CHAPTER 6

Piaget's Cognitive-Developmental Theory

BIOGRAPHICAL INTRODUCTION

In all psychology, few theorists are as important as Jean Piaget (1896–1980), who forged the single-most comprehensive and compelling theory of intellectual development.

Piaget was born in Neuchâtel, a small college town in Switzerland where his father was a medieval historian at the university. Piaget (1952) described his father as a careful and systematic thinker. His mother, in contrast, was highly emotional, and her behavior created tensions within the family. Piaget adopted his father's studious ways and found refuge from the family's conflicts in solitary research.

Piaget showed promise as a scientist from the start. At the age of 10 he published an article on an albino sparrow he had seen in the park. While he was still in high school, his research on mollusks brought invitations to meet with foreign colleagues and a job offer to become the curator of a museum—all of which he turned down because of his age.

At 15 years of age, Piaget experienced an intellectual crisis when he realized his religious and philosophical convictions lacked a scientific foundation. He therefore set out to find some way of bridging philosophy with science. He read widely and worked out his new ideas in writing, even though the writing was intended for no one but himself. This search did not occupy all his time—he still managed to earn his doctorate in the natural sciences at the age of 21—but Piaget's broader quest did at times leave him confused and exhausted. Finally, at the age of 23, he settled on a plan. He would first do scientific research in child psychology, studying the development of the mind. He then would use his findings to answer broader questions in epistemology, philosophical questions concerning the origin of knowledge. He called this new enterprise "genetic epistemology" (Ginsburg & Opper, 1988, pp. 2–3; Piaget, 1952).

Piaget decided to study children in 1920 while working in the Binet Laboratory in Paris. There, his assignment was to construct an intelligence test for children. At first he found this work very boring—he had little interest in scoring children's answers right and wrong, as intelligence testing requires. However, Piaget soon became interested in the younger children's responses, especially their *wrong* answers. Their mistakes, he found, fit a consistent pattern that suggested their thinking might have a character all its own. Young children, Piaget speculated, might not simply be "dumber" than older children or adults, but might think in an entirely different way (Ginsburg & Opper, 1988, p. 3).

In order to learn about children's potentially unique ideas, Piaget abandoned the standardized tests, which forced children's responses into "artificial channels of set question and answer," and devised a more open-ended clinical interview that "encourages the flow of spontaneous tendencies" (Piaget, 1926, p. 4). He also spent many hours observing children's spontaneous activities. The point was to suspend his own adult preconceptions about children's thinking and to learn from the children themselves.

While in Paris, Piaget published two studies based on his new approach, but he did most of this new research at the Rousseau Institute in Geneva, where he settled in 1921. He primarily interviewed children between the ages of 4 and 12 years, and he found that the younger children, before the age of 7 or so, do indeed think in a qualitatively different way about dreams, morals, and many other topics.

In 1925 Piaget's first child, Jacqueline, was born—an event that initiated an important series of studies on the cognitive behavior of infants. Piaget and his wife, Valentine Châtenay, made very careful observations of Jacqueline's behavior, as they also did of their next two babies, Lucienne and Laurent.

Beginning about 1940 Piaget returned to the study of children, and adolescents as well, but he changed his research focus. Whereas his earlier investigations covered such topics as dreams, morality, and other matters of everyday interest to the child, his new studies focused on the child's understanding of mathematical and scientific concepts—a focus that dominated his work until the end of his life (Ginsburg & Opper, 1988, pp. 15–16).

In the 1950s Piaget finally turned to philosophical questions in epistemology, although he continued to study children's cognitive development. In this book I will say little about Piaget's epistemological theory; rather, our task is to gain some understanding of his developmental theory.

Piaget's research has evoked different responses from psychologists at different times. His first work caught the attention of psychologists in many parts of the world. After this initial enthusiasm, however, interest in Piaget declined, especially in the United States. For one thing, psychologists had difficulty understanding his orientation. They also objected to his methodology.

Piaget sometimes changed his questions during an interview if he thought this might help him understand a particular child's thinking; this, many psychologists pointed out, violates the canon of standardized interviewing. Piaget also ignored such matters as reports on his sample sizes and statistical summaries of his results. He seemed to regard such matters as less important than rich, detailed examples of children's thinking (Flavell, 1963, pp. 10–11, 431; Ginsburg & Opper, 1988, p. 6).

By and large, Piaget's research suffered from the same methodological shortcomings throughout his career, but the 1960s saw a remarkable revival of interest in his work. In the decades that followed, growing numbers of psychologists recognized the stature and importance of his theory. Many have been skeptical of his claims, and many have tried to prove him wrong, but they have recognized Piaget's theory as something to be reckoned with. Today there is hardly a study of children's thinking that does not refer to Piaget.

OVERVIEW OF THE THEORY

Although Piaget's research changed over the years, each part of it contributes to a single, integrated stage theory. The most general stages, or periods, are listed in Table 6.1.

Before we examine these stages in detail, it is important to note two theoretical points. First, Piaget recognized that children pass through his stages at different rates, and he therefore attached little importance to the ages associated with them. He did maintain, however, that children move through the stages in an *invariant sequence*—in the same order.

Second, as we discuss the stages, it is important to bear in mind Piaget's general view of the nature of *developmental change.* Because he proposed

TABLE 6.1 The General Periods of Development

Period I.	Sensorimotor Intelligence (birth to 2 years). Babies organize their physical action schemes, such as sucking, grasping, and hitting, for dealing with the immediate world.
Period II.	Preoperational Thought (2 to 7 years). Children learn to think—to use symbols and internal images—but their thinking is unsystematic and illogical. It is very different from that of adults.
Period III.	Concrete Operations (7 to 11 years). Children develop the capacity to think systematically, but only when they can refer to concrete objects and activities.
Period IV.	Formal Operations (11 to adulthood). Young people develop the capacity to think systematically on a purely abstract and hypothetical plane.

an invariant stage sequence, some scholars (e.g., Bandura & McDonald, 1963) have assumed he was a maturationist. He was not. Maturationists believe stage sequences are wired into the genes, and stages unfold according to an inner timetable. Piaget, however, did not think his stages are genetically determined. They simply represent increasingly comprehensive ways of thinking. Children are constantly exploring, manipulating, and trying to make sense out of the environment, and in this process they actively construct new and more elaborate structures for dealing with it (Kohlberg, 1968).

Piaget did make use of biological concepts, but only in a limited way. He observed that infants inherit reflexes, such as the sucking reflex. Reflexes are important in the first month of life but have much less bearing on development after this.

In addition, Piaget sometimes characterized children's activities in terms of biological tendencies that are found in all organisms. These tendencies are assimilation, accommodation, and organization. *Assimilation* means taking in, as in eating or digestion. In the intellectual sphere, we have a need to assimilate objects or information into our cognitive structures. For example, adults assimilate information by reading books. Much earlier, a baby might try to assimilate an object by grasping it, trying to take it into her grasping scheme.

Some objects do not quite fit into existing structures, so we must make *accommodations*, or changes in our structures. For example, a baby girl might find that she can grasp a block only by first removing an obstacle. Through such accommodations, infants begin constructing increasingly efficient and elaborate means for dealing with the world.

The third tendency is *organization*. For example, a 4-month-old boy might have the capacity to look at objects and to grasp them. Soon he will try to combine these two actions by grasping the same objects he looks at. On a more mental plane, we build theories. We seem to be constantly trying to organize our ideas into coherent systems.

So, even though Piaget did not believe that stages are wired into the genetic code, but constructed by children themselves, he did discuss the construction process in terms of biological tendencies (Ginsburg & Opper, 1988, pp. 16–19).

If Piaget was not a maturationist, he was even less a learning theorist. He did not believe children's thinking is shaped by adult teachings or other environmental influences. Children must interact with the environment to develop, but it is they, not the external environment, who build new cognitive structures.

Development, then, is not governed by internal maturation or external teachings. It is an *active construction process*, in which children, through their own activities, build increasingly differentiated and comprehensive cognitive structures.

