Piaget's Theory of Intellectual Development

Biography and Basic Ideas

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Biography and Basic Ideas

We shall begin by reviewing Jean Piaget's life to give the reader an idea of the influences affecting his work and of the wide scope of his activities; then we shall discuss in a preliminary way some basic ideas and themes that underlie his theory of intellectual development.

BIOGRAPHY[1]

Jean Piaget was born on August 9, 1896, in the small university town of Neuchatel, Switzerland. His father was a historian who specialized in medieval literature, and his mother was a dynamic, intelligent, and religious woman. Piaget showed an early interest in nature; he enjoyed observing birds, fish, and animals in their natural habitat. At school, too, his leanings were toward the biological sciences. But his was no ordinary schoolboy enthusiasm: when he was only 10 years old, a natural history magazine published his first article, describing an albino sparrow seen in the park. Soon he was able to help the director of the natural history museum of Neuchatel, where his task was to assist in the classification of the museum's zoology collection. At this time, he began to study mollusks and, from 15 to 18 years of age, published a series of articles on these shellfish. One of the papers, written when Piaget was only 15 years old, resulted in the offer of the post of curator of the mollusk collection at the Geneva natural history museum. Piaget had to decline the position to complete his high school studies.

As an adolescent he spent a vacation with his godfather, Samuel Cornut, a Swiss scholar, who was to have a considerable influence on his intellectual development. Cornut felt that Piaget's horizons were too restricted in the direction of the biological sciences and decided to introduce the young man to philosophy, particularly to the work of Bergson. Consequently, Piaget, who until then had given his main attention to the study of biology and the natural behavior of organisms, now turned his thoughts to other pursuits. His readings broadened to include philosophy, religion, and logic. Contact with these subjects led eventually to a special interest in epistemology, the branch of philosophy concerned with the study of knowledge. He became curious to discover the answers to some of the basic questions of the discipline: What is knowledge? How is it acquired? Can one gain an objective understanding of external reality, or is

one's knowledge of the world colored and distorted by internal factors? Although fascinated by these issues, Piaget felt that their solution could not be provided solely by philosophy. In comparing the attributes of philosophy and science, Piaget's conclusion was that "an idea is only an idea, while a fact is only a fact" *(Insights and Illusions in Philosophy,* 1971b). In other words, he was convinced that the philosophical approach is too speculative, and the scientific approach is sometimes too factual. What is needed is a linkage between the two: an experimental philosophy, as it were.

We see, then, that during his adolescence Piaget concentrated on two major intellectual pursuits: biology and epistemology. There is, of course, a great gap between the two disciplines. One is concerned with life and the other with knowledge. One employs scientific methods and the other relies on speculation. Piaget began to wonder whether it might not be possible to bridge this gap between the two disciplines and to find some way of integrating his biological and epistemological interests. How could one investigate the very fascinating problems of knowledge, and at the same time utilize the scientific framework of biology?

Although interested in epistemological questions, Piaget put his major efforts into the study of biology. In 1916 he completed his undergraduate studies in natural sciences at the university of his hometown, Neuchatel. Only two years later, at the age of 21, he submitted to the same university his dissertation on the mollusks of the Valais region of Switzerland and received the degree of Doctor of Philosophy.

After finishing his formal studies, Piaget decided to explore psychology. He left Neuchatel for Zurich to work in two psychological laboratories and at Bleuler's psychiatric clinic. He then discovered psychoanalysis and the ideas of Freud, Jung, and others and later published an article on the relations between psychoanalysis and child psychology. In 1919 he left Zurich for Paris, where he spent two years at the Sorbonne University, studying clinical psychology as well as logic, epistemology, and the philosophy of science. His encounter with philosophy once more convinced him that it is necessary to supplement pure speculation with the scientific approach.

It was during his stay in Paris that an opportunity arose which was to shape the direction of his future work. In 1920 he accepted a post with Dr. Theophile Simon in the Binet Laboratory in Paris. (With

Alfred Binet, Simon had earlier constructed the first successful intelligence test.) Piaget's task was to develop a standardized French version of certain English reasoning tests. In a standardized test the wording of the questions and their order of presentation are precisely defined, and the examiner must not deviate from the pre-established procedure. The aim of a standardized test is to present each subject with the same problems so that the subsequent differences in performance can be attributed not to variations in the questions, but to differences in the subjects' intelligence (or other traits being measured).

At the outset, Piaget was not very enthusiastic about the work. Standardizing a test can be a very mechanical and tedious process. But then three major events occurred. First, although intelligence testing usually focuses on the child's ability to produce *correct* responses, Piaget felt that, on the contrary, the child's *incorrect* answers were far more fascinating. When questioning the children, Piaget found that the same wrong answers occurred frequently in children of about the same age. Moreover, there were different kinds of common wrong answers at different ages. Piaget puzzled on the meaning of these mistakes. He came to the conclusion that older children are not just "brighter" than younger ones; instead, the thought of younger children is *qualitatively different* from that of older ones. In other words, Piaget came to reject a quantitative definition of intelligence—a definition based on the number of correct responses on a test. The real problem of intelligence, Piaget felt, was to discover the different methods of thinking used by children of various ages.

Second, Piaget sought a different method for the study of intelligence. He immediately rejected the standardized test procedure. Such an approach, he felt, was too rigid: for example, it might lead to a considerable loss of information if the child did not understand the questions. Consequently, he sought a less structured method which would give him more freedom to question the child. His solution was to apply to the task his previous experience in clinical psychology: he modified psychiatric interview techniques to make them suitable for the study of children's thought. The new method was extremely flexible. It involved letting the child's answers (and not some preconceived plan) determine the course of questioning. If the child said something interesting, then it would immediately be pursued, without regard for a standardized procedure. The aim of this "clinical method" was to follow the child's own line of thought, without imposing any direction on it, to comprehend the underlying causes of the child's responses.

At about the same time as his work in the Binet Laboratory, Piaget was also studying abnormal children at the Salpetrière Hospital in Paris. He felt, like Freud, that knowledge of abnormal functioning might provide insight into the normal working of the mind. Piaget therefore applied the "clinical method" developed at the Binet Laboratory to his study of abnormal children. However, he found that the method was not adequate since abnormal children's verbal abilities were deficient. Consequently, for these children he added an important procedure: the child was required not only to answer questions, but also to manipulate certain materials. Unfortunately, Piaget did not immediately apply the supplemented clinical method—free verbal questioning plus materials for manipulation—to the testing of normal children. It was only after the exclusively verbal procedure proved inadequate that Piaget later made use of his experience at Salpetrière.

