Special Section

PIAGET’S LEGACY

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There have been many published assessments of Jean Piaget’s work over the years, both during his lifetime and since his death in 1980. One has only to look in any introductory textbook on developmental psychology or cognitive development to find examples. Most of these assessments mention both praiseworthy and criticizing aspects of his work, but often give more space to the latter than to the former. This is understandable. In most cases, identified weaknesses in his work are proxies for important scientific discoveries made by subsequent researchers. That is, we learn that some Piagetian developmental story is probably wrong by doing research that points to some alternative, more correct-seeming story. Naturally, it is important for the people who write about cognitive development to communicate both the weaknesses and the scientific discoveries that revealed them and look us the next step forward.

In the present assessment, I take a different tack, however. Useful though it is to examine the criticizing in Piagetiana, I focus entirely on the praiseworthy in this article. My objective is to summarize what I believe to be Piaget’s contributions to what we know about scientific development and how we think about it. Everyone knows that Piaget was the most important figure the field has known; the purpose of this article is simply to explain why.

PIAGET’S CONTRIBUTIONS

1. Piaget’s greatest contribution was to found the field of cognitive development as we currently know it. As Miller (1993) explained:

Piaget transformed the field of developmental psychology. If a developmental psychologist were somehow plucked out of the 1950’s and set down today, he would be bewildered by the talk around him. He would hear psychologists discussing strategies, rule-governed behaviors, cognitive structures, schemes, plans, and representations, instead of stimulus generalization, mean length of utterance, mental age, conditioning, discrimination learning, and learning set. To a great extent Piaget was responsible for this change. He altered the course of psychology by asking new questions that made developmentalists wonder why they had ever asked the old questions in the first place. Once psychologists looked at development through Piaget’s eyes, they never saw children in quite the same way. (p. 81)

As a developmental psychologist who began his career in the 1950s, I can attest to the accuracy of Miller’s characterization. Piaget provided the field with an entirely new vision of the nature of children, and of the what, when, and how of their cognitive growth. This vision invaded the field during the 1960s and 1970s and largely supplemented the rather limited and uninteresting visions that were already there. The result was that “almost everything people think and do in this field has some connection with questions that Piaget raised” (Flavell & Markman, 1983, p. viii). Thus, Piaget’s role in cognitive development was similar to Chomsky’s role in language development: He created and shaped a new field of inquiry.

2. Piaget’s assimilation-accommodation model of cognitive growth correctly emphasizes the active, constructive nature of the child. This model leads us to view cognitive development as a gradual, step-by-step process of structural acquisition and change, with each new mental structure growing out of its predecessor through the continuous operation of assimilation and accommodation. It is largely due to Piaget that we now take for granted that children are clearly not blank slates that passively and unselectively copy whatever the environment presents to them. Rather, the cognitive structures and processing strategies available to them at that point in their development lead them to select from the input what is meaningful to them and to represent and transform what is selected in accordance with their cognitive structures. As Piaget correctly taught us, children’s cognitive structures dictate both what they accommodate to (notice) in the environment and how what is accommodated to is assimilated (interpreted). The active nature of their intellectual commerce with the environment makes them to a large degree the manufacturers of their own development. (Flavell, 1992, p. 998)

Views similar to Piaget’s constructivist conception are widely held by present-day cognitive psychologists as well as by cognitive developmentalists. As Halford (1989, p. 326) has pointed out, Piaget’s conception also anticipated schema theory and the concept of constraints on learning. Bates and Elman (1993) even went so far as to predict that we will soon see a revival of Piagetian theory within a connectionist framework—not a mindless reinterpretation of the old theory in modern jargon, but a return to Piaget’s program of genetic epistemology, instating his principles of equilibration and adaptation in concrete systems that really work—and really change. (p. 17)

3. Piaget helped us to accept the idea that children’s cognitive behavior is intrinsically rather than extrinsically motivated. Although social and other reinforcements may influence children’s curiosity and cognitive explorations to some degree, basically children think and learn because they are built that way. For Piaget, cognitive adaptation to the environment via the mechanisms of assimilation and accommodation is a form of biological adaptation, and adaptation is something organisms have evolved to do. Cognitive functioning, and cognitive-structural change through repeated cognitive functioning, have their own internal power source and are certain to occur in every human child. It might be objected that everyone has always believed this, but that is not the case. In the 1950s, psychologists were just beginning to play with such notions as curiosity, competence, exploratory, and sensory motives and

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drives, and in the early 1960s it was natural to write, ‘It seems less improbable today than it once did to imagine that the Piagetian infant really does need to look at, listen to, and otherwise assimilate stimuli, even (perhaps especially) when he is not hungry’” (Flavell, 1963, p. 410).

