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The Development of Reasoning in Young Children

I

The development of reasoning in the child has been the object of numerous experimental and theoretical studies in child psychology. However, despite the considerable factual material gathered in these studies, the erroneous theoretical positions of most bourgeois authors has kept them from a proper understanding of the true causes and the nature of the development of reasoning in the child. Although these authors have incessantly repeated the word “development,” they have given it a completely antidialectical meaning, understanding development either as a quantitative accumulation of factual knowledge and association or as the unfolding or expansion of innate capacities.

It is not our purpose to provide a detailed review of studies of child reasoning, especially as some of them have already become obsolete, and others are of secondary importance. Therefore, in the critical section of this study (carried out under the supervision of A.N. Leontiev), we have devoted principal attention to work that occupies a central position in contemporary bourgeois child psychology, generalizes the enormous factual material, and in its negative aspects reflects not so much the individual faults of the author of the study as the flaws in the whole

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system of notions currently reigning in West European psychology.

We have in mind the studies of [Jean] Piaget. Piaget views intelligence as a particular case of biological adaptation. Further, he assumes that thought, like other organic functions, consists primarily of the assimilation of “objects to the subject.” It is not reason that is modified by things, says Piaget, but things that are modified by reason.

Piaget conceives of the development of reasoning in the child in this way: At first the infant is autistic. Psychologically he/she does not yet have ties to objective reality: the infant lives in his/her own world of subjective experiences, dreams, and desires, and his/her thoughts are not yet directed toward the resolution of real tasks, but rather serve for the immediate satisfaction of the child’s appetites.

Later, during preschool age, under the influence of contact and interchanges with adults, the child begins to direct his/her thoughts toward the objective real world, although he/she still assesses that world exclusively from his/her own subjective standpoint, adopting an egocentric position. The egocentric nature of a child’s thought, according to Piaget, is responsible for a number of peculiarities of a child’s logic, such as its syncretism, its lumping all things together, and so forth. All of these factors give a child’s thought a unique character, which Piaget, following Stern, calls transductive. This means that “a child’s thought is not based on any generalized induction, or on appeals to general postulates, as would be the case in demonstrating individual statements, but rather goes from particular to particular without thought’s once establishing any logical necessity.” As a result, the child appears vague to the point of contradiction in his thoughts.

In Piaget’s view, the thought of the preschool child is transductive, because it involves no generalizations. The child’s judgments are merely linked together externally: they are not intrinsically related; the child does not notice the contradictoriness of his statements and does not try to resolve them. All these features are explained by the child’s egocentric orientation, or, in other words, his/her lack of “socialization”; for in Piaget’s view, intellectual contact with adults is the only effective source of development of thought in the child.

Such an idealistic concept of the development of thought in a child has produced a number of theoretical and empirical objections to it. Among these are, in particular, the critical studies of Huang, Isaacs, Vygotsky, and others in our country. These studies have produced a num-

ber of important conclusions. Nevertheless, little headway has been made in discovering the concrete conditions of the emergence and evolution of different forms of thought in the child, either in terms of a criticism of Piaget's views or with regard to the positive development of the problem—except, that is, for some accurate but rather general evidence pointing to the role of experience and a knowledge of the real world in the changing forms of thought in the child.

Since the study of the conditions and nature of the development of reflective thought in the child is of considerable practical and theoretical interest, we performed some small, experimental studies in this area. For these studies we chose a method similar to Piaget's method in its external features, thus facilitating the comparison of our findings with those of Piaget.

One of the experimental procedures used by Piaget to study thought in the child consists in showing the child a glass filled with water, into which the experimenter drops a stone and asks why the level of the water in the glass rises. The child replies that this happened because the stone was heavy. Then the child is shown a number of objects, among which is a piece of wood. Answering the experimenter's question, the child says that it (i.e., the piece of wood) must also raise the water in the vessel, or that it is not heavy, and so forth.

From his analysis of these answers, Piaget concludes that a child's thought is syncretic and that it does not perceive contradictions. In Piaget's view, these experiments show clearly that events taking place before a child's eyes are unable to teach him/her, are unable to break down the egocentric character of his thought—in a word, a child is "impervious to experience."