Third, while using the clinical method to study children's thought, Piaget was reading extensively in logic. It occurred to him that abstract logic might be relevant in several ways to children's thinking. He noticed, for instance, that children younger than about 11 years were unable to carry out certain elementary logical operations. The possibility of extensively investigating this apparent deficiency immediately presented itself. Also, Piaget felt that thought processes form an integrated structure (not a conglomeration of isolated units) whose basic properties can be described in logical terms. For example, the logical operations involved in deduction seemed to correspond to certain mental structures in older children. He set himself the goal of discovering how closely thought approximates logic. This was a distinctive conception of the psychology of intelligence.

The years at the Binet Laboratory were very fruitful. Piaget published several accounts of his psychological research on children. But, more important, the stay in Paris taught Piaget that the problem of intelligence must be defined in terms of discovering children's ways of thinking, that the clinical method is useful for the study of thought, and that logic, rather than the imprecise natural language, might be an efficient way of describing thought. Furthermore, Piaget had now discovered a way in which he might integrate his biological and epistemological interests. As he saw it, the first step was to pursue the psychology of human intelligence. As a psychologist, he could study the inpidual's knowledge of the world, his attempts to comprehend reality. This kind of psychology, in other words, would be directed at epistemological issues. Also, it would be biologically oriented. For Piaget, this meant several things. First, psychological theory might make use of biological concepts. For instance, intelligence could be viewed in

terms of an organism's adaptation to its environment. Second, psychology might focus on the process of intellectual growth in the inpidual. He believed that a full understanding of human knowledge could be gained only through the study of its formation and evolution in childhood. How could one comprehend the final product without knowing how it developed? For these reasons, then, Piaget decided to engage first in the psychological study of the child's understanding of reality. His initial intention was to spend a few years in experimented studies of the child's intelligence and then turn to a second project, namely, the application of his psychological discoveries to the theoretical problems of epistemology. He felt that he could clarify epistemological issues only after he had developed an understanding of the inpidual's cognitive growth. As we shall see, Piaget spent more than a "few years" at his first task. It was only after some thirty years of psychological study that Piaget was able to turn his attention to theoretical questions of epistemology.

In 1921, the director of the Jean-Jacques Rousseau Institute in Geneva, Edouard Claparède, who had been impressed by Piaget's early articles on children, offered him the post of director of research at the Institute. Piaget accepted the offer, which gave him an excellent opportunity to carry on his study of child thought. The outcome of his research was a series of articles and the publication, from 1923 to 1932, of his first five books on children. The first one, *Language and Thought in the Child* (1926b), provides naturalistic and experimental observations on the child's use of language. Piaget found, for instance, that the young child's speech is substantially egocentric and that this tendency decreases gradually as the child grows older. *Judgment and Reasoning in the Child* (1926a) deals with the changes in certain types of reasoning from early to late childhood. *The Child's Conception of the World* (1929) uses the exclusively verbal clinical method to provide data on how the child views the surrounding world, and on what he believes to be the origins of dreams, of trees, the sun, and the moon. In *The Child's Conception of Physical Causality* (1960a), Piaget describes the child's ideas on the causes of certain natural phenomena, such as the movement of the clouds and of rivers, the problem of shadows, or the displacement of water when an object is immersed. Finally, *The Moral Judgment of the Child* (1932) provides information on the development of moral behavior and judgment. Here Piaget maintains that children show two types of moral judgment: the young child holds to a predominantly authoritarian moral code, whereas the older child develops a morality of social concern and cooperation.

Contact with psychoanalysis is evident in the early works: Piaget's theories make use of Freudian

ideas and are sometimes even stated in Freudian terms. The books also give a brief indication of what Piaget was later to expand upon: a view of intellectual development as consisting of a series of stages. Through his research, Piaget was becoming increasingly aware of the differences between the child's and the adult's thought processes. He realized that the child is not merely a miniature replica of the adult: not only does the child think less efficiently than the adult, but he also thinks differently. Thus, Piaget became convinced that it was necessary to conceive of intellectual development in terms of an evolution through qualitatively different stages of thought.

Piaget also attempted to discover the causes of this intellectual evolution. His first interpretation was that intellectual development resulted particularly from social factors, like language and contact with parents and peers. Later, after his study of infancy, where the role of language is negligible but where on the contrary the child's own activity is paramount, he changed his interpretation of the nature of intellectual development: he deemphasized the influence of social factors and stressed action as the source of thought.

Much to Piaget's astonishment, the first five books, which he himself calls his "adolescent" works, gained him considerable fame, particularly among child psychologists. Piaget, who had never in his life passed an examination in psychology, suddenly became an authority on the subject. The stir caused by the books disturbed him somewhat since he considered them to be only preliminary and tentative, and not an expression of his definitive views on the nature of intelligence. He was well aware of the books' deficiencies. Nevertheless, he agreed to publish the volumes, mainly because he felt they might lead others to further research eventually resulting in a fuller understanding of child thought.

In the United States, the books were at first received enthusiastically, and during the 1920s and 1930s, Piaget's work was highly regarded in this country. Then followed a period, lasting until the middle 1950s, when his views, as expressed in the early books, came under much criticism. Some investigators felt that Piaget's findings could not be replicated. But with the publication in the early 1950s of English translations of several of Piaget's later books, interest in his work revived.

During the period from 1920 to 1930, Piaget's time was fully occupied. He performed a great deal of research and at the same time also taught various courses in psychology, sociology, and scientific

thought at Geneva and Neuchatel. His three children were born during these years: a daughter in 1925, a second daughter in 1927, and a son in 1931. Piaget and his wife, one of his former students, became close observers of their children's behavior. The results of their study, which covered the "sensorimotor period" from birth until about the age of 2, were published in two volumes: *The Origins of Intelligence in Children* (1952c) and *The Construction of Reality in the Child* (1954). Piaget's study of infancy convinced him that thought derived from the child's action, and not from his language. This increased emphasis on action led Piaget to modify his testing technique for older children. He remembered his past experience at the Salpetrière Hospital and his solution to the difficulties encountered in trying to apply an exclusively verbal method to abnormal children. Consequently, he made the manipulation of concrete materials an essential aspect of the clinical method for children of all ages. The emphasis was no longer on language alone, but on manipulation supplemented by language.

From 1929 to 1939 Piaget's professional life became even more active. He was appointed professor of history of scientific thought at Geneva University. He became assistant director, and shortly afterward co-director, of the Jean-Jacques Rousseau Institute, which he helped to reorganize when it became attached to Geneva University. He taught experimental psychology at Lausanne University. Also, Piaget became involved in international affairs and accepted the chairmanship of the International Bureau of Education, later to become affiliated with UNESCO.