4. Piaget saw that to characterize human cognitive development adequately, one needs something less general than the functional invariants of assimilation and accommodation, co-present in all cognitive activity, but also more general than an endless list of specific acquired concepts. For Piaget, that something was cognitive structure:

There has to be some tertium quid: something which changes with age, as the functional invariants do not; but also something more general than individual contents, something which will pull diverse contents together into a single chunk. Piaget realized this early and wisely resisted what we think was the guiding spirit of the 1930’s: to move upward towards function (the child ‘learns’ more and more things as he grows, but the mind which learns is homogeneous throughout) and to move downward toward content (as he grows, the child acquires this, and this, and this, and this—period). However critical one may be of the particular structural analysis Piaget has made, we are much in his debt for seeing so clearly, and so early, the necessity for making one. (Flavell, 1963, pp. 409-410)

Although developmental psychologists have indeed criticized the particular structures Piaget proposed in the years since those lines were written, most continue to see the need for structural analyses of one kind or another. Thus, we continue to read about grammars, schemas, scripts, rules, systems, central conceptual structure, and other structural concepts. Similarly structural in nature are characterizations of cognitive development as the acquisition of naive theories within specific domains (Wellman & Gelman, 1992). One would not be licensed to describe the child’s knowledge about the mind as a theory of mind unless one thought it consisted of a set of interrelated concepts—and thus a knowledge structure—rather than a set of unrelated ones.

5. In elaborating his equilibration model, Piaget was one of the first psychologists to make a serious try at explaining as well as describing cognitive development. He argued that all significant intellectual advances are made through an equilibration process consisting of three major steps: first, cognitive equilibration at a lower developmental level; then, cognitive disequilibration, induced by awareness of puzzling, contradictory, discrepant, or otherwise unassimilable phenomena not previously noticed; and finally, cognitive equilibration (or reequilibration) at a higher developmental level, as the result of reconceptualizing the problem in such a way as to make sense of the previously nonassimilable phenomena. Although this model clearly has its problems (lack of clarity and specificity, apparent inapplicability to certain kinds of developmental change), we are only now beginning to see attempts at explanations of cognitive-developmental changes that appear more promising (Siegel, 1996). Moreover, recent explanations of naive theory development in children feature a change process very reminiscent of Piaget’s equilibration model (e.g., Bartsch & Wellman, 1995; Gopnik & Wellman, 1992).

6. Piaget proposed many insightful concepts and ideas in the course of his extensive theorizing about cognitive development. The Piagetian concept of scheme (or schema) is one such. The image of children searching for objects to assimilate to their developing action schemes—for example, searching for countables with which to exercise their newly minted counting scheme—seems very true to life (Gelman, 1979). Similarly, his concept of vertical décalage captures the possibility that there are hidden similarities or recursions in children’s functioning across different stages of development. “Development in the Piagetian mode has a cyclic character which buttresses the feeling that it is somehow all of one cloth” (Flavell, 1963, p. 408). Neo-Piagetian theorists such as Case and Fischer have also found it necessary to build such recursiveness into their stage theories. For example, Case et al. (1991) proposed that the three substages of unifocal, bifocal, and elaborated coordination are found within each of four major stages of development. Piaget’s belief that images are active internal imitations rather than passive copies of external objects and events anticipated the concept of mental rotation (Shepard & Metzler, 1971). The concepts of egocentrism, centration, and decentralization have proven to be very useful in understanding the development of both social and nonsocial thinking. Piaget’s idea that a person’s own point of view tends to be more salient and available to him or her than the points of view of other people finds its modern counterpart in Tversky and Kahneman’s (1973) availability heuristic. Piaget’s concepts of reflective abstraction and formal operations, involving the idea of cognition about cognition, live on in Karmiloff-Smith’s (1992) developmental theory and in the large developmental and nonddevelopmental literature on metacognition.