However, a thoughtful analysis of the procedure employed by Piaget shows that the very nature of the investigation determined the specific results obtained. The facts with which the child must deal are selected in such a way that on their basis he/she is unable to draw any generalized conclusions or find any single principle to serve as a groundwork for his own reflections. When a child is shown a number of disconnected facts for which no objective general patterns are evident, he/she is able to take a uniform approach to them only if the pertinent generalities or rules are known beforehand. However, if a serious attempt is to be made to resolve the question of the importance of experience for the development of a child's thought, it is necessary to organize, in an experiment,

the child's practical experience, his/her activities with an object, in such a way that the child will be induced to make his/her own positive generalizations and alter the course of his/her reflections, and then determine what experience and what activity brings about certain changes in the child's reasoning process. Our method was based on this position. This method, which outwardly bears a strong resemblance to Piaget's method, was in essence its opposite.

Our studies were based on transfer. In determining which objects floated and which sank, the child had actually to resolve a number of problems similar although not identical with one another. For example, the child was shown a number of light floating objects and then, if he/she took it for granted that the first presented object would float, we gave him/her a number of other light objects that would sink and observed the changes in the child's thinking. In this way we were able to watch how certain relationships between judgments were created in the process of activity and how these relationships were subverted or altered.

The study usually began with a preliminary test (in conversation) to determine whether the child understood the words "float" and "sink." Then we conducted a conversation, about the floating of different objects not present in the given situation, in which the child had to say what he/she thought would happen with some particular object if it were put into a vessel containing water, into a river or into the sea. After this conversation with the child, we deliberately focused on the objects before him/her.

During the course of the experiment, either the child or the experimenter would immerse the object in a vessel containing water and put the correctness of the child's assumption to a practical test. We carried out these experiments with children aged three to seven.

II

At the age of three, children already have their own unique way of linking judgments together. At the beginning of one of our experiments, we ascertained in a conversation whether the child (aged three years, three months) correctly used the terms "float" and "sink" and had a correct concept of whether some of the objects shown to him would float. Then we asked the child why a particular object would float or sink. The conversation went as follows:

Experimenter (showing the child a thin copper strip): What do you think, will it float?

Child: No, it won't.

Experimenter: So put it in the water (the child tosses the strip into a pan containing water). Well, does it float?

Child: No, it doesn't.

Experimenter: Why?

Child: It's small.

The child was then shown a metal button and a nail. He said correctly that they would sink and based his reasoning on the fact that they were small. Then the child was shown a piece of a matchstick.

Experimenter: Do you think this little matchstick will float?

Child: No, it'll sink.

Experimenter: Why?

Child: Because it's small.

Interestingly, in the preliminary conversation, the child did not make such a mistake, and, even with regard to a number of wooden objects of different sizes, correctly postulated that they would float. Evidently, a number of the judgments made in connection with the objects that we specifically selected led to alterations in the child's initial judgment about the piece of matchstick, which was based on his everyday experience. At first it seemed that these altered views about the objects occurred because the child made such a generalization about the several objects shown to him on the basis of one criterion or attribute alone, that he laid down a rule according to which small objects sank, and that this rule led him to mistakes.

However, this was not the way things were. Further analysis showed the elementary relationship between the nature of the child's judgments and the level of his development. To ascertain whether there were any significant uniform features on the basis of which, as we had initially supposed, the child had drawn the general conclusion that an object would float or not float, we showed the child a number of things that had no external feature in common whatsoever and were of different sizes, shapes, colors, and so forth.

Then the child was shown successively a floating aluminum spoon, a lead pencil, a wooden block, and so forth. Then once again the copper strip that he had encountered previously was shown to him. We found that in this instance the child asserted that the copper strip would float.

Therefore, despite the fact that an object and its properties were previously known to the child and the things that were shown to him subsequently were selected so that they could not induce him to make any generalized statement about them on the basis of any identical feature, which would hence have led him to a mistake, the child altered his initial judgment about the object and began to assume, incorrectly, that the metal strip would float.