Piaget's experiences led to several changes in his thinking. The studies of infancy influenced him to modify his techniques of research, and to place greater emphasis on the role of the child's activity in the formation of thought. Also, his teaching opened up new areas for research and experiment. The course on the history of scientific thought directed him toward the study of the child's understanding of certain scientific notions. With two important collaborators, Bärbel Inhelder and Alina Szeminska, he set out to explore this field, and in 1941 published two books on their research. The first, written with B. Inhelder was *The Child's Construction of Quantities* (1974). It shows how the child gradually comes to recognize that certain physical attributes of an object, like its substance or weight, do not vary when the object merely changes shape. Surprisingly, young children fail to *conserve* these invariants. The second book, written with A. Szeminska was *The Child's Conception of Number* (1952). Here Piaget describes the evolution of the child's efforts to master the notion of number.

The next book, published in 1942, *Classes, Relations, et Nombres,* deals with the correspondence between certain operations of formal logic and mental operations. Piaget uses logic to describe the mental operations available to the child from 7 to 11 in the stage of "concrete operations." The book is thus a fulfillment of Piaget's early intention at the Binet Laboratory in Paris to use a formal language for psychological purposes.

Piaget then became interested in the perceptual research of the "Gestalt" psychologists. His lack of agreement with some of their theories, however, led him and his collaborators to a lengthy series of experiments into the nature of perception. At first Piaget replicated the experiments of the Gestalt psychologists. Later his studies were extended to cover perception not only as an isolated process, but also its relation to intelligence. For some twenty years, from 1943 onward, Piaget and his associates produced a number of articles and monographs on perception. The culmination was the publication in 1961 of his book, *The Mechanisms of Perception* (1969), which describes perceptual structures and processes and relates them to intellectual ones.

In the early 1940s, Albert Einstein suggested to Piaget that it might be of interest to epistemology if he were to investigate the child's understanding of time, velocity, and movement. Piaget followed the suggestion and in 1946 published two books on these matters: *The Child's Conception of Time* (1970b) and *The Child's Conception of Movement and Speed* (1970a). In the same year, 1946, Piaget also published his book on symbolic thought, *Play, Dreams, and Imitation* (1951), which contains observations on his own children, from 2 to 4 years of age.

After the Second World War, appreciation of Piaget's work began to spread throughout the world. He received honorary degrees from several universities, including Harvard, the Sorbonne in Paris, Brussels, and the University of Brazil. In the United States, however, Piaget was honored but not fully understood; only his first five books had been translated. During the 1940s, he continued his activities in the International Bureau of Education and was appointed head of the Swiss delegation to UNESCO. In 1947 Piaget published a small volume entitled *The Psychology of Intelligence* (1950b). The book is a collection of lectures Piaget had given in 1942 to the College de France in Paris and sets out, for the first time at any length, an overview of Piaget's theory of mental development.

During this time, Piaget continued his research into various aspects of cognition. From the experiments on perception grew the study of two closely allied fields: the child's understanding of space and of geometry. In collaboration with Inhelder and Szeminska, he published in 1948 *The Child's Conception of Space* (1956) and *The Child's Conception of Geometry* (1960). In 1949 Piaget wrote *Traité de Logique*, a book dealing with the basic operations involved in logic. The book is the first full summary of his logical system: it expands upon the logical models already used in previous research and introduces additional logical models which he was later to apply to adolescent thought.

From about 1920 to 1950, Piaget had been engaged in experimental work with children in an attempt to understand the evolution of human intelligence. Now he felt prepared to apply the results of his psychological research to the epistemological problems which had originally motivated his interest in psychology. In 1950 he published a three-volume series on "genetic epistemology" entitled *Introduction a l'Epistémologie Génétique* (1950a). The books are a synthesis of his thinking on various aspects of knowledge, including mathematics, physics, psychology, sociology, biology, and logic. Piaget analyzes these facets of knowledge in terms of the relation between the inpidual and his environment—between the knower and the known. He tries to determine whether this relationship is affected by the type of knowledge involved, for instance, whether mathematical knowledge involves a different kind of interaction with the environment from that of physical knowledge. Piaget also draws a parallel between the historical and inpidual development of knowledge, and he finds that the evolution of inpidual thought sometimes follows the same progression as the history of scientific thought.

Next Piaget turned to the study of chance and the elementary concepts of probability. In 1951, he and Inhelder published a book entitled *The Origin of the Idea of Chance in the Child* (1975), which deals with the child's understanding of random events in his environment. In 1952 Piaget was appointed Professor of Genetic Psychology at the University of Paris (Sorbonne), where he remained until 1962. At the same time he continued to teach at Geneva University and to head the Jean-Jacques Rousseau Institute. He also pursued his research into both perception and logical thought. In 1952 he published a book called *Essai sur les Transformations des Opérations Logiques* (1952b), dealing with prepositional logic and various logical structures, like the group and lattice, which he used as models for adolescent and adult thought. After having studied the period of early and middle childhood, Piaget turned to the next phase of intellectual development: the thought of the adolescent and the adult. In 1955 Piaget and

Inhelder published a book on this subject, *The Growth of Logical Thinking from Childhood to Adolescence* (1958), which compared, again in logical terms, the thought processes of the adolescent with those of the younger child.

The year 1956 was important for Piaget, for he was able to initiate a project that he had been contemplating for some time. With his broad scope of interests, including biology, zoology, logic, mathematics, psychology, philosophy, and epistemology, Piaget had always dreamed of the possibility of an interdisciplinary approach to basic problems of cognition. The idea had initially encountered a certain amount of skepticism, but Piaget finally managed to establish an institution where such interdisciplinary cooperation was possible. An international Center for Genetic Epistemology was created within the Faculty of Science of Geneva University. The aim of the Center was to gather together each year a number of eminent scholars in various fields—biologists, psychologists, mathematicians, and others—who would combine their efforts to study a given problem. Each person would treat the problem from the point of view of his specialty, but the research was to be coordinated through regular discussions. At the end of the year, a symposium would be held, where the researchers' conclusions would be discussed. The deliberations of each symposium would be published in a series of monographs, entitled *Studies in Genetic Epistemology.* Over the past thirty years, approximately forty of these volumes have already been published, and have dealt with a variety of subjects such as the notion of causality, the learning processes, and mathematical thinking.

In 1959 Piaget published with Inhelder *The Early Growth of Logic in the Child* (1964). The book again uses logical models to describe the mental operations of the child from 7 to 11 years. It treats in particular the child's method of classifying and of ordering objects. In 1964 a small book containing six short essays on various psychological topics was published *(Six Psychological Studies,* 1967) and the following year, 1965, Piaget published *Insights and Illusions of Philosophy* (1971b). In this book he discusses the essential differences between philosophy, which leads to subjective "wisdom," and science, which leads to objective knowledge. He also explains why he turned away from his early preference for the former toward the latter. In the same year, 1965, he also published a book of four sociological studies entitled *Etudes Sociologiques,* which is a collection of some of the lectures he had given in his courses on sociology.

