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Piaget's Theory of Cognitive Development

To properly understand Jean Piaget's theory of cognitive development, it is important to consider it within the larger context of his work. Although Piaget is recognized as one of the greatest developmental psychologists, he described his own work as "genetic epistemology." Genetic (Greek *genno* = give birth) here refers to the origin and development of knowledge, rather than to genes, as the word is used today. The main goal of Piaget's epistemology was to explain the generativity and rigor of human knowledge. *Generativity* refers to novelty and invention, whereas *rigor* refers to logical necessity, that is, that an answer must necessarily and logically be true, could not be otherwise, and must universally hold to be true for all rational persons.

Even though Piaget also approached the genesis of knowledge from the perspectives of phylogeny and the history of science, the major portion of his work addressed this issue by studying the development of knowledge in children. In this way, Piaget addressed fundamental epistemological questions about the origin, development, and validity of knowledge in general. He concluded that the development of knowledge is a constructive process, and he emphasized the child's active role in the construction of knowledge: Knowledge is constructed through a process of active exchange between the individual and his or her environment. Piaget's constructivist theory is essentially a theory of dynamic self-organization, which is rooted in biological functioning, with cognitive development representing the extension and continuation of this process of biological self-organization to a new level of functioning. This process of cognitive development results in the construction of increasingly advanced forms of thinking that Piaget described as progressing through a series of stages.

Piaget's Constructivist View of Knowledge and Development

Theories of development are based on views of the nature of knowledge, and therefore, Piaget argued that it is essential to examine foundational assumptions about the nature of knowledge. He argued against "copy theories" of knowledge, according to which knowledge consists of acquiring images, pictures, or representations that match reality. A flaw in these theories is that it is not possible to check the accuracy of such copies except by comparing them to reality itself. But such comparisons are not possible according to copy theories, because the point of the copy was to provide knowledge of reality; if we could directly access reality in order to compare our representations against it, we would not need such representations in the first place. Therefore, this view does not explain the development of knowledge about the world; instead, it already presupposes its existence.

For Piaget, knowledge, rather than consisting of images or representations, is built up through action on the world and through coming to know what can be done to aspects of the world. Acquiring knowledge through action begins in infancy with simple acts such as pushing and pulling, and continues throughout development, because, according to Piaget, even the most sophisticated forms of thought are interiorized actions, now carried out mentally. Knowledge is not innately preexisting within the child, nor does it arise solely from empirical experience with objects, such that this experience produces a simple copy of the object. Rather, the essential characteristic of Piaget's constructivism is that intelligence is constructed through the child's continuous interaction with the world. In this sense, Piaget considered his constructivism a third way that avoids the problems with both nativism and empiricism.

Central in describing the process of development are Piaget's concepts of *scheme, assimilation*, and *accommodation.* These concepts describe the functional relation between the individual and the world at any point in development. A scheme is a general structure that is applied in a particular situation, and it is that aspect of any activity that can be generalized. For example, at the sensorimotor level, schemes are general patterns of activity that can be repeated, such as the sucking scheme, which can be applied to different objects. Assimilation is the incorporation of objects or events into an already acquired pattern of activity, or scheme. By integrating objects and events into preexisting knowledge structures or schemes, assimilation gives them meaning (e.g., "suckable"). Infants not only suck on nipples, but also on fingers; that is, a finger may be assimilated to the sucking scheme. But because of differences in the experience of sucking a finger (e.g., it provides no nourishment), the infant differentiates this experience, and *accommodation* is said to have occurred: Patterns of activity differentiate to allow for the assimilation of novelty. Assimilation and accommodation are inseparable and describe two fundamental aspects of any activity in the process of adapting to the world, that is, acquiring knowledge.

The concepts of assimilation and accommodation have several implications. First, they express the idea that development is a continuous process that, at the same time, leads to structural change (differentiation and integration of knowledge structures). Second, activity is always organized in the sense that it is based on a structure (otherwise objects interacted with would be devoid of meaning). Structures, however, do not exist as an entity in the mind that results in reasoning; rather, they exist as potential coordinations of operations. Third, assimilation and accommodation continue, on a functional plane, the material process of self-organization (metabolism), thereby securing the continuity between biological and psychological functioning.

Based on this constructivist view of knowledge, Piaget described a series of stages, or forms of thought, in the development of intelligence. These stages build on each other and, therefore, necessarily develop in the following sequence.

Sensorimotor Intelligence

During the first stage of cognitive development, infants interact with the world through sensorimotor patterns of activity that gradually come to be differentiated and coordinated, as a result of interaction with the world. Because of the relative lack of differentiation and integration of action patterns, infants' experience of the world is undifferentiated from and fused with their own activity on the world. Piaget argued that infants' initial experience of the world is centered on their own bodies, which he referred to as *egocentrism.* This does not mean that infants are focused on themselves (self-centered), but rather that they have not yet constructed an understanding of themselves as objects existing among other independent objects.