Gelman (1979) described another insight thusly:

Piaget was the first to point out the role of transformations in a theory of cognition. The world is known not only in terms of static representations of it; we “know” how transformations will affect objects or classes of objects. Likewise our representations include knowledge of those transformations that do and do not change certain properties of an object or class of objects. How such knowledge develops is a central concern of Piagetian theory. Since I cannot imagine anyone denying the central role of transformations in a theory of cognition, I think we will continue to be influenced by Piaget’s ideas and related observations on the object concept, conservation, etc. (p. 5)

Finally, although we often think of Piaget as focused on developmental discontinuities from one age to the next (qualitatively different stages, etc.), his emphasis on invariant developmental sequences strongly highlights underlying continuities in development. He emphasized the idea that, despite their novel features, later structures grow out of and build upon earlier ones:

He at once shows us wherein a new structure is really new, is a true emergent, and at the same time shows us wherein it is not new, is not something inexplicable in terms of antecedent events. In Piaget’s scheme of things, all structures are emergents but no structures are emergents ex nihilo. (Flavell, 1963, p. 416)

7. Piaget contributed importantly to our stock of research methods for studying children’s intellectual growth (Beilin, 1992). He pioneered the use of a clinical method, in which the researcher probes for the child’s underlying understanding and
knowledge through repeated questioning. Most of us still use variants of this method in our research, especially in the piloting phases. A related contribution is that early in his career he had the insight—novel at that time—that one can learn more about children’s thought by noting and querying their incorrect answers than by just tallying their correct ones. That is, he recognized that “the ‘wrong’ or ‘cute’ notions that preschool children have about the world are the symptom of a complex, probing intellectual system that is trying to understand reality” (Miller, 1993, p. 84).

8. For many people, of course, Piaget’s most important contributions have been his remarkable empirical discoveries, far too numerous to summarize here:

What may well be one of Piaget’s most important and enduring legacies to the field is simply that he has revealed the development of cognition to be a thing of unsuspected and extraordinary richness. Piaget has systematically ploughed his way through most of the principal modes of human experience and knowledge—space, time, number, and the rest. And in each case he has laid bare a complex succession of preforms and precursors for the most mundane and obvious of cognitions, cognitions we had no reason to assume needed a prehistory, let alone such an involved one. It is an uncommon experience to find out something about children’s behavior which really surprises, which produces a sense of shock and even disbelief; after all, people have been child-watching for a long time. But Piaget may have discovered more things about children which shock and surprise than anyone else, and this alone is an immense accomplishment. (Flavell, 1963, p. 411)

Gelman (1979) further noted that Piaget gave us “some of the most reliable phenomena in psychology” and that “they are amongst the phenomena that make it possible to claim there is a field of cognitive development” (p. 6). Clearly, Piaget had the greenest thumb ever for unearthings fascinating and significant developmental progressions. Just compare what Piaget discovered in his career with what the rest of us have discovered in ours (considered singly or—it sometimes almost seems—even collectively!).

9. Piaget’s descriptions give us a highly memorable and at least fairly true picture of how children at different ages think. The qualitative thought of the preschooler, the more quantitative and logical thought of the elementary school child, the more abstract and metacognitive thought of the adolescent—although these pictures are not wholly accurate, they do capture much of the essence of the child’s mental tendencies during these age periods. Siegler (1991) expressed this point well:

What explains the longevity of Piaget’s theory? Perhaps the basic reason is that Piaget’s theory conveys an almost tangible sense of what children’s thinking is like. His descriptions feel right. Many of his individual observations are quite surprising, but the general trends he detects appeal to our intuitions and to our memories of childhood. (p. 18)

10. Piaget’s work has had important influences on fields other than cognitive-developmental psychology. For example, his ideas and tasks have been used extensively in the fields of educational psychology, special education, socioemotional development, childhood psychopathology, and comparative psychology. His ideas have also influenced the thinking of professionals (e.g., Brazelton) who provide advice about parenting practices to the general public. His conception of children as active, constructive thinkers who learn only what they are structurally ready to learn has had an especially profound influence on educational thinking and practice. Indeed, it is hard to see how the contemporary field of instructional psychology would have developed as it did had there been no Piaget.