The titles of Piaget's books indicate that the contents deal in general with highly specialized aspects of thinking or cognition. Each book treats a particular topic, like geometry or number, in a similar manner. That is, the notion is studied from its origins in the child to the point, usually in late childhood or adolescence, where it reaches a mature status. Although such an approach is of interest to psychologists and educators, difficulties are presented for the person who wishes only to get a general understanding of Piaget's overall system. In 1966, therefore, recognizing the need for a short introductory work on his system, Piaget and Inhelder published a short book entitled *The Psychology of the Child* (1969), which was intended for the general public. The book gives a brief summary of Piaget's theory of intellectual development and also deals with related matters such as perception. In the same year, 1966, these two authors also published a book on mental imagery, *Mental Imagery in the Child* (1971), which describes the development of mental images and relates it to the growth of intelligence. In 1967 he published *Biology and Knowledge* (1971a), which deals with the relations between biological factors and the cognitive processes. He then turned his interests in another direction and in 1968 with Inhelder published *Memory and Intelligence* (1973). In this book, Piaget introduces a new approach to the study of memory: he examines the relations between memory and the development of intellectual functioning. He finds, for example, that memory does not always deteriorate over time; paradoxically, memory can improve as a result of the development of certain related intellectual skills. Another book published in 1968, *Structuralism* (1970d), reflects Piaget's continuing interest in the application of structural models to many different disciplines, and in particular to the operations of intelligence.

In the 1960s and 1970s Piaget's fame continued to spread, and his books were translated into many languages. In America, where his work had at first been received with a certain amount of skepticism, he was now recognized as a leader in his field. In 1969 he was honored by the American Psychological Association. In 1971, at the age of 75, Piaget retired as director of the Rousseau Institute, although he still actively pursued his research activities as head of the Center for Genetic Epistemology. He continued to be prolific in his writings and publications. A great many new books and articles, as well as reeditions of earlier works, were published in the 1970s. Some of the major titles include two books dealing with education, *Science of Education and the Psychology of the Child* (1970c) and *To Understand Is to Invent: The Future of Education* (1973b) and two books on genetic psychology, *Psychology and Epistemology: Towards a Theory of Knowledge* (1972b) and *The Child and Reality: Problems of Genetic*

Psychology (1973a). In *Adaptation Vitale et Psychologie de l'Intelligence: Selection Organique et Phénocopie* (1974a), Piaget returned to his early interest in biology and tried to relate a biological model of development to the intellectual processes.

Piaget also conducted studies with Garcia into the notion of causality *(Understanding Causality,* 1974). Stemming from this research has been Piaget's work on the child's growing awareness of his actions. Studies in this area have been published in three books, *The Grasp of Consciousness: Action and Concept in the Young Child* (1976b), *Réussir et Comprendre* (1974b), and *Le Comportement, Moteur de l'Evolution* (1976a). At the end of his life, Piaget published several important books dealing with issues of development and learning. These include *The Equilibration of Cognitive Structures* (1985), *Success and Understanding* (1978), *Experiments in Contradiction* (1981a), and *Le Possible et le Necessaire* (1981b, 1983).

The evolution of Piaget's interests is clearly illustrated by the titles and contents of his books and other publications. From his early work in biology, particularly the study of mollusks, he gradually turned to the psychological development of the child. His intention was to find a link between the biological study of life and the philosophical study of knowledge. His first few books on children's thought were exploratory, setting forth his preliminary theory of intellectual development. Later, however, he began to state his theories in terms of a formal language: logic. The subject matter of his books also began to change; he became attracted to the study of the child's understanding of scientific and mathematical notions, as well as to other aspects of the cognitive processes: perception, mental imagery, memory, consciousness. Once he had achieved a good measure of understanding of the child's intellectual processes, Piaget then wished to place his psychological theories within a larger framework. He returned, after more than forty years of psychological research, to his original interests—theoretical problems in epistemology and biology—and attempted to view the development of intelligence as the link between the two. Toward the end of his life, Piaget became involved in the problem of the relations among reality, necessity, and possibility and in the issues of development and learning. It is quite remarkable that, into his eighties, Piaget pursued his professional work with great vigor. He died on September 16, 1980.

BASIC IDEAS

In the present section, we will introduce several basic ideas that have shaped Piaget's approach to the study of intellectual development. A scientist usually employs a theoretical framework to guide experimentation and theorizing. The framework is not a detailed theory but a point of view or a set of attitudes which orients the scientist's activities. A psychologist, for example, may be basically committed both to Freudian ideas and to the personality test approach, which are then likely to give direction to research and analysis. For example, this framework may influence the scientist to choose to study the familial causes of neurosis rather than possible physical bases of the disorder. Further, this orientation might lead the scientist to investigate the matter by giving paper-and-pencil tests, which might produce results different from those which could be obtained by the direct observation of the child in the home. This is not to deny, of course, that scientists do change their opinions as a result of conflicting research evidence. It is nevertheless true that orienting attitudes can be influential; the scientist does not begin work without preconceptions, and these then organize the interpretation of research data.[2]

Piaget's orienting attitudes, stated quite explicitly, are concerned with the nature of intelligence and with its structure and functions.

Intelligence

First, how does Piaget define the nature of intelligence? The reader should be aware that Piaget had almost complete freedom in this regard. Previous to the 1920s, when he began his investigations, there had been little research or theorizing on intelligence. The mental testing approach was in evidence, as exemplified by the Binet-Simon IQ test, and there were also scattered experimental investigations of intellectual processes like memory in the adult. However, neither of these approaches had been developed extensively, and psychologists had hardly agreed, and do not concur even today, on the proper subject matter for the psychology of intelligence.[3] Does intelligence refer to rote memory, to creativity, to IQ test performance, to the child's reasoning, or to other matters? Because Piaget began his studies during a pioneering era, he was free to conceive of intelligence in terms of his unique perspective. He was careful not to begin by proposing too rigid or precise a definition of intelligence. Piaget did not want to fall into the trap of too narrowly circumscribing the subject matter when so little

was known about it. To lay down an overly restrictive definition at the outset would have been to curtail investigation and impede discovery. In fact, the major aim of Piaget's research was to discover what actually constitutes intelligence.