PERIOD I. SENSORIMOTOR INTELLIGENCE (BIRTH TO 2 YEARS)

Piaget's first developmental period consists of six stages.

Stage 1 (birth to 1 month)[1]: The Use of Reflexes

When Piaget talked about the infant's action-structures, he used the term *scheme* or *schema* (e.g., Piaget, 1936a, p. 34). A scheme can be any action pattern for dealing with the environment, such as looking, grasping, hitting, or kicking. As mentioned, although infants construct their schemes and later structures through their own activities, their first schemes consist primarily of inborn reflexes. The most prominent reflex is the sucking reflex; babies automatically suck whenever their lips are touched.

Reflexes imply a certain passivity. The organism lies inactive until something comes along to stimulate it. Piaget, however, showed that even a reflex like sucking quickly becomes part of the human infant's self-initiated activity. For example, when his son Laurent was only 2 days old, he began making sucking movements when nothing elicited them. Since he did this between meals, when he wasn't hungry, he seemed to suck simply for the sake of sucking. Piaget said that once we have a scheme, we also have a need to put it to active use (pp. 25–26, 35).

Furthermore, when babies are hungry, they do not just passively wait for the mother to put the nipple into their mouth. When Laurent was 3 days old, he searched for the nipple as soon as his lips touched part of the breast. He groped, mouth open, across the breast until he found it (p. 26).

Babies do not confine themselves to sucking on nipples. Piaget's children sucked on clothes, pillows, blankets, their own fingers—on anything they chanced upon. In Piaget's terms, they assimilated all kinds of objects into the sucking scheme (pp. 26, 32, 34).

Although assimilation is the most prominent activity during stage 1, we also can detect the beginnings of accommodation. For example, babies must learn to adjust their head and lip movements to find the breast and nurse. Such adjustments also demonstrate the beginnings of organization; babies organize their movements so that nursing becomes increasingly smooth, rapid, and efficient (pp. 29–31, 39).

[1]The age norms for this period follow those suggested by Flavell (1963). I use the stage headings suggested by Ginsburg and Opper (1988).

Stage 2 (1 to 4 months): Primary Circular Reactions

A circular reaction occurs when the baby chances upon a new experience and tries to repeat it (Piaget, 1936a, p. 55). A prime example is thumb-sucking. By chance, the hand comes into contact with the mouth, and when the hand falls the baby tries to bring it back. For some time, however, babies cannot do this. They hit the face with the hand but cannot catch it, or they fling their arms wildly, or they chase the hand with the mouth but cannot catch it because the whole body, including the arms and hands, moves as a unit in the same direction. In Piaget's language, they are unable to make the accommodations necessary to assimilate the hand to the sucking scheme. After repeated failures, they organize sucking and hand movements and master the art of thumb-sucking.

As with thumb-sucking, most of the primary circular reactions involve the organization of two previously separate body schemes or movements. For example, when we see a baby girl repeatedly bring her hand next to her face and look at it, she is exercising a primary circular reaction. She is coordinating looking with hand movements (pp. 96–97).

These circular reactions provide a good illustration of what Piaget means by intellectual development as a "construction process." The baby actively "puts together" different movements and schemes. It is important to emphasize the amount of work involved; the baby manages to coordinate separate movements only after repeated failures.

Stage 3 (4 to 8 months): Secondary Circular Reactions

The developments of the second stage are called *primary* circular reactions because they involve the coordination of parts of the baby's own body. *Secondary* circular reactions occur when the baby discovers and reproduces an interesting event *outside* herself (Piaget, 1936a, p. 154). For example, one day when Piaget's daughter Lucienne was lying in her bassinet, she made a movement with her legs that stirred the dolls hanging overhead. She stared at the dolls a moment and then moved her legs again, watching the dolls move again. In the next few days, she repeated this scene many times, kicking her legs and watching the dolls shake, and she often would squeal with laughter at the sight of the moving dolls (pp. 157–159).

Piaget sometimes referred to secondary circular reactions as "making interesting sights last" (p. 153). He speculated that infants smile and laugh at the recognition of a moderately novel event. At the same time, it seems they are enjoying their own power, their ability to make an event happen again and again.

Stage 4 (8 to 12 months): The Coordination of Secondary Schemes

In stage 3, the infant performs a single action to get a result—for example, kicking to move some dangling dolls. In stage 4, the infant's actions become more differentiated; he or she learns to coordinate two separate schemes to get a result. This new accomplishment is most apparent when infants deal with obstacles. For example, one day Laurent wanted to grab a matchbox, but Piaget put his hand in the way. At first, Laurent tried to ignore the hand; he tried to pass over it or around it, but he did not attempt to displace it. When Piaget kept his hand in the way, Laurent resorted to "storming the box while waving his hand, shaking himself, [and] wagging his head from side to side"—various "magical" gestures (1936a, p. 217). Finally, several days later, Laurent succeeded in removing the obstacle by striking the hand out of the way before he grabbed the box. Thus Laurent coordinated two separate schemes—striking and grabbing—to obtain the goal. One scheme, striking, became a means to an end, grabbing the box.

Such simple observations are very important for our understanding of how children develop the basic categories of experience, of space and time. We cannot talk to babies and ask them about their experiences of space and time, but we can see how these categories are developing through their actions. When Laurent learned to move the hand to get the box, he showed a sense that some objects are *in front of* others in space, and that some events must *precede* others in time (Ginsburg & Opper, 1988, p. 52).

Stage 5 (12 to 18 months): Tertiary Circular Reactions

At stage 3, infants perform a single action to obtain a single result—to make an interesting sight last. At stage 4, they perform two separate actions to obtain a single result. Now, at stage 5, they experiment with different actions to observe the different outcomes.

For example, one day Laurent became interested in a new table. He hit it with his fist several times, sometimes harder, sometimes more gently, in order to hear the different sounds his actions produced (Piaget, 1936a, p. 270).

Similarly, one day when our son Tom was 12 months old, he was sitting in the bathtub, watching the water pour down from the faucet. He put his hand under the faucet and noticed how the water sprayed outward. He repeated this action twice, making the interesting sight last (stage 3). But he then shifted the position of his hand, sometimes nearer, sometimes farther away from the faucet, observing how the water sprayed out at different angles. He varied his actions to see what new, different results would follow.

It is worth pausing to note that the infants were learning entirely on their own, without any adult teaching. They were developing their schemes solely out of an intrinsic curiosity about the world.

Stage 6 (18 months to 2 years): The Beginnings of Thought

At stage 5, children are little scientists, varying their actions and observing the results. However, their discoveries all occur through direct physical actions. At stage 6, children seem to think out situations more internally, before they act.

The most widely known example of stage 6 behavior involves Lucienne and a matchbox. Piaget placed a chain in the box, which Lucienne immediately tried to recover. She possessed two schemes for getting the chain: turning the box over and sticking her finger in the box's slit. But neither scheme worked. She then did something curious. She stopped her actions and looked at the slit with great attention. Then, several times in succession, she opened and shut her mouth, wider and wider (Piaget, 1936a, p. 338). After this, she promptly opened the box and obtained the chain.

Piaget (p. 344) noted that at stage 5 the child probably would have obtained the chain through a slow trial-and-error process of experimenting with different actions. Because Lucienne stopped acting and thought out the situation, she was able to achieve the result much more quickly. She did not yet have a good grasp of language, so she used motor movements (her mouth) to symbolize the action she needed to perform.

Children's progress at stage 6 can also be seen in their efforts at imitation. Piaget observed that for some time children cannot imitate new models at all; they can only reproduce actions that already exist in their behavioral repertoires. By stage 5, though, they can make the necessary accommodations to imitate new behavior through experimental trial and error. But it is only at stage 6 that children are capable of *deferred imitation*—the imitation of models hours or days after observing them. For example, at 16 months of age Jacqueline

> had a visit from a little boy . . . whom she used to see from time to time, and who, in the course of the afternoon, got into a terrible temper. He screamed as he tried to get out of a play-pen and pushed it backwards, stamping his feet. J. stood watching him in amazement, never having witnessed such a scene before. The next day, she herself screamed in her play-pen and tried to move it, stamping her foot lightly several times in succession. The imitation of the whole scene was most striking. (Piaget, 1946, p. 63)

Piaget argued that because Jacqueline's imitation came an entire day later, she must have carried within her some internal representation of the model. Since she lacked the vocabulary to represent his actions in words, she probably used some form of motoric representation. She may have imitated his behavior with very brief muscle movements when she saw it, and these movements served as the basis for her later imitation.