11. Ultimately, Piaget’s most important and enduring legacy may not be his theory and research findings as much as the deep questions and issues he raised: What development-making cognitive equipment is the child born with? What role do interactions with the environment play in the child’s development? How can we diagnose the child’s competencies accurately, without either overestimating or underestimating them? What would it mean to claim that cognitive development is stagelike, and how stagelike is it in fact? Are there invariant developmental sequences and, if so, why are they invariant? What are the mechanisms or processes that cause cognitive development to occur? And so on and on. Piaget got us started, and by continuing to wrestle with the issues he bequeathed us, we will continue to learn more about children’s intellectual development (Siegler, 1991).

CONCLUSION

This description of Piaget’s contributions has been very laudatory. Has it been too laudatory? Some readers may think so, but I do not. I think we are in more danger of underappreciating Piaget than of overappreciating him, for much the same reason that fish are said to underappreciate the virtues of water. That is, many of Piaget’s contributions have become so much a part of the way we view cognitive development nowadays that they are virtually invisible. The invisible would quickly become more visible if one were to examine a child psychology textbook written in the 1950s and compare what the field was like then to what it is like now. A footnote in Beilin’s (1992) article on “Piaget’s enduring contribution to developmental psychology” says it all:

An anonymous reviewer of a draft of this article . . . observed that “assessing the impact of Piaget on developmental psychology is like assessing the impact of Shakespeare on English or Aristotle on philosophy—impossible. The impact is too monumental to embrace and at the same time too omnipresent to detect.” I agree. (p. 191, fn. 1)

Me too.

REFERENCES


This centennial celebration of Piaget’s birth offers an opportunity to reflect upon the lasting impact that he has had on developmental psychology. The contributions that we consider most important in his theory of infant development reflect what is most important in his general theory: his emphasis on infants as active agents constructing their own worlds and his focus on the dynamic role of physical and social contexts in that construction.

Piaget’s emphasis on the infant’s role as an agent in constructing his or her own reality was revolutionary in its effects on psychology, and it remains an important insight that is often overlooked in people’s haste to mold their children’s personalities and intelligences. Piaget insisted on remembering that “children are people from the time they are born”—a refrain that is echoed in many current calls for change, such as those of Chess and Thomas (1987). Neither tabulae rasae (Locke, 1794) nor lumps of clay (Watson, 1925), children are from birth active agents in their own development, and it was Piaget whose research made that fact indisputably clear.

In the same manner, Piaget’s description of development as a dynamic interplay between an infant’s assimilation of environmental events to preexisting schemes and his or her adjustment of those schemes to accommodate to information from the environment presaged current transactional-ecological theories of development, which attempt to recognize the important roles of environmental affordances and sociocultural settings in the developing agency of the child (Bronfenbrenner, 1993; Fischer, Bullock, Rotenberg, & Raya, 1993; Gibson, 1979; Molenaar, Rijmakers, & Hartelman, 1994; Reed, 1993; van Geert, 1994; Whiting & Edwards, 1988). An infant is an agent-in-environment, with other people, objects, and events collaborating in the baby’s activities.

Research and theory have built upon these two insights and moved toward a framework that includes both of them: Infants are active agents constructing their own worlds, and at the same time the physical and social contexts in which they act dynamically shape their constructions. In recognition of Piaget’s central contributions to this view of infants as agents-in-context collaborating in their own development, we begin by describing Piaget as an agent-in-environment, creating his theories from the combination of his own schemes and information from his environment, both personal and historical.