How can such a further change in the child's thinking be explained in such cases? Evidently, the reason must be sought in the sequence in which the child put the objects, one after the other, into the vessel containing water. For an object that directly followed a number of floating objects would, in the child's mind, float, whereas an object that came after sinking objects would also sink.

As a result of the perception of a number of similar objects and judgments related to them, the child began, as it were, to have a definite orientation or expectation, which temporarily influenced his later judgments.

The relationship between judgments that arose in these instances reflected the relationship among phenomena, although it did so in a superficial and limited sense.

If we can speak about a generalization here, it is only in the sense that the child altered his judgment about a certain object according to the kind of things in which this object actually was included. The dependence of a child's reasoning on the number of similar objects that were presented one after the other was so strong that it existed even in cases in which the object presented was well known to the child from his previous experience. For example, a piece of matchstick following a series of sinking objects would, in the child's mind, sink, and a metal strip following a series of floating objects would also float.

What is the purport of this dependence? To answer this question, let us return to the experiment described above.

After the child declared that the metal strip would float, the experimenter suggested that he toss it into the water. The child satisfied himself that the strip would sink. Then the child was shown a number of floating objects (a piece of wood, a wooden pen, a pencil case, a wooden strip) and, finally, was again shown the same metal strip.

Experimenter: Well, will the strip float?

Child (nodding his head that it would, and then beginning to shake his head to the contrary).

Experimenter: What do you think, will it float or not?

Child: It will float.

Experimenter (suggesting that the child toss the strip into the vessel containing the water; when it sinks, he asks the child): Well, what happened to it?

Child: It floats.

Thus, the influence of an earlier set of facts and judgments related to them was so strong that it altered not only the child's assumptions but also his asseveration of a previously perceived fact. This orientation continued to exert an influence on a number of later judgments, although it was gradually altered under the influence of new facts. The child would begin first to alter his affirmative judgments and bring them into line with the facts, and then later would alter his assumptions and expectations in the same direction.

Unlike Piaget's experiments, with the help of our method we endeavored to find out how the way a child's thoughts were related depended on how the objects with which he/she operated were related. This dependence is of fundamental importance for the formation and change of a child's reasoning.

In one experiment a four-year-old child, after being given a number of wooden objects that floated, began to assume that the metallic objects (a metal clamp, a copper screw, a piece of lead, a lead bead, a small weight) later presented to him would also float. However, as soon as the child saw that a given object sank, he affirmed this fact correctly.

Thus, two types of judgment emerge: forecasting judgments, which depend on a number of previous objects and the reasoning related to them, and affirmative judgments, which depend directly on the facts before the child.

These two kinds of judgment come into conflict with one another, something the child does not always perceive. It seems as if he/she cannot completely bring these two kinds of judgments together. However, such an assumption turns out to be incorrect since, as the experiment shows, mutual influences and reciprocal relations exist between forecasting judgments and confirming judgments.

If, after a number of floating objects a child is given a number of nonfloating objects, his/her forecasting judgments and confirming judgments at first diverge and he/she incorrectly assumes that the given objects will float, although later he/she will say correctly that they will sink.

However, as the experiment goes on, if a number of sinking objects are given, the discrepancy between the two kinds of judgments levels out, and forecasting judgments begin to be correct, having been reconstructed with a direct bearing on the new facts and in such a way as to agree with the confirming judgments.

In the same children it was possible to observe a reverse influence of forecasting judgments on affirmative judgments. When, after a large number of floating objects, the child was shown a nonfloating object, a cufflink, the child not only incorrectly assumed that it would float but, contrary to expectations, affirmed that the cufflink was floating even when it had already sunk before his very eyes.

In light of this observation, our method brought us to theoretical conclusions fundamentally different from those of Piaget. In our view, a child's reasoning and its associations depend on the nature of the child's relationship with objects and on their objective properties, which are revealed to the child in the process of his/her acting with them. For this reason we think it is incorrect for Piaget to state that a child's thinking depends on so-called transductive logic, which is determined by subjective schemata of association and syncretism.

In our opinion, the truth lies, in the final analysis, not in the fact that the child is unable to engage in self-observation and analyze his/her own thinking, but in the fact that the daily life of a child and his/her concrete activity do not pose such tasks for him.