The Development of Object Permanence

We have so far described only some of the main features of the six sensorimotor stages. Piaget studied other developments during this period; he showed how infants construct concepts of permanent objects, time, space, and causality. Because of space limitations, we will briefly review only one important development—that of object permanence.

During stages 1 and 2, babies have no conception of objects existing outside themselves. If a person or an object leaves their field of vision, the most babies do is to continue to look for a moment to where they last saw it. If the object does not reappear, they go on to something else. They make no attempt to search for it. For the baby, out of sight is out of mind (Piaget, 1936b).

At stage 3, new progress is made. As babies increasingly explore and interact with the outer world, they gain a better sense of the permanence of external things. If objects are dropped from their line of vision, they now look to the place where the object has fallen. They also can find partly hidden objects (if, for example, a blanket covers only part of a toy). Also, if they momentarily put an object aside and look elsewhere, they can return their attention to the object and recover it. But they only recover the object when it was related to their own actions. At this stage they cannot find objects that are completely hidden by others.

Stage 4 marks the beginning of a genuine sense of object permanence. Babies can now find completely hidden objects. If we completely cover a toy with a blanket, the baby will lift the blanket and find it.

However, Piaget found an interesting limitation at this stage. When he hid an object at point A, his children could find it, but when he then hid the same object at point B, they again tried to find it at point A—the place of their prior success. In Piaget's terms, they could not follow a series of displacements (movements from hiding place to hiding place).

At stage 5, children can follow a series of displacements, so long as they can see us making them. It is only at stage 6 that infants can follow invisible displacements. For example, it was only at the sixth stage that Jacqueline could recover a ball that rolled under the sofa by making a detour around the sofa. She could do this because she now had the ability to visualize to herself, internally, the ball's trajectory path even when it was invisible.

For Piaget, such detour behavior is very important. It shows that the child has constructed a sense of space that has the characteristics of a mathematical model called a *group*. For example, Jacqueline's detours demonstrate the principle of *associativity*, that one can reach a point through different interconnected paths. She also demonstrates the group principle of *reversibility* by bringing the ball back. Similarly, detour behavior reveals the other principles that define a coherent group structure (Piaget & Inhelder, 1966, pp. 15–17).

Less technically, we can note the tremendous progress that infants make. At the beginning of life, they have no sense of objects existing apart from themselves—from their vision and actions. By the end of the sensorimotor period, objects are separate and permanent. Children have developed a universe containing independent objects, in which they are only one object among many. Along with object permanence, then, they have a clear sense of themselves as independent beings (Piaget, 1936b, pp. 108–109).

PERIODS II AND III. PREOPERATIONAL THOUGHT (2 TO 7 YEARS) AND CONCRETE OPERATIONS (7 TO 11 YEARS)

By the end of the sensorimotor period, the child has developed efficient and well-organized actions for dealing with the immediate environment. The child continues to use sensorimotor skills throughout life, but the next period, that of preoperational thought, is marked by a major change. The child's mind rapidly advances to a new plane, that of symbols (including images and words). As a result, the child must organize her thinking all over again. This cannot be done at once. For some time, during the entire preoperational period, the child's thinking is basically unsystematic and illogical. It is not until the age of 7 or so, the beginning of concrete operations, that thinking becomes organized on a mental plane (Piaget, 1964a, p. 22).

The Growth of Symbolic Activity

Children begin to use symbols when they use one object or action to represent an absent one (Ginsburg & Opper, 1988, p. 70). Actually, as we have seen, children begin to do this during the sixth stage of sensorimotor development. For example, when Lucienne opened her mouth before opening the matchbox, she used her mouth to represent an action she had not yet performed. Piaget emphasized that the first symbols are motoric, not linguistic.

We also see nonlinguistic symbols in children's make-believe play, which also begins toward the end of the sensorimotor period. One day Jacqueline pretended that a piece of cloth was her pillow. She put her head on the cloth and, laughing, pretended to go to sleep. Her play was symbolic because she used one object, a piece of cloth, to represent an absent one, the pillow (Piaget, 1946, p. 96).

As their make-believe play develops, children start adding words. When Jacqueline had just turned 2 years old, she moved her finger along a table and said, "Horse trotting." A few days later, she slid a postcard along the table and said, "Car." Her words, like her finger and the postcard, symbolized objects not present in the immediate situation (Piaget, 1946, p. 124).

Language develops rapidly during the early preoperational years (from about age 2 to 4), and it vastly widens the child's horizons. Through language, the child can relive the past, anticipate the future, and communicate events to others. But precisely because the young child's mind is so rapidly expanding, it initially lacks the properties of a coherent logic. This is apparent in the young child's use of words. He or she does not use words to stand for true classes of objects, but merely as *preconcepts*. For example, when Jacqueline was 3 years old, she said that a daddy is a man who "has lots of Luciennes and lots of Jacquelines" (p. 255). She did not yet possess the concept of a general class, *children*, within which those with the names Lucienne and Jacqueline comprise only a small subset.

Because children lack general classes, their reasoning is frequently *transductive*, shifting from the particular to the particular. At 4½ years Lucienne said, "I haven't had my nap yet so it isn't afternoon" (p. 232). She did not yet understand that afternoons are general time periods that contain many particular events, of which her nap was only one.

Some psychologists believe that children learn to think more logically as they master language. In this view, language provides us with our conceptual categories (see Brown, 1965). Piaget, however, disagreed. Although language is tremendously important—it provides us with a source of shared symbols for communicating with others—it does not itself provide the structure of logical thinking. Logic, instead, stems from actions. Infants develop logically coherent action systems during the sensorimotor period, before they talk, and later logic is simply organized actions of a more internal kind (Piaget & Inhelder, 1966, pp. 86–90). To study how internal actions form logical systems, Piaget gave children various scientific tasks. He usually began such experiments with children at age 4 years, because they could now sit down, focus on the tasks, and communicate with the examiner.

Scientific Reasoning

Conservation of Continuous Quantities (Liquids). This is Piaget's most famous experiment. In one version (Piaget & Szeminska, 1941, p. 17), the child is shown two glasses, A1 and A2, that are filled to the same height (see Figure 6.1). The child is asked if the two glasses contain the same amount of liquid, and the child almost always agrees that they do. Next, the experimenter (or the child) pours the liquid from A2 to glass P, which is lower and wider. The child is asked if the amount of liquid is still the same. At the *preoperational* level, the responses fall into two substages.

At the first substage, the children clearly fail to conserve—that is, they fail to realize that the quantity is the same. Usually, they say that A1 now has more because it is taller. Occasionally, the child says that P now has more because it is wider. In either case, the child "centers" on only one dimension, the height or the width. The child is so struck by a single perceptual dimension—the way it looks—that he or she fails to understand that logically the liquid must remain the same.

FIGURE 6.1
Conservation-of-liquid experiment A child sees that beakers A1 and A2 contain the same amount of liquid He then pours A2 into P and claims that now A1 has more because it is taller

At the second substage, the child takes steps toward conservation but does not achieve it. A boy might at one moment say that A1 has more because it is taller, then change his mind and say that P has more because it is wider, and then become confused. The boy is showing "intuitive regulations"; he is beginning to consider *two* perceptual dimensions, but he does not yet reason about the two dimensions simultaneously and recognize that a change in one dimension cancels out a change in the other. His confusion, however, means he is becoming aware that he is contradicting himself, and it is a good bet that he will soon resolve the contradiction and move on to the stage of conservation.