Desiring to avoid premature restrictions, Piaget offered several definitions of intelligence, all couched in general terms. These definitions reflect Piaget's biological orientation. For example, "intelligence is a particular instance of biological adaptation . . ." *(Origins of Intelligence,* pp. 3-4). This states quite clearly that human intelligence is one kind of biological achievement, which allows the inpidual to interact effectively with the environment at a psychological level. Another definition states that intelligence "is the form of equilibrium towards which the successive adaptations and exchanges between the organism and his environment are directed" *{Psychology of Intelligence,* p. 6). The use of the term "equilibrium," borrowed from physics, suggests a balance, a harmonious adjustment between at least two factors—in this case between the person or his cognitive structures and his environment. Although the balance may be disturbed, the inpidual can perform actions to restore it. Intelligence is the "instrument" which enables the inpidual to achieve this equilibrium or to adapt by means of certain actions carried out on the environment. The definition also implies that equilibrium is not immediately achieved: as the child develops, the type of actions that he is able to carry out on the environment will change and so, too, will the resulting equilibrium. Thus, for Piaget, there is no single and final intelligence, but rather a succession of intellectual stages. It is of special interest to the psychologist to study the evolution of attempts at equilibrium and the dynamic processes underlying it. Piaget's primary goal, then, could be defined as the study of children's gradual attainment of intellectual structures which allow for increasingly effective interactions with the environment.

Another definition stresses that intelligence is "a system of living and acting operations" (*Psychology of Intelligence,* 1950b, p. 7). Piaget is interested in mental activity, in what the inpidual *does* in his interaction with the world. Piaget believes that knowledge is not given to a passive observer; rather, knowledge of reality must be discovered and constructed by the activity of the child. As we shall see later, this position is at odds with the behaviorist view which for a long time dominated American psychology.

Finally, Piaget's definition of intelligence involves intellectual competence. He is interested in the

inpidual's optimum level of functioning at his current developmental stage. For Piaget, intelligence does not necessarily refer to the inpidual's ordinary or habitual activities, but to the best that he can do. This competence may of course be obscured by all kinds of conditions, both temporary and long-lasting—for example, fatigue, boredom, illness. Factors like these may produce *performance* that falls short of possible *competence.* While it is important to understand how and why this happens, Piaget's main interest is in what the inpidual *can* do, whether or not this is what he ordinarily does.

Thus far, we have seen that intelligence involves biological adaptation, equilibrium between the inpidual and the environment, gradual evolution, mental activity, and competence. These definitions are intentionally quite general. It is also instructive to take note of what the definitions do *not* stress. They do not emphasize inpidual differences in intelligence. While such an emphasis would be quite consonant with a biological approach, Piaget is not concerned with whether one person is more intelligent or more clever than another, or why. Piaget, of course, recognizes that differences in intellectual ability do exist, but he is not particularly interested in their analysis; instead, he seeks to abstract from the various idiosyncratic manifestations of behavior a description of the general form of thought. Thus, for Piaget, the issue is not why one baby starts to talk at 18 months and another at 22 months; the issue is rather what words mean to both babies once they do talk. Similarly, for Piaget, the question is not why one child can remember the names of twenty-four states while another child remembers twenty-eight; it is rather what mental processes allow each child to remember whatever he does. So Piaget is less concerned with explaining intellectual differences than understanding the mental processes which we all share.

It is important to note that the definitions place little emphasis on the emotions. Piaget, of course, recognizes that the emotions influence thought, and in fact, he repeatedly states that no act of intelligence is complete without emotions. They represent the energetic or motivational aspect of intellectual activity. Nevertheless, Piaget's empirical investigations and detailed theories substantially ignore the emotions in favor of the structure of intellect.

Piaget has chosen one of several available strategies with which to investigate the psychology of intelligence. He deemphasizes inpidual differences and the effects of emotions on thought and, instead, focuses on the optimum level of functioning. Many psychologists, particularly British and American, have concentrated on inpidual differences by means of the test approach to investigate intellectual activity.

Others have attempted from the outset to consider the influence of the emotions, especially anxiety, on intellectual performance. Which strategy is best? The answer seems to be that all are of interest. All view the problem of intelligence from different angles and deal with somewhat different issues. Unable to study everything, the scientist usually settles on one approach to accomplish anything at all. As we shall see in the pages that follow, Piaget's approach seems to have amply demonstrated its merits.

In addition to proposing general definitions, Piaget has structured the psychology of intelligence by the selection of the particular subject matter he has investigated. As we saw in the biographical review, Piaget's early works were concerned with such matters as verbal communication and moral judgment. With the passage of time Piaget has come to stress the child's understanding of various scientific and mathematical ideas like velocity and one-to-one correspondence. To understand Piaget's conception of intelligence, therefore, we must not only consider his definitions, but the nature of his research activities. The latter, especially in recent years, reveal rather unique scientific and epistemological concerns.

In conclusion, we have seen how Piaget's two major interests—biology and epistemology—have shaped his approach to the psychology of intelligence. The biological concern resulted in definitions of intelligence in general terms of growth, stages, adaptation, equilibrium, and similar factors. The epistemological focus has resulted in the empirical investigation of the child's understanding of space, time, causality, and similar notions. Piaget looks at intelligence in terms of content, structure, and function. We will consider aspects of these in the following sections.

Content

One simple aspect of thought is its manifest content. This refers to what the inpidual is thinking about, what interests him at the moment, or the terms in which he contemplates a given problem. For instance, when asked what makes a car go, the mechanic gives an answer in terms of the explosion of gas, the movement of pistons, the transfer of power from one point to another. These statements reflect the contents of his thought. If a young child were posed the same question, the response would be quite different. Ignorant of the workings of the motor, he might suppose that the car's movement results from all the horses inside. Obviously, the content of his thought is quite different from that of the adult.

During the early portion of his career, Piaget's research focused on the contents of the child's thought. *The Child's Conception of the World* and *The Child's Conception of Physical Causality*, both written in the 1920s, paid particular attention to the child's views of the physical world. The clinical method was used to obtain the child's answers to such questions as: Where do shadows come from? What causes rivers to flow or the clouds to move? Despite these initial investigations, Piaget felt that the study of content was only a minor goal for the psychology of intelligence. While descriptions of content may have some interest, they do not get at the heart of the matter; they do not explain why thought takes the form it does. For Piaget, therefore, the primary goal of the psychology of intelligence is not the mere description of the content of thought but the understanding of basic processes underlying and determining the content. Piaget has therefore devoted the greater part of his career in psychology to the study of the structures and functions of intelligence.