PIAGET’S CONSTRUCTION OF HIS THEORY

The years between 1925 and 1930 were momentous ones for developmental psychology. In 1925, during a lecture at Clark University, John Watson issued his now-famous challenge: “Give me a dozen healthy infants, well-formed, and my own specified world to bring them up in and I’ll guarantee to take anyone at random and train him to become any type of specialist I might select” (Watson, 1925, p. 3). Three years later, he published a manual on child rearing, based on his behaviorist principles, that was to become a child-rearing bible for a generation of parents (Watson, 1928). During the 1920s, another American, Arnold Gesell (1928), was accumulating a storehouse of observations that he published in 1928 as a manual describing the maturational emergence of behavior during infancy and childhood. These two frameworks represented the poles of environmental versus organismic explanation that have been at the center of so many debates in the behavioral sciences, especially in English-speaking nations.

Important as these events were, they were overshadowed in our view by other events happening during the same period in Geneva—events that would eventually lead Piaget to begin to construct new kinds of explanations that moved beyond the environment-organism split. In 1925, Jacqueline Piaget was born, followed by Lucienne in 1927 and Laurent in 1931. For their father, they provided the opportunity to move beyond the world of theory and philosophy and into the world of infant development.

Following the example of Charles Darwin (Darwin & Darwin, 1887), Piaget and his psychologist wife, Valentine, kept diaries detailing the behavior of their infants. More than other baby diarists of the time, however, the Piagets brought to their observations a rich theory about the nature of development. Drawn heavily from the earlier work of James Mark Baldwin (1894), it was a theory of development as transformation, with predictable sequences of transformation occurring as a result of infants’ early activities encountering their environment. The power of the Piagets’ work has much to do with their unique ability to tie these abstract concepts to observation. The Piagets combined elegant theory with intensive longitudinal observation that was sensitive to the nuances of infant behavior as well as with a remarkable creativity at generating age-appropriate tasks to test systematically their infants’ changing activities and to relate them to the ontogenetic theory of transformation (Cahan, 1984).

Jean Piaget (1927/1977) first presented his and Valentine’s theory of infant development in a paper to the British Psychological Society in 1927, and he later elaborated this theory in three books, The Origins of Intelligence in Children (1956).
TWO VIEWS OF INFANT DEVELOPMENT IN PIAGET’S WORK

The Piagets’ theories and observations of infants in the first 2 years of life are divided primarily between The Origins of Intelligence in Children and The Construction of Reality in the Child, and that division reflects two distinct and sometimes contradictory views—infants as constructing their activities with real objects, events, and people in particular contexts versus infants as unfolding through a fixed sequence of developmental stages that are defined by patterns of action but seem relatively impervious to contextual influence. The constructive-contextual view is especially strong in Origins, in which Piaget spent many pages explicating the relation between child and environment outlined in Figure 1. The fixed-stage view is more prominent in Construction of Reality, despite the title.

Both views are present in both books, of course. The books share a series of elements that make a powerful general argument: (a) Infants develop through six stages, from simple reflexive actions toward representational thinking. (b) Infants build up schemes of action through circular reactions in which the infants repeat similar activities to build increasingly complex organizations of action and perception. (c) In these activities, infants constantly generalize their actions to specific objects and events (assimilation) and particularize the actions to those objects and events (accommodation). In many ways, the differences in subject matter between the two books enrich the explication of the underlying theory, describing a wide range of activities, including looking, reaching, listening, locomoting, and sucking. The framework of assimilation, accommodation, and circular reactions put forth in Origins is explicated in Construction through the Kantian categories of object, space, causality, and time.

The most notable discrepancy between the two books relates to the role assigned to the environment in eliciting and supporting the behaviors through which an infant constructs his or her understandings. In Origins, Piaget clearly focused on the importance of interchanges between child and environment (including people and objects) in shaping a child’s developing schemes. “In all behavior patterns it seems evident to us that learning is a function of the environment” (Piaget, 1936/1952, p. 31). For example, discussing Laurent’s organization of his reflexive sucking behavior into efficient feeding, Piaget noted that adaptation depends from the start on combining accommodation and assimilation. Only practice with appropriate objects will lead to normal sucking, as contact with the object modified Laurent’s reflex activity. Piaget recognized that from the start, babies actively construct their understanding of the world through transactions with their environments.