The findings of our experiments show that three- and four-year-old children are able to make judgments about objects on the basis of their true properties. But a child most frequently predicts, and does not guess, what will happen when an object is placed in the vessel of water. However, it is usually impossible to make a prediction without there being any links between judgments and without the reasoning process having any connection with the object a judgment is about. The fact that the children in our experiments recognized an object with which they had already dealt and, let us say, foresaw what would happen to it when it was placed in the water doubtless tells us something about the relationship between past and present judgments concerning the same object.

Accordingly, children generalize a number of facts that characterize a particular object, and this becomes their judgment. But the children whom we observed in our studies also made generalizations, so to speak, along another line, in which the judgment about one object depended on the child's reasoning about a series of objects presented one by one.

The strength of such generalizations was so great that the relationship between judgments about one object gave way to a relationship between judgments about several objects.

In the next stage of development, the nature of a child's reasoning changes. The child's everyday experience expands; the conditions of his activity become more complicated and richer. As a consequence, specific changes occur in a child's reasoning processes, as we observed in children from the ages of five to seven.

However, the reason for the change in a child's thinking at this stage of development lies not only in a mere accumulation of experience but, to some extent, in the nature of the child's activity, in the nature of his or her orientation toward the surrounding reality.

Children learn to perform certain acts in connection with certain objects and at first cannot distinguish one from the other. However, later on they learn to master such acts to such an extent that they can transfer them to another object situation. Children see that a relationship between an object and an act is variable, that the same act may be carried out with different objects, and that one may operate with the same object differently. Thus, in a child's daily life as such, his/her acts acquire a certain relative independence and come, in turn, to exert an independent influence on the child's reasoning.

Our study showed that at the stage of development we are considering here, a child's reasoning depends not so much on the sequence of the objects themselves as on the sequence of the child's acts with these objects, or on how the objects performed in these acts.

A child of the age of five years and six months was asked to lower an aluminum spoon into a vessel containing water. The child carefully lowered the spoon and said, "It floats." Then the child did the same thing another time, and this time the spoon collected water and sank. The child was asked: "Why did the spoon sink?" The child answered that he had put it in incorrectly, that if you lower a spoon that way, it will sink.

Then the child was shown a lid from a metal box and asked: "Can you do the same thing with this so that it will sink?" "Yes," the child replied.

Then the child did the same thing with the lid as he had done with the spoon, placing the lid on its end in the water so that it collected water and sank.

"Why did it sink?" the child was asked. "Because I put it in the way I did," he answered.

To test the force of his act (placing the object in such and such a way),

after the lid, the child was shown two objects, which he then put into the water “in the same way” as the spoon and the lid, so that they also sank.

After these objects the child was shown a piece of wood such as he had already encountered in our experiment and was asked, “Will the piece of wood float?” “Yes,” said the child. “And can you do the same thing with it so that it will sink?” “Yes,” the child replied, and then took the piece of wood and, immersing it in a vertical position in the vessel containing the water, tried to sink it.

“Well, does it float?” “No,” answered the child.

These examples show that for five- to seven-year-old children, what they do with an object and how they do it is of tremendous importance.

In a number of cases, a child would try to justify his/her reasoning by drawing on elements from his/her own practical experience or that of others.

A child aged five years, eleven months, was shown a wooden locomotive and asked: “Will the locomotive float?” “No, it will not,” said the child. “Why?” “Because it is on wheels, and it needs rails.”

Then the child was asked what would happen with a toy duck if it was placed in a vessel containing water. The child said, “The duck would float, because I have seen how real ducks float on the water.”

One more example will show the relationship of a child’s reasoning to his experience:

The experimenter asked a seven-year-old child: “If you put a piece of iron in the water, what will happen to it?”

“Anyone who swims in that water will cut himself,” answered the child. “The other day Victor was swimming and he cut his foot.”

“And what will happen to this pencil box if you put it in the water?” the child was asked. “If it draws water,” answered the child, “it will sink.”

The experimenter suggests to the child that he put some water in the pencil box and in this way test whether it will sink or float. The child puts water in the pencil box and says: “Well, it doesn’t sink.”