Specific Heredity

It should come as no surprise that Piaget's theoretical framework deals with the role of biological factors in the development of intelligence. These factors operate in several ways: one of them is defined as the *hereditary transmission of physical structures*, or *specific heredity.* Different species are, of course, endowed by heredity with different physical structures. The nervous system, for example, varies considerably from worm to human, and the effects of this variation are obvious. The inherited physical structures both permit certain intellectual achievements and prohibit others. The eye is one example of such a structure. Gibson (1966) points out that predatory animals are generally endowed by heredity with frontal eyes which allow them to see clearly what is ahead and therefore what can be pounced upon. By contrast, preyed-upon animals are generally endowed by heredity with lateral eyes which allow wide peripheral vision so that potential enemies can be identified. Indeed, the rabbit can even see *behind* its own head. The physical structure of the organism quite literally determines its basic view of the world.

Another form of specific heredity is the *automatic behavioral reaction.* For example, members of many species possess various *reflexes* from birth. When a specified event in the environment (a *stimulus*) occurs, the organism automatically responds with a particular behavior. No learning or training or other experience with the environment is usually necessary for the reflex response to occur. Moreover, all

members of the species, unless they are in some way defective, possess the reflex. The basis for this automatic behavior is an inherited physical mechanism. When the stimulus occurs it activates this mechanism which produces the response. One example of automatic behavior is the sucking reflex, which is necessary for survival. When any object (the stimulus) touches an infant's lips, the automatic response is to suck. The newborn does not need to be taught to make an elementary sucking response. A further example is the ability to cry.

The newborn's physical structure is such that when hungry he automatically signals discomfort with a wail. Often the reflexes are adaptive: they help the organism in its interaction with the environment.

Piaget feels that in the case of human intelligence, reflexes and other automatic patterns of behavior play only a minor role. It is only the infant, and more specifically the newborn, whose behavior is heavily dependent on the elementary behavioral reactions of the type described. Piaget's research has shown that after the first few days of life, the reflexes are modified by the infant's experience and are transformed into a new type of mechanism—the psychological structure—which is not directly and simply provided by heredity. As we shall see, psychological structures form the basis for intellectual activity and are the product of a complex interaction between biological and experiential factors.

A third aspect of specific heredity is physical maturation. The genetic code provides the basis for the growth of physical structures along certain paths. For example, as the child grows older, the brain grows larger, and the muscles of the legs become stronger. Such physical maturation is often associated with various psychological activities: as the brain grows, speech emerges; as the leg muscles strengthen, permitting greater mobility, the child expands his exploration of the world. Maturation alone is not sufficient to cause the development of these and other activities, but appears to be necessary for many, if not all, of them. We shall see shortly that, in Piaget's view, experience and other factors are also necessary.

General Heredity

We have seen that specific heredity affects intelligence in three ways: (1) inherited physical

structures set broad limits on intellectual functioning, (2) inherited behavioral reactions have an influence during the first few days of human life but afterward are extensively modified as the infant interacts with his environment, and (3) the maturation of physical structures may have psychological correlates. Piaget's theoretical framework postulates that biological factors affect intelligence in a fourth way: all species inherit two basic tendencies or "invariant functions": *organization* and *adaptation.* This is general heredity.

Let us first consider organization. This term refers to the tendency for all species to systematize or organize their processes into coherent systems which may be either physical or psychological. In the former case, fish possess a number of structures which allow functioning in the water, for example, gills, a particular circulatory system, and temperature mechanisms. All these structures interact and are coordinated into an efficient system. This coordination is the result of the organization tendency. It should be emphasized that organization refers not to gills or the circulatory structure in particular, but to the tendency observed in all life to integrate their structures into a composite system (or higher-order structure).

At a psychological level, too, the tendency to organize is present. In his interaction with the world, the inpidual tends to integrate his psychological structures into coherent systems. For example, the very young infant has available the separate behavioral structures of either looking at objects or of grasping them. He does not initially combine the two. After a period of development, he organizes these two separate structures into a higher-order structure which enables him to grasp something while looking at it. Organization, then, is the tendency common to all forms of life to integrate structures, both physical and psychological, into higher-order systems or structures.

The second general principle of functioning is *adaptation.* All organisms are born with a tendency to adapt to the environment. The ways in which adaptation occurs differ from species to species, from inpidual to inpidual within a species, or from stage to stage within any one inpidual. Nevertheless, the tendency to adapt in some way or another is an invariant function and therefore considered an aspect of biology. Adaptation may be considered in terms of two complementary processes: *assimilation* and *accommodation.*

We will illustrate these processes first by means of a simple physiological example, namely, digestion. When a person eats something his digestive system reacts to the substances incorporated. To deal with the foreign substance, the muscles of the stomach contract in various ways, certain organs release acids, and so on. Putting the matter in general terms, we may say that the person's physical structures (the stomach and related organs) *accommodate* to the environmental event (the food). In other words, the process of accommodation describes the inpidual's tendency to change in response to environmental demands. The functional invariant of *assimilation* is the complementary process by which the inpidual deals with an environmental event in terms of current structures. In the case of digestion, the acids transform the food into a form which the body can use. Thus the inpidual not only modifies structures in reaction to external demands (accommodation), he also uses his structures to incorporate elements of the external world (assimilation).

For Piaget, intellectual adaptation is also an interaction, or an exchange, between a person and his environment and involves the same two processes—assimilation and accommodation—as are found in biology. On the one hand, the person incorporates or assimilates features of external reality into his own psychological structures; on the other hand, he modifies or accommodates his psychological structures to meet the pressures of the environment. Consider an example of adaptation in infancy. Suppose an infant of 4 months is presented with a rattle. He has never before had the opportunity to play with rattles or similar toys. The rattle, then, is a feature of the environment to which he needs to adapt. His subsequent behavior reveals the tendencies of assimilation and accommodation. The infant tries to grasp the rattle. To do this successfully he must accommodate in more ways than are immediately apparent. First, he must accommodate his visual activities to perceive the rattle correctly, for example, by locating it in space. Then he must reach out, adjusting his arm movements to the distance between himself and the rattle. In grasping the rattle, he must mold his fingers to its shape; in lifting the rattle he must accommodate his muscular exertion to its weight. In sum, the grasping of the rattle involves a series of acts of accommodation, or modifications of the infant's behavioral structures, to suit the demands of the environment.

At the same time, grasping the rattle also involves assimilation. In the past the infant has already grasped things; for him, grasping is a well-formed structure of behavior. When he sees the rattle for the first time, he tries to deal with the novel object by incorporating it into a habitual pattern of behavior. In a

sense he tries to transform the novel object to something with which he is familiar, namely, a thing to be grasped. We can say, therefore, that he assimilates the object into his framework and thereby assigns the object a "meaning."

Adaptation, then, is a basic tendency of the organism and consists of the two processes of assimilation and accommodation. How do the two relate to one another? First, it is clear that they are complementary processes. Assimilation involves the person's dealing with the environment in terms of his structures, while accommodation involves the transformation of his structures in response to the environment. Moreover, the processes are simultaneously present in every act. When the infant grasps the rattle, his fingers accommodate to its shape; at the same time he is assimilating the rattle into his framework, the grasping structure.

