coming back to the question of the influence of concrete models on the development of perception in children, it is necessary to stress that, being peculiar analogues of sensory images, the models are not sensory images and it is yet to be discovered how the external modeling is, so to say, "internalized"—how it is converted from external to internal. As is known, a study of

PLATE 4A

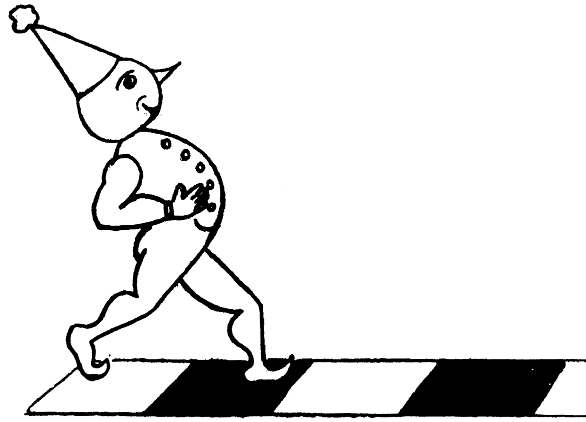


PLATE 4B

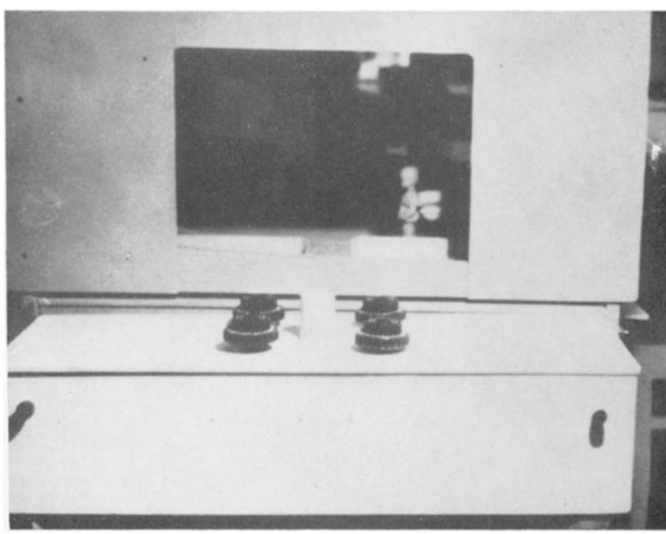
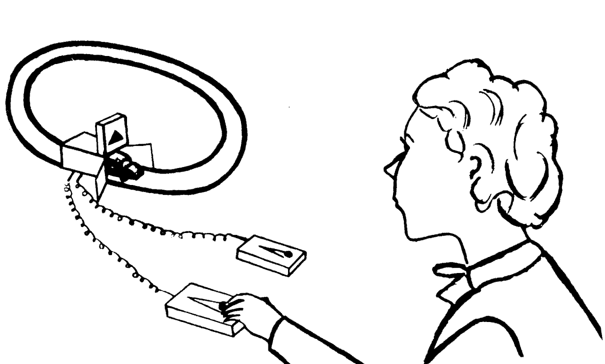


PLATE 4C



internalized intellectual processes was made by J. Piaget in the West; in Soviet psychology, it was started by L. S. Vygotsky and A. N. Leontiev and is being intensively continued by P. Y. Galperin.

The experiments done in our laboratory show that, although there is much in common in the internalization of intellectual and perceptive processes, the process of forming the latter has some specific distinctions. The results of our experiments show that new methods of becoming acquainted with reality are initially started within the practical activities connected with new practical problems the child has to solve. And here, at the first stages, they are methods of accomplishing executive actions, immediately aimed at achieving certain practical results, and it is only later, under certain conditions, that they become methods of orienting-exploratory modeling activity.

For example, N. N. Poddiakov studied the process of forming a habit of operating a relatively complicated mechanism. A child sat at the switchboard and could, by pushing buttons, make, for example, a doll move in different directions (Plate *4B*). The subject was given the task of leading the doll around an obstacle and bringing it to a certain point. The experimenter first demonstrated the work of the mechanism, but the children could not understand immediately the principle of its operation. That is why, when they started to solve the problem, they usually began by pushing different buttons chaotically, trying to achieve the desired goal at once. But with such methods, the doll rushed about chaotically, and the necessary result could not be achieved. The difficulties in the practical solution of the problem made the child study the situation and it was here that a characteristic change in behavior took place. When the buttons were pushed, quick energetic movements of the hand became slow, careful, and probing, the movements accompanied by glances toward the moving doll. In other words, just at the moment that the executive actions were becoming orienting-exploratory, an elementary method was being created to test any system of button control.