“Why?”

“Because it is made of wood.”

“And what must be done in order to make it sink?”

“You can put some bricks in it; that will make it sink.”

“How do you know this?”

“I watched some boys doing this on the river, and I did it myself,” answers the child.

Thus, in our experiments we found a connection between the judgments of older children and their practical experience. However, it should be noted particularly that a child's reasoning at this age is related not just to his practical activity.

The reasoning of children at this age is directly a part of their present practical activity; and indeed, their reasoning is so closely bound up with that activity that the children consciously check it out against their practical actions.

Many children, before they answer the experimenter's question about whether an object will float or sink, try to put it in the vessel containing water. Sometimes the children even refuse to answer the experimenter's question, pointing out that they have to test it first.

This is important, because it shows that the practical activity of five- to seven-year-old children has changed in comparison with the activity of three- to four-year-old children in the sense that particular acts become voluntary, and the children consciously make use of them to buttress their judgments. This means that in their reasoning, children do not simply follow along with sinking or floating objects, that is, the facts, but themselves deliberately create facts on the basis of which they form their judgments.

Thus, five- to seven-year-old children begin to sense the contradictoriness and inadequacy of their judgments, especially their forecasting and confirming judgments. This showed up in our experiments in that the children endeavored, through their acts, to force the facts to conform to their reasoning. For example, if a child said about any object that it would sink, then he/she would thereupon try to put it into the water in such a way that the object would indeed sink: he/she would plunge it into the water, throw it in so that it would collect water, and so on. The children tried, as it were, to help the objects and the facts not to contradict their reasoning.

One little girl, aged six years, six months, in our experiments said that an iron object would sink in water, but a wooden one would float. "Iron objects sink because they are heavy and because iron expands in water."

This little girl was shown a piece of thin wire and a wooden strip and was asked: "Which will sink in the water and which will float?"

Pointing to the wire, the girl answered: "This one will sink because iron expands in water. And the strip of wood will float because it is light and the water holds it up." The child then said: "If there's a lot of iron, then even people will have difficulty holding it up."

After this, the child put the strip of wood and the wire in the vessel containing the water and said: “I said that the wood was light and that it would float and the iron wire would sink.”

“Why?” asked the experimenter.

“Because the iron expands in the water.” And then, to demonstrate the correctness of what she said, the girl put her hand in the water, took the wire, straightened it out, and said, “Well, see for yourself: it expanded.”

Then the child made the same judgment about all objects as about the wire; and when the experimenter asked, “Why do they sink?” answered: “I’ve already said a thousand times that they expand in the water.”

This fact and many others show that an older child’s reasoning differs from that of three- to four-year-olds in terms of both its content and its associations.

On the basis of a number of facts, a child comes to a certain conclusion and generalization, which in turn begin to influence his/her later judgments.

In the course of our study, a child aged five years, six months, came to the conclusion that iron sank. Then the child was shown a tin box, and asked: “What is this box made of?” The child took the box in his hands, examined it, and said: “It is made of iron.”

“What will happen to it,” asked the experimenter, “If it is put in water?”

“It will sink,” said the child.

“Why?”

“Because it is made of iron.”

The child was told to put the box in the vessel containing water. He did so, quickly turned around and said: “It sank.” (The box was floating.)

The experimenter suggested the child should take a look and see that the box had sunk, but the child did not want to, and, turning away from the vessel containing the water, said that the box had sunk.

When the child was asked once again to take a look at the floating box, he said: “The box is floating.”

“They why did you say that the box had sunk?”

“I was guessing,” answered the child, “that it had sunk.”

The child, of course, did not think that the box had sunk. He quite clearly saw that the box was floating, and turned away in order to be able to reconcile his forecasting judgment with his confirming judgment. This innocent bit of trickery unquestionably shows that children sense the contradictoriness in their judgments.

premise that a child's capacity to reason is gradually acquired in the process of living, as he familiarizes himself with objective reality and activity with things.

This unique, vital relationship acquires a dual character, for a child, on the one hand, acts practically with regard to the things around him/her, satisfying his/her own vital needs, yet, on the other hand, also acts theoretically with regard to them, that is, he/she at the same time generalizes about them, reflects them in his/her consciousness, and accumulates experience about them. Thus, a child's reality is a reality of objects.