In sum, Piaget postulates that there are two general principles of functioning which affect intelligence: *organization* and *adaptation* (assimilation and accommodation). These biological factors, aspects of general heredity, are common to all species. While organization and adaptation are inherited, they are not structures (like reflexes) but *tendencies.* The particular ways in which an organism adapts and organizes its processes depend also on its environment and its learning history. In Piaget's view, human beings inherit few particular intellectual reactions; rather, they inherit a tendency to organize their intellectual processes and to develop particular adaptations to their environment.

Psychological Structures

We have seen that the inpidual tends to organize his behavior and thought and to adapt to the environment. These tendencies result in a number of psychological structures which take different forms at different ages. The child progresses through a series of stages, each characterized by different psychological structures, before attaining adult intelligence. From birth to about 2 years, the infant is unable to think and can only perform overt action. For example, if a toy falls apart he cannot first think how it might best be put together again; instead, he might immediately act on the toy and try to reassemble it. His activities, however, are not random, but display order and coherence. Almost immediately after birth the infant shows organized behavior. As-we have seen, some of these patterns of action, like the reflex, are due mainly to hereditary factors. However, specific heredity cannot explain all

the orderliness in the infant's behavior. For example, the 2-month-old infant usually sucks his thumb or a finger. When put in the crib he regularly brings his hand to the mouth in a relatively quick and efficient way. In the common language we would probably say that the infant has acquired the "habit" of thumb-sucking. The word "habit" implies a regularity, a coherence, in the infant's actions. It is clear that thumb-sucking is not based entirely on inherited physical structures. While there is a reflex to suck any object touching the lips, there is no innate tendency to bring the hand to the mouth; this activity must be learned. In Piaget's theory, such an organized pattern of behavior is termed a *scheme*.[4] The concept of scheme is used in a very broad way. It can refer to the reflexes and other kinds of innate behavior already discussed. It is in this way that Piaget speaks of the "sucking scheme." But the vast majority of schemes are not innate; instead, they are in some way based on experience, as in the case of the thumb-sucking scheme.

Thus far we have spoken of the scheme only as a pattern of behavior, or as an action which displays coherence and order. However, there are a number of additional aspects of the scheme. First, it involves activity on the part of the child; the concept is used to describe things he *does.* Most often, use of the term in this way presents no difficulties. Occasionally, however, scheme is used to describe actions which are not immediately obvious. For example, Piaget speaks of the "looking scheme." The use of "scheme" here is quite deliberate since he means to imply that vision is an active process; the child's eyes move as they actively *search* the environment. Second, scheme refers to the basic structure underlying the child's overt actions. Scheme is used to designate the essence of the child's behavior. Let us take thumb-sucking as an example. If we examine the infant's behavior in detail, we will see that no two acts of thumb-sucking performed by one child are precisely the same. On one occasion the activity starts when the thumb is 10 inches from the mouth, on another when it is 11 inches away. At one time the thumb travels in almost a straight line to the mouth; at another time its trajectory is quite irregular. In short, if we describe behavior in sufficient detail, we find that there are no two identical actions. There is no one act of thumb-sucking, but many; in fact there are as many as the number of times the child brings the thumb to the mouth. At first glance this situation might seem to pose insurmountable difficulties for the psychologist. How can she describe and explain behavior if each act is different from every other? Fortunately, the difficulty is only apparent, since most psychologists are not really interested in the fine details of behavior. What is important, especially for Piaget, is the structure of behavior, that is, an abstraction of the features common

to a wide variety of acts which differ in detail. In the case of thumb-sucking, whether or not the act starts from a distance of 10 or 11 inches is of no significance. What is crucial is that the infant has acquired a regular way of getting the thumb into the mouth. This "regular way" is an abstraction furnished by the psychologist. The infant puts the hand into his mouth in many particular ways, no two being identical, and the psychologist detects in these specific actions a certain regularity which she then calls a scheme.

Let us now consider another type of psychological structure: that of the *classifying operations* of the older child from about 7 to 11 years. Suppose an examiner presents the child with a collection of red and blue beads mixed together. Confronted with this situation the older child first thinks of the objects as being members of classes. There is the class of red beads and the class of blue ones. Further, unlike the younger child, he realizes that the class of red beads is included in a larger class, that of beads in general. Another way of putting the matter is to say that he groups the red beads into one class and conceives of it as being a part of a hierarchy of classes. The class immediately "above" the red beads (that is, the more inclusive class) is that of beads-in-general. Of course, the class of beads-in-general may also be located in a classification hierarchy. The class of solid objects contains the class of beads.

Obviously, the older child's operational schemes are quite different from the infant's behavioral schemes. The latter involve patterns of behavior; the infant acts overtly on the world. Although the older child's schemes also involve acting on the world, this is done intellectually. He considers, for example, the relatively abstract problem of whether given classes are contained in others. Piaget describes this aspect of the older child's thought in terms of the operations of classification. What is important for Piaget is not that the child can answer questions about beads (that, of course, is trivial), but that his activities reveal the existence of a basic thought structure, namely, the operations of putting things together, of placing them in classes, of forming hierarchies of classes, and so on. Classification, then, is composed of a series of intellectual activities which constitute a psychological structure. Of course, the child does not realize that he has such a structure and may not even know what the word "classification" means. The classification structure and "schemes" both describe an observer's conception of the basic processes underlying the child's activities; the child himself is certainly not aware of these structures.

The Description of Structures

How can we describe the psychological structures so basic to Piaget's theory? One way is by using common language. We can say that the child classifies objects or that his moral judgment is "objective," and so forth. Sometimes the common language adequately conveys meaning, but sometimes it does not. Unfortunately, there are occasions when an ordinary word means different things to different people. When this occurs the scientist is in danger of being misunderstood. Consequently, the sciences have tended to develop various formal languages to guarantee precise communication. The physicist does not say that objects "fall very fast" or "pick up speed as they go along." Instead, he writes a formula in which each term is precisely defined and in which the relations among the terms are completely specified by the formal language of mathematics. If the reader of the formula knows what the terms mean and understands the requisite mathematics, then the physicist's meaning can be accurately transmitted without the danger of misinterpretation.

Piaget feels that psychology, too, should attempt to use formal languages in describing the structures underlying thought. Psychological words in particular are quite ambiguous. While the theorist may intend a particular meaning for words like "habit," or "thought," or "classification," it is extremely probable that these terms will signify to others a wide variety of alternative interpretations. Consequently, Piaget has attempted to use formal languages—particularly aspects of logic and of mathematics—to describe the structures underlying the child's activities. In later chapters we shall consider in detail both the formal description of the structures and Piaget's rationale for using it.