Analogous changes were observed by Y. Z. Neverovich when she studied kinesthetic perceptions, but in her case the changes were specific to different age groups (they were not only functional this time). The children were asked to reproduce actively in a Zhukovsky kinemometer the movements they had made passively with the help of the experimenter (Fig. 9). A correct reproduction was initially reinforced by approval from the experimenter or a signal from a light. It was revealed that the movements of younger children (3 years of age) were definitely executive and immediately directed to a desired goal. They moved the hand of the kinemometer to a certain point quickly, without any hesitations, and were glad beyond limits if reinforced and deeply sorry if not. We do not see any preliminary orientation in the conditions of the task in this case. At higher genetic stages (children of 4 to 5 years of age) you could observe, along with the described movements, slow, probing movements through which the

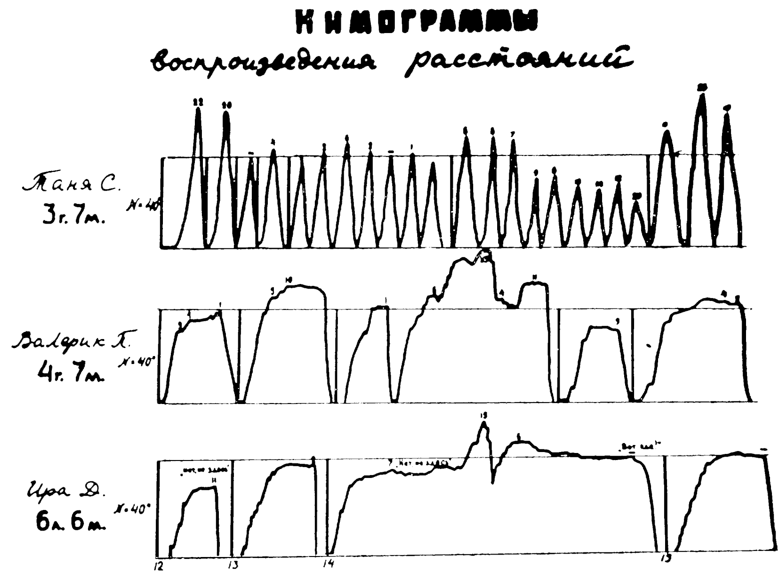


FIG. 9

inner, proprioceptive picture of the task was clarified and a model of the future motor action created.

The data illustrate the convergence of immediate movements of the hand from executive into orienting-modeling. But we also received analogous results when we dealt with indirect actions that led to the creating of new objects and situations. For example, in the experiments of Boguslavskaya, Sokhina, and others mentioned above, it was found that children first mastered constructing, replicating, or drawing as certain kinds of practical operations that led them directly to results they themselves found interesting. And it was only later, when these actions became stable, that you could give them the new functions of examining a situation and of preliminary modeling, for these results can be achieved in the course of experience following executive actions.

Thus, the first and most important stage characterizing the beginning of a new perceptive act is the conversion of a practical executive act into an orienting and modeling one. This is the reason why, at the beginning, a new way of becoming acquainted with an object is usually carried into practice by organs that are capable of performing both practical and cognitive functions, such as by the hands' touching and manipulating an object, or by the muscle apparatus of the larynx, which plays an important role in communications and serves as an important means of analyzing musical and speech sounds at the same time. No longer dependent upon practical activity and having acquired new orienting functions, the subsequent actions of the child undergo considerable changes. For example, each touch and manipulation of the object give the child new information about it. This is why, as we have mentioned, children try at first to use the assimilated practical actions both for practical and cognitive ends. But the cognitive effect of such actions is insignificant, and the actions must be changed and restructured to perform new cognitive functions effectively. This process of differentiating and particularizing perceptive actions, and the subsequent internalization as well, were studied in a number of projects in our laboratory.