Children generally achieve conservation of liquids at about 7 years. When they do so, they are entering the stage of *concrete operations*. Basically, children demonstrate conservation by using three arguments. First, the child might say, "You haven't added any or taken any away, so it has to be the same." This is the *identity* argument. Second, the child might say, "This glass is taller here, but the other one is wider here, so they're still the same." This is the argument of *compensation*—that the changes cancel each other out. The child assumes that the changes are part of an organized system—that a change in one dimension is necessarily related to a compensating change in another dimension. Third, the child might say, "They are still the same because you can pour this one back to what it was before." This is the argument of *inversion* (Piaget & Inhelder, 1966, p. 98). Piaget believed the concrete operational child can use all three arguments, although the child might not spontaneously do so on any given task.

Underlying these arguments are logical *operations*—*mental actions* that are *reversible* (p. 96). When the child argues that a change in height is canceled out by a change in width, the child understands that the end result is a return, or reversal, to the original amount. The principle of reversibility is obvious, of course, when the child uses the inversion argument, pointing out that "You can pour it back."

Operations, it is important to note, are mental actions. The child has not actually performed or seen the transformations she is talking about. She is only thinking, for example, about pouring water back. Operations are similar to the actions of the infant (as when an infant places a toy under a blanket and pulls it back out), but operations are on a more mental plane.

People sometimes wonder if young children might fail to conserve simply because of their difficulties with language. They might think that what the experimenter means by "more" is "taller," and therefore they point to the taller glass. One can get around such difficulties by changing one's wording—for example, by asking, "Which one would give you more to drink?" Usually we find that the young child still fails to conserve (Peill, 1975, p. 7, chap. 2).

How does the child learn conservation? The most ready answer is that conservation is taught. However, as we shall see, the teaching of conservation frequently meets with unexpected resistance. The preoperational child does not genuinely believe the adult's explanations.

Piaget argued that children master conservation *spontaneously.* The crucial moment comes at the second substage, when the child first says that one glass has more because it is taller, then says the other has more because it is wider, and then becomes confused. The child is in a state of *internal contradiction,* which she resolves by moving on to a higher stage. Sometimes we can see this change happen before our very eyes. The child says, "This has more . . . no, that one is wider, no, wait. They're both the same. This looks taller, but you've poured it into a wider glass."

Conservation of Number. In one of his experiments Piaget gave children a row of egg cups and a bunch of eggs (Piaget & Szeminska, 1941, pp. 49–56; Inhelder, 1971). Piaget then asked the children to take just enough eggs to fill the cups. Again, the responses at the preoperational period fell into two substages.

At the first substage, the children simply made the rows equal in length, ignoring the number of eggs in the row. When Piaget then asked them to actually put the eggs in the cups, they were surprised to find they had too many or too few eggs.

At the second preoperational stage, the children spontaneously created a one-to-one correspondence, placing one egg beneath each cup (see Figure 6.2). According to Piaget, they used an intuitive approach to achieve a precise perceptual order. However, their success was limited to this simple perceptual arrangement. When Piaget then bunched up (or sometimes spread out) one of the rows, the children claimed that now one had more. As with conservation of liquids, the children failed to conserve because they were more influenced by their immediate perceptions than by logic. Because one row now looked so much longer, they failed to reason that the number must remain the same.

At this stage, in addition, children sometimes begin to waver in their answers. One moment they say that one row has more because it is longer, but the next moment they think the other row has more because it is denser. This state of conflict marks the transition to concrete operations.

At the stage of concrete operations, children realize that the number in each row is the same despite the different appearances in length. They reason that the two rows are the same because "you haven't taken any away or added any" (identity), because "one row is longer here but this one is more bunched in" (compensation), or because "you could make this row long again and make them equal" (inversion).

Other Conservation Experiments. Piaget has studied several other kinds of conservation, such as the conservation of substance, weight, volume, and length. For example, in a conservation-of-substance experiment, the child is shown two equal balls of plasticine or play dough and then watches as one

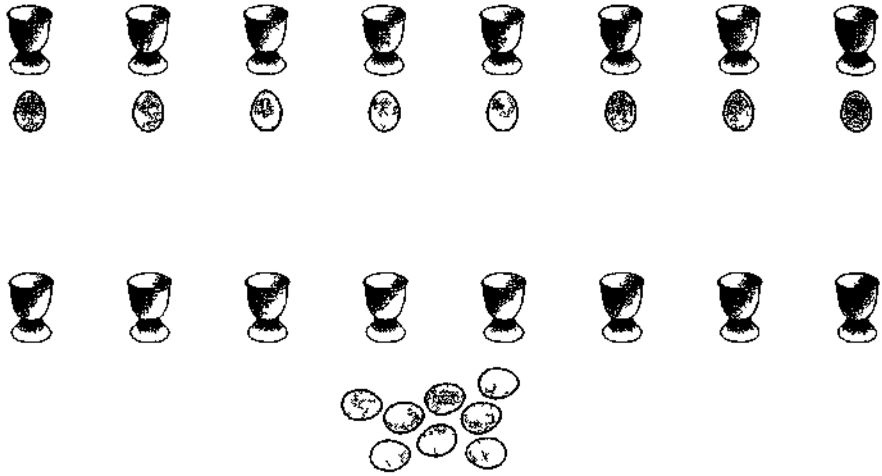

FIGURE 6.2
Conservation of number experiment Young children can often create two rows of equal number, but if we shorten or bunch up one row, they think that the number has changed

ball is rolled into a longer, thinner shape, like that of a hot dog. At the preoperational level, the child thinks the two balls now have different amounts of play dough.

We will not describe the various kinds of conservation here, but simply note that they all are thought to involve the mastery of the same logical concepts—identity, inversion, and compensation. Nevertheless, some kinds of conservation appear more difficult than others and are mastered later.[2] Thus the attainment of conservation is a gradual process within the concrete operational period.

Classification. In a typical classification experiment, Piaget (Piaget & Szeminska, 1941, pp. 161–181) presented children with 20 wooden beads—18 brown and 2 white. Piaget made sure the children understood that although most beads were brown and two were white, they all were made of wood. He then asked the children, "Are there more brown beads or more wooden beads?" At the preoperational level, the children said there were more brown beads. Apparently they were so struck by the many brown beads in comparison to the two white ones that they failed to realize that

[2]In fact, the mastery of one series—conservation of substance, weight, and volume—may always occur in the same invariant sequence (Ginsburg & Opper, 1988, pp. 151–153; Piaget & Inhelder, 1966, p. 99).

both brown and white beads are parts of a larger whole—the class of wooden beads. As with conservation, children master such classification tasks during the period of concrete operations, and the same logical operations appear to be involved (p. 178).

Social Thinking

Egocentrism. Piaget believed that at each period there is a general correspondence between scientific and social thinking. For example, just as preoperational children fail to consider two dimensions on conservation tasks, they also fail to consider more than one perspective in their interactions with others. Preoperational children are frequently egocentric, considering everything from their own single viewpoint. This is apparent from young children's conversations (Piaget, 1923). A little girl might tell her friend, "I'm putting this here," oblivious to the fact that the place to which she is pointing is blocked from her friend's vision.

One of Piaget's most widely quoted studies on egocentrism dealt with the child's perception of space. In this study (Piaget & Inhelder, 1948) the child was taken for a walk around a model of three mountains so he or she could see how the model looked from different angles. After the walk, the child was seated on one side of the model, facing a doll that looked at the model from the opposite side. The child was then asked to select from among several photographs the picture that best showed what he or she saw and the picture that showed what the doll saw. All the children could pick the picture that represented their own view, but the youngest children (from about 4 to 6 years) frequently chose the same picture to show the doll's view. Apparently, they did not understand that the doll's perspective differed from their own.