Over the first one and half to two years of life, this initial egocentrism, or centration on the self as the reference point of epistemic experience, is gradually overcome, thanks to the functional interplay of assimilation and accommodation. Piaget described this process as occurring over a series of six substages. To get a sense of how radical Piaget's theory is, consider that it is during this period that, according to Piaget, the infant gradually constructs a sensorimotor, practical understanding of what will only later be reflectively understood as space, time, causality, and objects. For adults, such a conception of the external world is simply taken for granted, and assumed to be given by perception. Yet, according to Piaget, infants must gradually construct such an understanding of the external world.

Particular interest was generated by Piaget's description of infants' development of object permanence; that is, infants' growing understanding that objects exist as "things out there," independent of their own activity. During the sensorimotor period, object permanence undergoes a systematic, stagewise development. For example, at substage 3 in the development of object permanence, infants will not search for an object if it is completely covered, but they can retrieve an object if part of it is still visible. At substage 4, infants can successfully search for an object even it is completely covered. However, if they have found it under cover A, and then they see it placed under cover B, they will still continue to search for it under A. This curious phenomenon, referred to as the *A not B error*, has generated a great deal of research. Piaget's explanation for this characteristic error is that the object is not yet sufficiently separated from the infant's own action of finding it in the first location. With increasing integration and combinations of schemes, the object will eventually be conceived of as external to and separate from the infant's own activity: The more an infant can do with an object (e.g., grasp, suck, look, drop), and the better they can coordinate these action schemes, the more the object takes on an existence independent of the infant's activity.

Sensorimotor intelligence is practical or lived knowledge, which means that such knowledge is dependent on interaction with objects and is not yet reflective in nature. Further development requires a gradual process in which this knowledge is conceptualized and reconstructed at a higher level within the organization of the succeeding stage. The sensorimotor stage ends with the emergence of the symbolic or semiotic function, which is the ability to use symbols or signs to represent objects or events that are not present. The semiotic function is made possible by the interiorization of imitative actions such that these actions are performed internally and serve as images for the signification of schemes.

Preoperational Intelligence

Thanks to the emergence of semiotic functioning, cognition at the preoperational stage is no longer limited to the immediate here and now, but can re-present objects that are not in the immediate spatio-temporal field. As a result, the interplay between assimilation and accommodation becomes more complex because it involves both perceptual and representational levels of functioning, and thus absent objects as well as present objects. The development of the semiotic function requires that the child laboriously reconstruct, on the new representational plane, the practical concepts of object, space, causality, and time that had been constructed and only practically understood at the sensorimotor stage; Piaget termed this process of reconstructing concepts at a qualitatively different plane *vertical decalage.*

The semiotic function manifests itself in a number of different activities such as deferred imitation (i.e., imitation in the absence of the model), pretend play, drawing, psychological functions based on mental images (e.g., recall memory), and language. These activities are practiced and refined during the first substage of the preoperational stage, which Piaget termed *preconceptual thought.* Preconceptual thought is no longer tied to particular objects or events, but it fails to distinguish between individual members of a concept and the generality of concepts. In the second substage of preoperational thought, lasting from about 4 to 6 or 7 years and termed *intuitive thought* by Piaget, representational schemes become increasingly coordinated, and children become capable of relating two representational schemes to each other by means of a unidirectional logical relation. For example, thought and attention may be centered on one dimension, such as using height in order to infer amount of liquid, even though neglecting the width of the container. However, intuitive thought is incapable of understanding the simultaneous reversible and bidirectional nature inherent to logical operations.

Concrete Operational Intelligence

During the next stage of development, concrete operational intelligence, the semiotic functions of the

preoperational level come to be coordinated into what Piaget called operational systems. Operations are actions (e.g., putting like objects together, putting objects into one-to-one correspondence) that are interiorized and reversible. Reversibility means that transformations that have occurred in reality can be compensated for on the representational plane by incorporating these transformations into a system of logical relations. As a result, the child at the level of concrete-operations is liberated from centering on only one aspect of a situation (e.g., a perceptually salient aspect of situation).

Piaget constructed a number of tasks to assess concrete operational thought. Many of these entail forms of conservation. Conservation refers to the understanding that a whole remains intact despite undergoing transformations. For example, the number of objects in a collection, as a whole, does not change if the objects are rearranged. An operative understanding of conservation, therefore, is logical in nature—it is a logical truth that is not given by empirical observation of transformations. Piaget's conservation tasks were designed such that children who lacked an operative understanding of conservation would be misled by the appearance of transformation in the tasks. For example, conversion of liquid requires understanding that the amount of liquid does not change even if its shape is transformed by being poured into a tall thin glass.