Functions, Structures, and Equilibrium

We cannot emphasize sufficiently the extent to which Piaget believes that the functional invariants —organization and adaptation (assimilation and accommodation)—and the psychological structures are inextricably intertwined. As we have seen, assimilation and accommodation, although complementary, nevertheless occur simultaneously. A balance between the two is necessary for adaptation. Moreover, adaptation is not separate from organization. In the process of organizing his activities the inpidual assimilates novel events into preexisting structures, and at the same time accommodates preexisting structures to meet the demands of the new situation.

Furthermore, the functional invariants (organization and adaptation) are closely related to the structures of intelligence. As a result of the tendencies toward adaptation and organization, new structures are continually being created out of the old ones and are employed to assist the inpidual in interaction with the world. Looking at the matter another way, structures are necessary for adaptation and organization. One could neither adapt to the environment nor organize one's processes if there were no basic structures available at the outset. On the other hand, the very existence of a structure, which by Piaget's definition is an organized totality, entails the necessity for organization and adaptation.

There are, however, important differences between the invariant functions and the structures. As the inpidual progresses through the life span, the functions remain the same but the structures vary, and appear in a fairly regular sequence. Another way of saying this is that intellectual development proceeds through a series of *stages* with each stage characterized by a different kind of psychological structure and a different type of interaction between the inpidual and the environment. An inpidual of any age must adapt to the environment and must organize his responses continually, but the instruments by which the person accomplishes this— the psychological structures—change from one age level to another. Both the infant and adult organize and adapt, but the resulting psychological structures are quite different for the two periods.

Piaget further proposes that organisms tend toward equilibrium with the environment. The organism—whether a human being or some other form of life—tends to organize structures into coherent and stable patterns. These ways of dealing with the world tend toward a certain balance. The organism tries to develop structures which are effective in interaction with reality. This means that when a new event occurs the organism can apply to it the lessons of the past (or assimilate the events into already existing structures) and easily modify current patterns of behavior to respond to the requirements of the new situation. With increasing experience the organism acquires more and more structures and therefore adapts more readily to an increasing number of situations.

SUMMARY AND CONCLUSIONS

Early in his life Piaget developed two major intellectual interests: biology, the study of life, and epistemology, the study of knowledge. After devoting a number of years to each of these disciplines,

Piaget sought a way to integrate them. In the course of his work at the Binet Laboratory in Paris, he came to the conclusion that psychology might provide the link between biology and epistemology. Piaget decided to spend a few years studying the evolution of knowledge in the child and then apply the fruits of this research to the solution of the theoretical problems which initially motivated him. Fortunately for child psychology, the few years became many, and in their course Piaget has produced over forty volumes reporting his investigations into such matters as the child's moral judgment, the infant's patterns of behavior, and the adolescent's solution of scientific problems. Only in the 1950s was Piaget able to return to theoretical issues in epistemology. Late in life, Piaget continued his contributions to psychology, and published works on causality, consciousness, and development and learning. He died in 1980.

Piaget's research and theory have been guided by a framework which can be defined as a set of orienting attitudes. His definition of intelligence is not restrictive, but states that intelligence involves biological adaptation, equilibrium between the inpidual and his environment, and a set of mental operations which permit this balance. Piaget's research activities also have increasingly come to focus on the growth of the child's understanding of the basic concepts of science, mathematics, and similar disciplines. Piaget is less interested in studying the contents of the child's thought than the basic organization underlying it.

The inpidual inherits physical structures which set broad limits on intellectual functioning. Many of these are influenced by physical maturation. The inpidual also inherits a few automatic behavioral reactions or reflexes which have their greatest influence on functioning in the first few days of life. These reflexes are rapidly transformed into structures which incorporate the results of experience. Another aspect of inheritance involves the general principles of functioning. One general principle of functioning is organization; all species have the tendency to organize their processes.

A second aspect of general functioning is adaptation, which may be further subpided into assimilation and accommodation. Accommodation refers to the organism's tendency to modify its structures according to the pressures of the environment, while assimilation involves using current structures to deal with the environment. The result of the principles of functioning is a series of psychological structures which differ qualitatively from one another throughout a person's lifetime. For

example, the infant employs behavioral schemes or patterns of action, while the child from about 7 to 11 uses mental operations. What is important for Piaget is not the child's behavior in all its detail but the structure underlying his activities. For the purpose of clarity, Piaget has made an attempt to describe these structures in terms of formal languages—logic and mathematics. The general tendencies—adaptation and organization—and the structures are all related to one another.

Assimilation and accommodation are complementary, whereas organization and adaptation are interwoven. For instance, one assimilates an environmental event into a structure, and one accommodates a structure to the demands of the environment. Eventually the organism tends toward equilibrium, aiming at a balance between existing structures and the requirements of the world. In this balance the structures are sufficiently developed so that the organism need exert little effort either to accommodate them to reality or to assimilate events into them.

Piaget's framework is quite general, and at this point the reader must find it hard to evaluate. In the following pages we will see the fruitfulness of Piaget's orienting attitudes. We will review, for example, the evolution of the psychological structures underlying the child's intelligence, we will examine the ways in which assimilation and accommodation affect the child's interaction with the world, and we will consider Piaget's theory of equilibration.

Notes

1 Piaget has written short autobiographies in several volumes. One, although outdated, appears in English: J. Piaget, "Autobiography," in E. G. Boring et al., eds., *History of Psychology in Autobiography*, Vol. IV (Worcester, Mass.: Clark University Press, 1952), pp. 237-56. See also Chapter 1 in J. Piaget, Insights and Illusions in Philosophy, trans. W. Mays (New York: World Publishing Co., 1971).

2For a discussion of these and related matters, see T. S. Kuhn, *The Structure of Scientific Revolutions*, 2nd ed. (Chicago: University of Chicago Press, 1970).

3In this connection, it is interesting to compare two sources. One is a 1921 symposium in which leading psychologists attempted, with considerable difficulty, to define intelligence: L. E. Tyler, ed., *Intelligence: Some Recurring Issues* (New York: Van Nostrand Reinhold Company, 1969). A second is a similar symposium, held in 1974: L. B. Resnick, ed., *The Nature of Intelligence* (Hillsdale, N.J.: L. Erlbaum Associates, 1976). How much progress in defining intelligence has been made in the past fifty years?

4Piaget's French term *scheme* has usually been translated into English as *schema* (plural, *schemata*). We do not follow this practice since Piaget had been using the French word *schema* for another purpose. Also, the reader should be aware that scheme need not refer only to behavior; there are mental schemes too.