Egocentrism, then, refers to the inability to distinguish one's own perspective from that of others. Egocentrism does not, however, necessarily imply selfishness or conceit. This point can be clarified by an example. One day two boys went shopping with their aunt for a birthday present for their mother. The older boy, who was 7, picked out a piece of jewelry. The younger boy, who was $3\frac{1}{2}$, selected a model car. The younger child's behavior was not selfish or greedy; he carefully wrapped the present and gave it to his mother with an expression that clearly showed that he expected her to love it. However, his behavior was egocentric; he did not consider the fact that his mother's interests were different from his own.

As long as children are egocentric, they tend simply to play alongside one another. For example, two children in the sandbox will build their own structures. As they overcome egocentrism, they learn to coordinate their actions in joint endeavors. Each might dig a tunnel so that the tunnels eventually connect. This requires considering each other's perspective. Such cooperative play occurs at the stage of concrete operations.

Egocentrism also may influence young children's speech, as when they engage in "collective monologues." Two little girls may appear to be holding a conversation while they play, but each girl is actually just talking about what is on her own mind. One girl might talk about a toy house she is building while the other talks about a trip she took, and no connection is ever made. As children overcome egocentrism, they consider the reactions and viewpoints of their listeners.

Much peer interaction, then, is initially egocentric. Nevertheless, Piaget (1923, p. 101; 1932, p. 94) speculated, children overcome egocentrism as they interact less exclusively with adults and more with other children. They discover that whereas grownups seem to understand whatever is on their minds, their peers do not. Consequently, they learn to consider others' viewpoints in order to make themselves understood.

Furthermore, children are less impressed by the authority of other children and feel freer to engage in conflicts with them. They argue with their peers and sometimes reach compromises and cooperate with them. They begin to coordinate alternative viewpoints and interests (Piaget, 1924, p. 205).

Whether children overcome egocentrism primarily through peer interaction or not, the most crucial point for Piaget's theory is that children themselves play an active role in grasping the fact of alternative viewpoints. On this point, I recall an instance in which our son Adam, then 5 years old, seemed actually to make this discovery. He was riding alone in the car with me when, after a few minutes of silence, he said, "You know, Dad, you're not remembering what I'm remembering." I asked him what he meant, and he replied, "Like I was remembering about my shoes, but you can't see what I'm remembering; you can't be remembering what I'm remembering." At that moment he seemed actually to discover, by himself, that others' perspectives differ from his own. He might not have completely surmounted his egocentrism at that instant, but the point is that whatever step he took, he took on his own.

Moral Judgment. Piaget investigated children's social thought in many areas, including morals. In his classic work, *The Moral Judgment of the Child* (1932), he paid particular attention to how children understood the rules of the game of marbles.

Piaget first observed how children actually played the game, and he found that between the ages of 4 and 7 children typically played in an egocentric manner. If two boys were playing, each would play in his own way. They had little sense of winning—one might exclaim, "I won and you won too!" After the age of about 7 years, children tried to follow common rules and win according to them (pp. 29–46).

Piaget next investigated children's *thinking* about the rules. He was particularly interested in whether children thought the rules could be changed. Here, he found that children for several years—up to the age of 10 or so—believed the rules were fixed and unchangeable. They said the rules came from some prestigious authority, from the government, or from God. The rules could not be changed, they asserted, because then it wouldn't be the real game.

After the age of 10 or so, the children were more relativistic. Rules were seen simply as mutually agreed-upon ways of playing the game. Children no longer considered the rules as fixed or absolute; they said the rules probably had changed over the years, as children invented new rules. And they added that they too could change them, as long as everyone in the game agreed (pp. 50–76).

These different conceptions of rules, Piaget said, reveal two basic moral attitudes. The first, characteristic of the younger children, is moral *heteronomy*, a blind obedience to rules imposed by adults. Children assume there is one powerful law that they must always follow. The second morality—that of the older children—is *autonomy*. This morality considers rules as human devices produced by equals for the sake of cooperation (pp. 401–406).

Piaget believed that moral heteronomy is tied to egocentrism; children view rules from a single perspective, seeing only what powerful adults impose. As a form of egocentrism, moral heteronomy is overcome quite late, at the age of 10 or so, compared to egocentric play, which is usually overcome by age 7. Here, Piaget reminded us that heteronomy is a form of egocentric *thought* and said that thought often lags behind action. Children may need to engage in a good deal of genuinely cooperative play with peers, in which they actually change rules to meet everyone's satisfaction, before they can discuss the relativity of rules on a conscious plane (pp. 94–95).

In their informal play, older children's interest in the formulation of rules can become quite keen. Piaget (1932, p. 50) described how a group of 10- and 11-year-olds, preparing for a snowball fight, spent considerable time debating the rules for voting on a "president" for the game, dividing themselves into teams, deciding the distances of the shots, and discussing the appropriate sanctions for violations of the rules. According to one account of the episode, the boys were called home before they got a chance to begin the actual snowball fight, but all seemed content with their afternoon (Ginsburg & Opper, 1988, p. 98). What really interested them was the discussion of rules. Children at this age are like little lawyers, discussing what is fair and right. In the process, they develop their conceptions of justice.

Animism. Piaget described other ways in which young children's thinking differs from that of older children and adults. Like Werner, Piaget observed that young children do not make the same distinctions between living and nonliving things that adults do. As Werner said, they perceive everything, including physical objects, physiognomically, as full of life and feeling. A loud truck may seem angry and a single cloud lonely. Piaget called this view of the physical world *animistic*.

Although Piaget and Werner were struck by a similar attitude in young children, they studied it somewhat differently. Werner was concerned with children's direct perceptions of objects; Piaget was more interested in their concepts and definitions of life.

At first, Piaget found that children equate life with any kind of activity. For example, one boy was asked,

> Is the sun alive?—*Yes.*—Why?—*It gives light.*—Is a candle alive?—*Yes because it gives light. It is alive when it is giving light, but it isn't alive when it is not giving light.* . . . Is the play-bell alive?—*Yes, it rings.* (Piaget, 1926, p. 196)

Such thinking is common between the ages of 4 and 6 years.

A bit later, between the ages of about 6 and 8, children restrict life to things that move. For example,

> Is a stone alive?—*Yes.*—Why?—*It moves,* . . . How does it move?—*By rolling.*—Is the table alive?—*No, it can't move.* . . . Is a bicycle alive?—*Yes.*—Why?—*It goes.* (p. 196)

Only after 8 years or so do children restrict life to objects that move on their own and, later, to plants and animals.

Piaget found roughly similar stages in thinking about the kinds of objects that have feelings and consciousness. At first, children believe that an object has feelings if it reacts in any way. For example, a stick feels fire because it gets burnt. A bit later, children restrict feelings and consciousness to objects that move, then to objects that move on their own, and finally to animals.

Thus children gradually abandon their animism and come to make the distinctions characteristic of most adults. The fate of animism in Piaget's theory, we might note, differs from that of physiognomic perception in Werner's. For Werner, physiognomic perception, while less dominant in most adults than in young children, nevertheless remains with us and contributes to our artistic and poetic outlooks. For Piaget, animism is simply overcome.

Dreams. One of Piaget's earliest studies examined children's conceptions of dreams (1926, chap. 3). As with conceptions of life, young children's understanding of dreams seems to follow a specific stage sequence. Since Piaget's first study, others (especially the American psychologist Lawrence Kohlberg, 1966a) have refined Piaget's dream sequence.

At first, children seem to believe that dreams are real. For example, when a 4-year-old girl was asked if the giant in her dream was really there, she answered, "It was really there but it left when I woke up. I saw its footprint on the floor" (Kohlberg, 1966a, p. 6). Soon afterward, children discover that dreams are not real, but they still view dreams quite differently from the way older children or adults view them. They think their dreams are visible to others and that dreams come from the outside (from the night or the sky, or through the window from the lights outside). They also think dreams remain outside themselves while they are dreaming. It is as if they were watching a movie, with the action taking place in their rooms in front of their eyes. Gradually, stage by stage, children realize that dreams not only are unreal but are also invisible, of internal origin, of internal location, and possess the other characteristics that adults assign to them. Children usually complete their discoveries by the age of 6 or 7 years, at the beginning of concrete operations.