A limitation, however, of concrete operational thinking is that although it is logical, it is still restricted to reasoning about actual objects. For example, consider an experiment in which a child is faced with an experimenter holding a poker chip in his hand saying, "Either the chip in my hand is green or it is not green." The child is then asked if the statement is true or false, or if he or she cannot tell. The child using concrete operational reasoning would be uncertain and would have to ask to see the chip. However, the statement is a tautology; it has to be true regardless of the chip in the experimenter's hand. That is, the statement is necessarily true based on its *form*, and therefore, looking at the actual chip is not required.

Formal Operational Intelligence

The next stage of development, formal operational intelligence, involves operating on logical classes or forms rather than on concrete objects, which are specific instantiations of logical classes. Piaget considered hypothetico-deductive reasoning to be the hallmark of formal operational thinking. This form of thinking involves the reversal of the direction between reality and possibility: Whereas on the level of concrete operations, possibility remains an extension of reality, on the level of formal operations, reality is subordinated to possibility. As a consequence, the adolescent can now reason about possibilities. Bärbel Inhelder and Piaget studied the emergence of formal operations by presenting children and adolescents with problems involving concrete material to be manipulated in order to discover scientific laws. For example, the pendulum task involves discovering which of several factors (length of string, weight of object, height of dropping point, or force of push) determines the frequency of the pendulum's oscillations. These experiments revealed that children differed qualitatively in their approach to scientific problems compared to adolescents. Although children were capable of classifying and cross-classifying an independent variable along one dimension, and of putting these seriations into correspondence with their effects on the dependent variable, they still failed to design systematic experiments, and, as a result, did not supply adequate proof for their statements. By contrast, adolescents formulated hypotheses and tested them systematically by controlling all variables except the one under investigation (isolation of variables) in order to gradually converge on the correct hypothesis.

Piaget recognized that there is more to thinking than logic, but logic and formal operational thinking about possibilities are not separate from social life and are intertwined with adolescents' construction of a scale of values that underlies their plans as they enter adult society. Thus, affective life, for Piaget, is not separate from cognition.

Structure, Equilibrium, and Equilibration

The coordination of operations (interiorized actions) into structures leads to Piaget's solution to the problems of generativity and rigor of human thought. Generativity of thought is due to the coordinations of actions, resulting in a range of new possibilities. Rigor, or necessity—understanding that an answer is necessarily correct—follows from the completion of a *structure*, which then entails *logical necessity*. For example, a child who fully understands the concept of numbers knows that 5 plus 7 is necessarily 12. The *equilibrium* and closure of a structure results from the

operations being *reversible;* every operation, such as addition, can be compensated for by another operation, such as subtraction. Higher forms of knowledge involve more adequate forms of equilibrium. Development is a process leading to increasingly more stable (complete and consistent) forms of equilibrium, and, therefore, development is progressive; it is not mere change. Equilibrium can involve a balance among a child's own activities (*organization*) or between the child and the environment (*adaptation*). *Disequilibrium* could be cased by gaps or contradictions in knowledge, and *equilibration* is the process of achieving a new, and often more complete, form of equilibrium following disequilibrium.

Although Piaget's stage theory is the best-known aspect of his work; this has been at the cost of neglecting his theory of equilibration. Perhaps because Piaget was trained as a biologist, it was natural for him to classify children's thinking into different stages or forms of thought. Yet, for Piaget, this was only the first step in understanding the development of knowledge. The second and more important task was to explain development from one form of thinking to another. This was the goal of Piaget's theory of equilibration, which brings out his interactive process account of development. Piaget emphasized equilibration as a process rather than equilibrium as a state. Every point of equilibrium is only partial. Piaget argued that equilibration is an essential factor in development, in addition to maturation and experience with the physical and social environment.

Piaget's later work focused on delineating in more detail the specific processes involved in equilibration. In this work he emphasized the roles of consciousness, affirmation and negation, contradiction, and reflective abstraction. Essentially, Piaget suggested that in the course of their interaction with the environment, and in the context of encountering obstacles to their actions, children become increasingly aware of their knowledge schemes and the coordinations involved in their actions. By reflecting on the coordinations of these actions, children become aware of the coordinatory structure involved in their actions. Reflective abstraction, thus, can be seen as a mechanism that, at each level of knowing, abstracts form (i.e., the coordinatory structure of action) from content and, in turn, projects this form to a higher level. With each new and higher stage, the forms become increasingly abstract. Through the mechanism of reflective abstraction, then, development proceeds by way of successively conceptualizing the forms or structures of knowledge underlying previous knowing levels.