This objective nature of a child's activity derives from the fact that in the course of daily life a child has to deal not simply with physical bodies or facsimiles of them but with objects that are part of a context of specific actions and have practical functions in human life.

As a result of this specificity of objects, a child acquires practical command of them, that is, he/she learns to use them, and in the process acquires command of his/her own actions. This process of acquiring command of objects is the practical side of a child's activity, and acquisition of command of his/her actions constitutes its theoretical side. For, once a child has mastered his/her actions, he/she can consciously regulate or predict them, and a theoretical relationship to reality is henceforth within his/her reach. The development of a child's reasoning is an integral part of the development of a child's practical activity.

In his general, idealistic concept, Piaget wrongly divides a child's judgments into predicative judgments and judgments about relationships. But according to dialectical materialism, the relations of an object are also its properties. It has not been our purpose here to consider the logical side of the question; we have concentrated our attention mainly on the relationships between a child's reasoning and his/her practical activity. Thus, we have distinguished confirming judgments and forecasting judgments. The former follow acts and accomplished tasks, whereas the latter precede them.

The origin and development of these kinds of judgments and the changes taking place in the relationships between them are associated with the general process of change taking place in the nature of a child's everyday life and activity.

Even in the early preschool period, a child becomes acquainted with a number of objects in the household and begins to use them in accordance with their purpose. Indeed, it becomes the specific purpose of

early children's games and manipulations to directly reproduce the functions of these objects. However, though a child may have learned to perform some act with an object, at this age he/she has not yet acquired such a command of it that he/she can transfer it to another object. Hence, acts are not yet separated from objects, and are still firmly entrenched in specific objective situations. Many authors have called attention to the peculiar fastidiousness a young child shows in his/her games and practical situations.

All these general features of the activity of young children show up in the nature of their reasoning. Their reasoning follows an action and affirms whatever property of the object has entered into the child's experience. Having not yet mastered his/her acts, a child is unable to contrast his/her experience in a single situation and cannot anticipate his/her practical operations with theoretical operations.

Thus, confirming judgments and forecasting judgments in children are not yet sufficiently differentiated from one another. They stand, as it were, on the same place; and a sequence of similar events occurring one after the other force the child to presume, or rather to expect, that further events will occur in the same way. A child expects that some object he/she has encountered after having observed a number of other objects that sank will also sink.

Later, a child's activity becomes more complicated. After having become acquainted with the "ways" of a number of objects, a child endeavors to adapt them to new conditions or to translate what he/she has learned to new objects previously unknown to him/her.

In this way a child acquires command not only of objects but also of his/her own actions. In his/her activity he/she begins practically to distinguish between those actions and the object to which the actions are applied, that is, between the process of activity and its result. As a consequence, forecasting judgments are distinguished from confirming judgments and enter into new interrelationships. A child predicts that if he/she does this or that, this or that will ensue. For example, if he/she places an object carefully in the water, it will float, and so on.

Then this intellectual schema, which has its origins in practice, begins to be adapted to the most diverse and manifold areas of activity, giving the child additional cognitive tools. The child seeks and finds regular relationships among the various properties of an object, finding out that heavy iron things sink, and light things float, and so forth.

In light of this description of a child's reasoning and the distinctive features of the relationships between confirming judgments and forecasting judgments, we can say that voluntary elements are evident in a child's reasoning even at the age of five, and, especially, among seven-year-olds.

The voluntary element in the reasoning of five- to seven-year-old children consists in the fact that the children consciously compare their forecasting judgments with confirming judgments and consciously organize their acts with an object in such a way that there are no contradictions between individual judgments. In addition, the voluntary element shows up in the fact that children compare and check their judgments in relation to facts, to objects, and to their own acts.

These peculiarities of a child's reasoning do not derive from introspection, but from comparisons with reality, in which a child learns how to master not only his/her practical actions with objects but also his/her judgments with regard to objects and actions.

All this means that the cognitive abilities of a child at this stage of development go beyond the bounds of his/her immediate, practical dealings with things.