How do children learn about dreams? Our first assumption probably is that they learn about them from adults. When children have nightmares, parents reassure them, saying, "Don't worry, it was only a dream. It wasn't real; it was only in your mind." Piagetians, however, maintain that children actually discover the various properties of dreams on their own. Kohlberg (1966a), for example, argued that because children master the dream sequence in an invariant six-stage sequence, it is unlikely that their thinking is the product of adult teachings; adults do not take the trouble to teach children about dreams in such a detailed, precise order. Instead, children arrive at different conceptualizations on their own, in an order of increasing difficulty.

To gather additional information on the role of adult teaching, Kohlberg (1966a) administered the dream interview to children in an aboriginal society in which the adults believe dreams are real (the Atayal on Formosa). Despite the adults' beliefs, these children seem to progress through the stages in the same order as American or Swiss children. That is, they first discover that dreams are unreal, then that they are invisible, and so on. Finally, when they reach the last stage, they feel the impact of the adult views and change their minds, adopting the view that dreams are real after all. Still, they initially progress through the dream sequence in opposition to any adult beliefs, so adult views cannot be the sole determinants of their learnings.

Summary and Conclusion

Piaget argued that children's thinking during the preoperational period is very different from that of older children and adults. Preoperational thinking is characterized by egocentrism, animism, moral heteronomy, a view of dreams as external events, a lack of classification, a lack of conservation, as well as other attributes we have not had the space to cover.

The list is a long one, and you might ask, "What do all these characteristics have in common?" The question is central to Piaget's theory, for it maintains that each developmental stage has a basic unity. Unfortunately, Piaget did not give as much attention to this question as we would like, but most often (e.g., 1964a, pp. 41–60), he tried to link the various preoperational characteristics to the concept of egocentrism.

In speech, children are egocentric when they consider matters only from their own perspective. Animism—the attribution of life to physical objects—also stems from egocentrism; children assume that everything functions just as they do. Similarly, Piaget tried to show that young children's conceptions of dreams are related to egocentrism. As long as children are egocentric, they fail to realize the extent to which each person has private, subjective experiences such as dreams. In the realm of morals, furthermore, egocentrism goes hand in hand with moral heteronomy. Young children regard rules from only one perspective, as absolutes handed down from above. They do not yet see how rules are based on the mutual agreements of two or more actors attempting to coordinate their different objectives in a cooperative way.

There is also a link between egocentrism and children's performances on scientific tasks, such as the experiments on conservation. Just as the egocentric child views things from a single perspective, the child who fails to conserve focuses on only one aspect of the problem. For example, when water is poured from one glass into a shorter, broader one, the child "centers" on a single striking dimension—the difference in height. The child cannot "decenter" and consider two aspects of the situation at once.

Children at the level of concrete operations are able to consider two aspects of a problem simultaneously. In their social interactions, they consider not only what they are saying but also the needs of the listener. When they perform conservation experiments, they consider not only the most visible change but also a compensating change. The coordination of two perspectives forms the basis of both their social and their scientific thinking (Piaget, 1947, pp. 156–166).

PERIOD IV. FORMAL OPERATIONS (11 YEARS TO ADULTHOOD)

At concrete operations, children can think systematically in terms of "mental actions." For example, when water is poured into a new glass, they can tell us about the implications of reversing the process, without actually performing the activity. However, there is a limit to such abilities. They can think logically and systematically only as long as they refer to tangible objects that can be subjected to real activity (Piaget, 1964a, p. 62).

During formal operations, in contrast, thinking soars into the realm of the purely abstract and hypothetical. The capacity for abstract reasoning can be seen in responses to questions such as the following: If Joe is shorter than Bob, and Joe is taller than Alex, who is the tallest? At the level of concrete operations, children can handle this problem only if they actually place people in order and compare their heights; beyond this, they simply guess. At the level of formal operations, however, adolescents can order their thoughts in their minds alone (p. 62).

Piaget was most concerned with the capacity to reason with respect to hypothetical possibilities. In one experiment (Inhelder & Piaget, 1955, pp. 107–122), children were given four flasks containing colorless liquids, labeled 1, 2, 3, and 4. They also were given a small container of colorless liquid, labeled *g*. Their task was to mix these liquids to make the color yellow.

At the level of preoperational intelligence, children typically made a mess. They poured the liquids in and out of the bottles in a haphazard way.

At the level of concrete operations, children's actions showed more organization. A typical strategy was to pour *g* into each flask: *g* into 1, *g* into 2, *g* into 3, and *g* into 4. However, they then gave up. When questioned, these children usually said there wasn't anything more they could do. Thus their actions revealed some organization, as we could have expected from their systematic behavior on conservation tasks, on which they can think in terms of two dimensions at once. But they entertained only a limited range of possibilities.

At the level of formal operations, the adolescents worked systematically in terms of *all possibilities*. Some started out by trying various combinations and then realized they had better make sure that they would include all possible combinations, so they wrote them down before acting any further.

When adolescents think about the various possibilities inherent in a situation beforehand and then systematically test them, they are working like true scientists. For example, a teenage girl might test the effects of a new soil for plants. At the level of formal operations, she does not just put new soil into one pot and old soil into the other and watch the plants grow; she considers other possibilities. Perhaps these two plants would have grown to different heights anyway, because of individual differences, so she obtains several plants and examines the average effects of the different soils. Perhaps the sunlight also has an effect, so she makes sure that all the plants are exposed to the same sunlight. Perhaps the amount of water is also important, so she controls for this variable too. The essence of such reasoning is that one is systematically thinking about hypotheses. One is not just entertaining a new possibility but is isolating one hypothesis by controlling for the effects of other possible variables.

As with the other periods, Piaget introduced logico-mathematical models to describe formal operational thinking. These models are in some respects similar to those that apply to earlier developmental levels, but they also go beyond them. The models are very complex, and we will not attempt to cover them here. It is important to note, however, that at the level of formal operations, thinking reaches its highest degree of equilibrium. This means, among other things, that the various operations are more tightly interrelated and apply to the widest possible field of application—the realm of hypothetical possibilities.

Although Piaget limited most of his research on adolescents to mathematical and scientific reasoning, he did speculate on the role of formal operations in the adolescent's social life (Inhelder & Piaget, 1955, chap. 18). Unlike the concrete-operational child, who lives primarily in the here and now, adolescents begin to think about more far-reaching problems—about their futures and the nature of the society they will enter. In this process, their new cognitive powers can lead to a striking idealism and utopianism. They can now grasp abstract principles and ideals, such as liberty, justice, and love, and they envision hypothetical societies very different from any that presently exist. The adolescent becomes a dreamer, constructing theories about a better world.

Piaget believed that such idealistic and utopian thinking carries with it a new kind of egocentrism. To fully appreciate this new egocentrism, we must review how egocentrism appears whenever the child enters a new realm of intellectual life. At first, infants are egocentric in the sense that they have no conception of the world apart from their own actions. External objects have no permanent existence of their own. Only at the end of the sensorimotor period do children situate themselves in a world of permanent objects, of which they are only one.

At the next level—that of preoperational thought—children enter a new, vastly enlarged world—one that includes language, symbolic representation, and communication with others. Children once again become egocentric and have difficulty considering more than their own immediate perspective. Gradually, they learn to consider alternative perspectives—as long as they are thinking about concrete objects immediately before them.

Finally, adolescents enter a broader world yet—the world of possibilities—and egocentrism reappears. This time egocentrism is seen when adolescents attribute unlimited power to their own thoughts. They dream of "a glorious future or of transforming the world through Ideas" (p. 346), without attempting to test out their thoughts in reality. Young people overcome this final form of egocenrism, in Piaget's view, when they actually take up adult roles. They then learn the limits and resistances to their own thoughts. They learn that a theoretical construction or a utopian vision has value only in relation to how it works out in reality.