Understanding Piaget's Theory Through Evaluating Common Criticisms

Although Piaget has been extremely influential in developmental psychology, his theory has been misinterpreted in numerous ways, partly because his goals have not always been recognized. There are now two views of Piaget's theory: the familiar "received view" that has become entrenched in textbooks, and a more recent and close reading of Piaget's work advanced by Michael Chapman and others that differs in striking and important ways. From the perspective of the received view, Piaget is acknowledged as a pioneer in many areas but nonetheless is heavily criticized for a number of reasons. The implication is that Piaget has little to offer current research and theory in developmental psychology. Therefore, to give a contemporary summary and assessment of Piaget's theory, it is now necessary to discuss both views of his work.

The primary diversity of interpretation of Piaget's theory revolves around the concept of developmental stages. Piaget's idea of stage is commonly interpreted to imply that once children demonstrate a form of reasoning, such as concrete operational reasoning (e.g., conservation tasks), they are in this stage and therefore should be able to pass all other concrete operational reasoning tasks. That is, the principle of conservation is the same, whether the concept conserved is substance, volume, weight, or liquid. However, there is now overwhelming evidence of inconsistency in reasoning across tasks that have identical logical formal properties, such as conservation. This inconsistency is known as *horizontal decalage.* For example, children's understanding of conservation develops in the following order, with each type being separated by approximately two years: substance (7–8 years), weight (9–10 years), and volume (11–12 years). This evidence is generally seen as a fatal flaw for Piaget's theory. However, Chapman pointed out that Piaget never did make this claim so often attributed to him about consistency in reasoning within stages, and, in fact, Piaget stated the opposite in several of his writings. If we begin from Piaget's basic insight that thought originates in action, then horizontal decalage is not an embarrassing surprise at all; rather, it ought to be expected. That is, as children engage in new forms of actions (e.g., displacing

water, weighing with a scale), new understandings (e.g., types of conservation) should emerge. This discussion also highlights the point that Piaget was classifying forms of reasoning (knowledge) as the object of his study; he was not classifying children as being at one particular stage, as is commonly understood.

It has also been claimed that Piaget underestimated children's abilities because his tasks include extraneous factors (i.e., factors not intrinsically related to the concept being tested). Consequently, researchers have modified Piaget's tasks and removed what they considered to be extraneous factors in order to uncover children's true competence. For example, the conservation of numbers task was administered with two or three objects instead of five objects, and younger children did pass this simplified task. However, this work was later criticized because it became evident that children could pass the simplified tasks with different forms of reasoning. That is, the simplified tasks were no longer assessing the form of reasoning that they were originally designed to assess. Furthermore, this line of research overlooks the crucial point that, within Piaget's theory, age is only an indicator not a criterion for children's competence. The issue that competencies develop in an ordered, sequential manner was more important to Piaget than the question of when these competencies emerge.

Piaget has been criticized for neglecting the importance of social factors and language in development. Moreover, it is generally assumed that he took a strictly individualistic perspective on development. However, in several of his books Piaget emphasized that social interaction is an essential factor in development but that it is necessary to go beyond such obvious statements to clarify how particular forms of social interaction influence development. Early in his career, Piaget argued that reasoning develops from the social process of argumentation. Later, Piaget recognized the roots of logical thought in infants' prelinguistic activity and thus argued that although social factors are necessary, they are not in themselves sufficient as a complete explanation for cognitive development. Social factors are important in knowledge being imparted from one generation to another, but this could not explain how new forms of knowledge emerge, nor how children develop to the point at which they can begin to assimilate such socially available knowledge. Although Piaget did focus on the child's physical action on the world, for a full appreciation of Piaget's thought, his research should be viewed in the context of the larger framework in which he worked.

Implications for Education

Interpretations of Piaget's theory as individualistic might suggest that his theory has little to offer education. However, Piaget himself was explicitly concerned with education, and his theory is a general approach to cognitive development that has implications for social–cognitive development and for education. Piaget's theory directs our attention to the child's level of development because a child can only understand instruction if he or she has developed structures or forms of understanding with which to do so. Furthermore, according to Piaget, knowledge is constructed through interaction with the world, and he emphasized the child's active role in the constructive process. This suggests that rote memorization or passive reception by children is not the best way to learn. However, Piaget's theory does not imply that there is no role for teachers; teachers are essential in creating situations that facilitate children's ability to develop understanding.

Another example of the implications of Piaget's work for education follows from his approach to moral development in which he emphasized the role of two types of relationships: constraint and cooperation. Relationships of constraint involve unilateral respect and the imposition of views from authority. In contrast, relationships of cooperation are best suited for the development of knowledge because they involve mutual respect, and each person is obliged to listen to the other and to fully explain themselves. This situation is most likely to lead to mutual understanding, which is essential in the development of all forms of knowledge.

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See also Conservation; Constructivism; Egocentrism; Equilibration; Object Permanence

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