A. L. Ruzskaya studied, in children of different preschool age groups, the formation of perceptive actions in discriminating geometrical figures. There were two response keys on the table before the child. At some distance away there was a toy garage with a car in it. A small screen was fixed above the garage on which geometric figures were projected by a special mechanism. When one kind of figure (*triangles*) appeared, the child was to push the left key; he was to push the right one at the appearance of other figures (*rectangles*). The correct choice was reinforced by a toy car's coming out of the garage (Plate 4C).

During preliminary experiments, the children were trained to discriminate the forms by one pair of figures, presented repeatedly. When the differentiation had been worked out, we began control experiments. We projected on the screen different variations of the figures in various positions. All the children made numerous mistakes in discrimination and the number was especially great for children of 3 and 4 years (Table 5).

This testifies to the fact that the forming of perceptive images in such conditions of training is not sufficiently constant and generalized and, consequently, does not enable the child to solve difficult sensory problems.

Proceeding from this hypothesis of the genesis of perceptive actions, Ruzskaya tried in the following experiments to form, especially in children, some ways of examining perceived objects. The children were given cardboard figures which they could touch and manipulate. All the younger children and some of the older group showed rather primitive methods of acquainting themselves with the figures. They moved them from one hand to the other, touched the angles or heaped them up without any careful examination of the figures themselves. It is in this connection that we started especially to teach the children how to acquaint themselves with objects in a more rational way. The child was taught to follow the outline of the figure with his finger, stressing the changes of directions at the angles and counting (one, two, three). The study of triangles was alternated with that of rectangles, and the children learned about differences in their structures, and about the difference in the number of angles and sides. Thus, the child assimilated an algorism of exploratory actions that allowed him to recognize any version of that or another figure independently of its position (Table 5). In the first stages, the function of examining and modeling could only be performed with a palping hand while the eyes played an auxiliary role, that of tracing the movements of the hand. But later the eye became able to solve independently such problems of perception by tracing the outline of the figure as had been done by the palping hand. Very interesting transitional forms could also be observed when the child could differentiate figures visually but his eye movements were accompanied by some movements of the hand modeling the form of the object at a distance, thus organizing and correcting the processes of the visual examination of the object.

Later, the children passed to purely visual orientation. In the first stages the movements of the eye were very extended (Zinchenko) and the child visually traced the whole outline of the figure perceived, modeling its peculiarities in detail. In the last stages of the formation of perceptive processes (after the child was trained for a long time in recognizing and discriminating figures of a certain kind), exploratory movements of the eye became reduced consistently, concentrating on the separate, most informative features of the object. It was at this stage that the highest form of internalization of perceptive process was achieved. On the basis of earlier external models that were created with the help of movements of the hand or eye, for example, and were repeatedly compared with the object and corrected according to its features, there was formed at last an internal model—a constant and orthoscopic perceptive image.

The material substratum of this internal ideal model is, evidently, what Pavlov calls a "dynamic stereotype," a system—a constellation of interconnected cortical excitations—that corresponds to the stereotype of influences stemming from the object.

Now, without any extended exploratory operations, one short glance at the object, the distinguishing of some characteristic feature, can signal into action the whole internal model and thus lead to the immediate grasping of the properties of the perceived object. It is exactly in this form that supporters of Gestalt theory described the process of perception, proving, incorrectly, that it is initial in the ontogenesis and determined by physical laws of the formation of the structure. In reality, as we have tried to show in our paper, a given form of perception is the product of a continuous development that goes on in the child under the influence of practical experiences and learning. It is only a genetic study that can disclose the reflex origin of this perceptive process and its connection with practical and cognitive activity in children.

I should like to stress, in conclusion, that the development of the child's perception is not spontaneous; it takes place under the influence of practice and learning, in the course of which the child assimilates social sensory experiences and joins the sensory culture created by mankind. The adults give the child methods of learning the environment by acquainting him with the systems of musical sounds—speech phonemes, geometrical forms, etc. —that have been developed by man. They also teach him to designate the particulars of his environment, by means of language. As a result, the child assimilates a certain system of generally accepted sensory measures, sensory standards that he uses later in his perceptive activity to analyze the reality and reflect it in synthetic images.

Our studies show that the process of sensory learning can flow chaotically and not be productive. But if you can organize the process in accordance with the psychological regularities of the stage of formation of perceptive actions, the effectiveness of this learning can be considerably raised.