THEORETICAL ISSUES

The Stage Concept

Many psychologists use the term *stage* loosely, as merely a convenient device for summarizing their findings. This, however, is not the case with Piaget. As Kohlberg (1968) stressed, the Piagetian stage concept implies several strong positions on the nature of development.

First, in a rigorous stage theory, the stage sequence should be invariant. People proceed through the stages at different rates, and some may not reach the highest of Piaget's stages; but to the extent that they move through them, they proceed in order.

Second, stages imply that growth is divided into qualitatively different periods. If intellectual development were a continuous, quantitative process, any division into separate stages would be arbitrary (Flavell, 1963, p. 19). For example, if knowledge can be scored from 0 to 100, then any division into stages at 40, 50, and 70 makes no more sense than any other series of cutoff points. Piaget, however, believed that thinking at different times is organized along qualitatively different lines. Thinking at concrete operations, for instance, is qualitatively different from that at formal operations. (It is logical insofar as it refers to concrete objects and activities, but it is not yet truly abstract and hypothetical.) Consequently, there is a natural, valid distinction between the two periods.

Third, stages refer to general characteristics. Kohlberg liked to discuss this point by asking the following question: At the age of 4 years, a child cannot copy a diamond. At the age of 5, the child can. Has the child reached the diamond copying stage? Kohlberg explained that this proposal sounds somewhat silly because diamond copying is too specific to be called a stage. If we were to call each particular achievement a stage, we would have thousands of stages. It is more appropriate to say that the child has reached a new *general* stage of perceptual-motor coordination that permits him or her to do many new things. Similarly, Piaget's stages refer to general patterns of thought, and if we know a child is in a particular stage, we should be able to predict behavior across a wide variety of tasks. This is not completely true, for children may be at somewhat different stages in different areas (e.g., in scientific versus social reasoning). Piaget called such irregularities *décalages.* However, there should be a substantial unity in performances at each general period.

Fourth, Piaget (Inhelder & Piaget, 1955) believed his own stages represent hierarchic integrations. That is, the lower stages do not disappear but become integrated into, and in a sense dominated by, new broader frameworks. For example, a teenage boy who begins using formal operations can still use concrete operations—he can still reason systematically about concrete, visible events. However, he now realizes these events are only a part of a wider range of theoretical possibilities, and he will prefer to approach difficult problems with this wider range in mind.[3]

Fifth, Piaget, like other rigorous stage theorists, claimed his stages unfold in the same sequence in all cultures. This proposal frequently puzzles readers. Don't different cultures teach different beliefs, particularly with regard to morals? We will take up this issue in the next chapter, but in general the Piagetian answer is that the theory is not concerned with specific beliefs but

[3]Piagetians imply that successive hierarchic integrations characterize development for all the periods except for preoperational thought. The illogical features of this period do not seem to be retained and integrated into any higher structures; they are simply overcome (see Inhelder, 1971).

with underlying cognitive capacities. So young children, regardless of their cultural beliefs on matters such as sex or fighting, will base their views on what they think authority condones or punishes. It is not until adolescence, when young people acquire formal operations, that they will give abstract, theoretical treatises on moral matters, whatever their specific beliefs.

In summary, then, Piaget advanced a rigorous stage theory, which means he believed his stages (1) unfold in an invariant sequence, (2) describe qualitatively different patterns, (3) refer to general properties of thought, (4) represent hierarchic integrations, and (5) are culturally universal.

Movement from Stage to Stage

Piaget devoted a great deal of attention to the structures of his stages and far less attention to the problem of movement through them. Nevertheless, he had definite views on this topic.

He acknowledged (1964b) that biological maturation plays some role in development. For example, children probably cannot attain concrete operations without some minimal maturation of the nervous system. However, Piaget said that maturation alone cannot play the dominant role because rates of development depend so much on where children live. Children who grow up in impoverished rural areas frequently develop at slow rates, apparently because they lack intellectual stimulation. The environment is also important.

However, it is easy to exaggerate the role of the environment, as learning theorists do. Generally speaking, learning theorists believe the child's mind is primarily a product of external reinforcements and teaching. Piagetian concepts, they assume, must be taught by parents, teachers, and others. However, it is not at all clear that this is the case, as we will discuss in the last section of this chapter.

In Piaget's view, the environment is important, but only partly so. The environment nourishes, stimulates, and challenges the child, but children themselves build cognitive structures. As children seek out the environment, they encounter events that capture their *interest*. They are particularly intrigued by events that are moderately novel—events that do not quite correspond to their past experience. Children then adjust their actions to learn about these events, and in the process they build new ways for dealing with the world. For example, I mentioned earlier how our son Tom, at the age of 12 months, was struck by the way water sprayed outward when he placed his hand under it. He then adjusted his hand up and down to learn more about it, and as he did so, he probably learned a little about the efficacy of actively experimenting with different actions to see different results (stage 5 of sensorimotor development). In such behavior, it is not the environment that structures the child's mind, but the child who develops new schemes.

Experiences that promote cognitive development, in addition, are not only interesting, but usually place the child in a state of *conflict*. For example, an infant might be unable to grasp an object because an obstacle is in the way. The child needs to invent a new structure—a means-ends relationship—to obtain the object. The child assimilates new objects by making accommodations that build new cognitive structures.

The concept of conflict is involved in a formal model of developmental change that Piaget called *equilibration* (1964b). We already have discussed the essence of this model, without using its name, when we discussed how children achieve conservation. For example, a little girl sees a ball of clay elongated and initially thinks the amount has increased. After a while, however, she considers the clay's narrow width and thinks the clay has shrunk; she perceives something that *contradicts* her initial view. When she thinks about both the length and the width, she becomes confused. This conflict motivates the child to realize that one change cancels out the other, leading to the discovery of conservation. Piaget's equilibration model tries to assign numerical probabilities to the chances that the child will consider one dimension, then the other, and finally both.

In philosophy, Piaget's equilibration model would be called a dialectical theory. *Dialectical theory* holds that change occurs when our ideas meet with counterevidence that motivates us to formulate new and better ideas.

Another source of new, conflicting information is the social environment. For example, preoperational children overcome egocentrism when they interact with peers, with whom they get into arguments and conflicts. In such interchanges, they learn that others have views different from their own, and they also learn to coordinate different interests to behave in a cooperative fashion. This ability to coordinate viewpoints also contributes to the growth of scientific thinking, where the coordination of dimensions is also important (Piaget, 1947, pp. 156–166).

Piaget, then, tried to indicate different ways in which interesting and conflicting pieces of information lead children to develop new cognitive structures. It is important to emphasize that development is always a spontaneous process. It is the children themselves who assimilate new information, resolve contradictions, and construct new cognitive structures.

IMPLICATIONS FOR EDUCATION

Piaget did not write extensively on education, but he did have some recommendations. Essentially, his overall educational philosophy is similar to that of Rousseau and Montessori. For Piaget, too, true learning is not something handed down by the teacher, but something that comes from the child. It is a process of spontaneous invention and discovery. This is clearly true of infants, who make incredible intellectual progress simply by exploring and manipulating the environment on their own, and it can be true of older children as well. Accordingly, the teacher should not try to impose knowledge on the child but should find materials that will interest and challenge the child and then permit the child to solve problems on her own (Piaget, 1969, pp. 151–153, 160).

Like Rousseau and Montessori, Piaget also stressed the importance of gearing instruction to the child's particular level. He did not agree with Montessori's maturational view of stages, but the general principle still holds: The educator must appreciate the extent to which children's interests and modes of learning are different at different times.

Say, for example, a boy is just entering the stage of concrete operations. He is beginning to think logically, but his thinking is still partly tied to concrete objects and activities. Accordingly, lessons should give him opportunities to deal actively with real things. If, for example, we wish to teach him about fractions, we should not draw diagrams, give him lectures, or engage him in verbal discussions. We should allow him to divide concrete objects into parts (Flavell, 1963, p. 368). When we assume he will learn on a verbal plane, we are being egocentric; we are assuming he learns just as we do. The result will be a lesson that sails over his head and seems unnatural to him.

It might appear that this principle—tailoring education to the child's own stage—is self-evident. Unfortunately, this is not always so. A case in point was the wave of curricular reforms that the United States initiated in the late 1950s and 1960s in response to the Soviet Union's launching of *Sputnik*. To try to catch up with the Russians, educators introduced the "new math," "new science," and other studies designed to teach children abstract, theoretical reasoning at very young ages. Initially, this seemed to be a great idea, but the new curriculum was not very successful. The reason, according to Kohlberg and Gilligan (1971), was that it attempted to teach young children, largely at the level of concrete operations and lower, ideas that assume capacities only attained at formal operations. The curricular reforms began with an adult conception of what children should learn and ignored children's own cognitive levels.

Beginning in the late 1970s and early 1980s, we witnessed a similar trend—a trend that continues today. U.S. leaders, worried that the country was losing its technological leadership to the Japanese, began calling for a new excellence in education. Parents, too, became anxious about their children's future and wanted to give them an early academic start. One result has been more and more academic instruction at younger and younger ages—all the way down to kindergarten and even earlier. David Elkind (1981, 1986), a Piagetian, was one of the first to protest this trend. Five-year-olds, Elkind pointed out, learn primarily through play and direct sensory contact with the environment; formal instruction, including workbooks and worksheets, does not coincide with the young child's natural modes of learning. Early formal instruction primarily teaches young children that learning is stressful and unnatural.

It is not always easy to find the educational experiences that are most natural for a given child. A knowledge of cognitive stages can help, but children are sometimes at different stages in different areas (Piaget, 1969). What is needed is sensitivity and flexibility on the teacher's part—a willingness to look closely at the child's actions, to learn from the child, and to be guided by the child's spontaneous interests (Ginsburg & Opper, 1988, p. 239). For active learning always presupposes interest (Piaget, 1969, p. 152).

Like Rousseau and Montessori, then, Piaget believed learning should be a process of active discovery and should be geared to the child's stage. But Piaget disagreed with Rousseau and Montessori on one point. Piaget saw much greater educational value in social interactions. Children begin to think logically—to coordinate two dimensions simultaneously—partly by learning to consider two or more perspectives in their dealings with others. So interactions should be encouraged, and the most beneficial ones are those in which children feel a basic equality, as they most often do with peers. As long as children feel dominated by an authority who knows the "right" answer, they will have difficulty appreciating differences in perspectives. In group discussions with other children, in contrast, they have a better opportunity to deal with different viewpoints as stimulating challenges to their own thinking (pp. 173–180).

Kamii's Constructivism

Several attempts have been made to bring Piaget's ideas into the classroom, particularly the preschool and the early grades (DeVries & Kohlberg, 1987, chap. 3). Some educators have focused on Piaget's tasks, attempting to teach conservation, classification, and so on. Others have been more concerned with the spirit of Piaget's theory. An inspired proponent of this approach is Constance Kamii.

Kamii begins with the Piagetian premise that real cognitive growth occurs only when children construct their own knowledge. Children need opportunities to figure things out on their own. They will not do this, Kamii has found, if teachers use worksheets and tests. These practices make children so worried about getting the "right answers," the answers that the teacher will mark as correct, that they don't think problems out for themselves. Instead of worksheets and tests, then, teachers need to provide experiences that children will find so interesting and meaningful that they will work on them for their own sake. Such problems, Kamii says, can be found throughout children's daily lives. For example, first-graders will enthusiastically work on arithmetic problems as they come up during card games, keeping score during outdoor games, voting on class decisions, and taking attendance. During such activities, the teacher can ask questions that further stimulate the child's interest in arithmetic. If children are playing softball, the teacher might ask, How many points do you need to reach 11? If a child brings pudding for the class, the teacher might ask, Are there just enough cups for all the children? The teacher's questions set the children's minds in motion, but the teacher always leaves the problem solving to the children themselves. The teacher should even respect the children's "wrong answers." For it is better for children to come up with a wrong answer that is their own than to feel that they must turn to an adult to know what is correct (Kamii, 1985, pp. 119–121, 161–165; Kamii & DeVries, 1977).

As children move into the second and third grades, Kamii adds many dice, card, and board games that stimulate mathematical thinking. She also presents children with standard problems in addition, subtraction, and so on, but she always encourages the children to invent their own solutions. Kamii vehemently opposes the conventional practice of teaching algorithms (e.g., a teacher tells a child to add 18 + 17 by adding the 8 and the 7, carrying the 1, and so on). Algorithms, she points out, teach children to follow mechanical procedures without the slightest understanding of why they are performing them. Children in a constructivist class invent methods that make sense to them (such as, "I'll make this two 10s, with a 7 and an 8 left over."). They create methods for surprisingly difficult problems, and their methods are often quite original (Kamii, 1994, 2004).

Kamii applies her approach to nearly every aspect of school life, including "discipline problems." If some children get into an argument during a card game, the teacher should resist the impulse to step in and solve the problem for them. Instead, the teacher might ask, "Can you think of a way that would be fair to everybody?" (Kamii, 1985, p. 48) In this way, the teacher prompts the children themselves to work on a question of justice.

Piagetian teaching, Kamii (1973) says, often means giving children more time to work on problems than schools usually do. Kamii tells, for example, about lessons in specific gravity. Children in the elementary grades are usually surprised to see that a pin sinks in water, whereas a block of wood (which is larger) floats. And it usually takes children some time to figure out why this is so. Teachers are therefore tempted to explain the answer to their pupils, especially when the teacher wants to move on to a new lesson. But Kamii urges the teacher to wait. It is far better, she says, for the children to keep thinking and wondering about the matter than "to be told the answer and to learn incidentally that the answer always comes from the teacher's head" (p. 225).

Kamii (1985, 1994, 2004) has conducted evaluation research on her method of teaching arithmetic in the early elementary grades. She has found that on traditional standardized tests, her children do almost as well as those taught by conventional methods. But her children demonstrate a far greater understanding of the logic behind their work. They also are much more independently minded. When a teacher tried to help one first-grade girl with a hint, the girl said, "Wait, I have to think it in my own head" (Kamii, 1985, p. 235). To Kamii, such responses are very important. Like Rousseau and

Montessori, Kamii is less interested in the amount of knowledge children gain than in their desire to think for themselves.

EVALUATION

Since about 1960 Piaget has stimulated a vast amount of research and theoretical discussion. We cannot summarize all of it here, but we can look at some trends and issues. I will organize this section around some basic questions.

Has Research Supported Piaget on His Tasks?

As mentioned in the introduction, Piaget's own research has been criticized for its scientific shortcomings. For example, he based some conclusions only on observations of his own three children—hardly a representative sample. Consequently, when Piaget was rediscovered in the early 1960s, many people wanted to see if they could replicate his findings.

Stage Sequences. On the whole, the replication research using Piaget's own tasks has supported his stage sequence. That is, children do seem to move through the substages, stages, and periods in the order in which Piaget initially found. His stages have held up particularly well for the sensorimotor period and for scientific and mathematical reasoning with respect to the later stages (E. Evans, 1975; Harris, 1983; Lovell, 1968; Neimark, 1975). The results have been somewhat less clear cut for Piaget's stages of social thought, such as animism (Looft & Bartz, 1969), moral judgment (Kohlberg, 1964), and egocentrism (Damon, 1983, pp. 120–121), but in general younger children do differ from older children as Piaget found. This replication research, it should be noted, has typically used Piaget's own tasks. A bit later we will mention some studies that have questioned Piaget's conclusions by modifying his tasks.

Stage Generality. Although Piaget's sequences have received support, his position that stages are general modes of thought has fared less well. That is, researchers have found rather low correlations among tasks that should tap the same general stages of thinking (Flavell, 1977, p. 248; Gelman & Baillargeon, 1983, pp. 169–172). For example, a child who demonstrates conservation of liquid might not exhibit the grasp of class inclusion that would seem to go along with it. Piaget himself recognized that children will master different tasks at different rates—he called such unevenness *décalage*—but he implied more consistency than has been found.