Piaget is often criticized for neglecting the extent to which children construct their knowledge through transactions between child and environment (Chapman, 1988; Feldman, 1980; Fischer, 1980; Noam, 1990; Rogoff, 1990; Sameroff & Chandler, 1975). This critique is more appropriate for Construction than for Origins because in Construction, he emphasized the stage view and neglected the contributions of context to construction. He described how infants move through six stages in understanding objects, space, causality, and time, and in this description neglected the formative and supportive roles that context plays in infants’ activities as well as the wide variability in infants’ activities.

Although Piaget believed that these two views of development are related, he never fully integrated them, and his lack of integration has helped catalyze many of the debates about cognitive development. His stage theory has often been taken to indicate organically unfolding stages that are allegedly universal and are presumed to unfold through species-specific genetic
There is a dynamic order in development that shows both stagelike changes and powerful variation with context (Bidell & Fischer, 1996; Case & Edelstein, 1993; Fischer, 1980). The variation with context does not contradict the evidence for stagelike change but instead helps to explain it. Figure 2 illustrates how the weblike pathways of development can be mostly independent even while they show stagelike change that is approximately concurrent. Each pathway or strand represents a domain, with its own distinctive properties that give it coherence and make it partly independent of other domains, as suggested by various domain theorists (Carey, 1985; Case & Griffin, 1989; Gardner, 1983; Keil, 1986).

Despite the independence of the pathways, most of them show stagelike discontinuities as a result of the dynamics of their growth. These discontinuities tend to cluster within concurrent zones like the one marked in Figure 2. Note that there are additional concurrent zones in the pathways before and after the one marked. During these times of stagelike change, there is evidence of rapid growth and reorganization across domains, especially when contextual support produces optimal functioning.

In infancy, the evidence is especially strong for several periods of concurrent change across domains, such as object permanence (search for hidden objects), vocal imitation, visual-motor means-end action, pretend play, and speech (Corrigan, 1983; Fischer & Hogan, 1989; McCall, Eichorn, & Hogarty, 1977; Uzgiris, 1976). Although there is also clear evidence of such periods at later ages, the evidence for infancy is stronger than for other age periods—perhaps because infancy researchers can do successful research only if they are exquisitely sensitive to the sources of variability in their subjects’ activities. In general, clusters of discontinuities can be detected consistently only when researchers include considerations of variability in their research designs (Fischer et al., 1993; van Geert, 1994).

Piaget’s work on infants remains uniquely valuable in providing a framework for describing how infants interact with their environments to develop understandings of both the world and themselves-in-the-world. With its rich descriptions, this framework still provides the best single source for capturing how infant and context together shape development through complex developmental webs like the one in Figure 2.

**OBJECT PERMANENCE AND SERIAL SEARCH IN INFANCY AND BEYOND**

To capture some of the power of Piaget’s seminal work, we focus on one of the strands (domains) in the web—search for hidden objects, which is usually referred to as object permanence. This domain has been a near-obsession of hundreds of researchers affected by Piaget’s work, and it remains the source of much controversy (e.g., Baillargeon, 1993; Diamond, 1991; Spelke, 1988). In this recasting in the spirit of Piaget, we emphasize infants’ active construction of activities in context: Infants coordinate and differentiate activities in similar tasks and generalize across those tasks. Similarities in action, task, and context give the domain coherence and support infants’ constructive activities. In this way, situation and action together
produce infants' development through a series of schemes or skills that follow a branched sequence of search. These constructive activities show stagelike discontinuities within the domain when infants construct a radically new kind of activity, but there is no single point when the one true object concept appears. Present-day researchers would do well to take to heart Piaget's insistence that development always involves sequences, not punctate achievements.

Piaget's (1937/1954) constructivist model posited a gradual series of reorganizations in the emergence of object notions or concepts, resulting in a developmental sequence of changing ideas about objects and people during infancy. (Although the standard English translation is "object concept," a more appropriate translation from the French is "object notion" because Piaget reserved the French term concept for the later development of operational thought.) The classic skill of searching for hidden objects through displacements is a relatively late-appearing and sophisticated type of object notion, constructed out of precursor skills and forming the basis of even more complex skills that develop later.

Piaget described the infant in the first few months as having primitive single reflexes or actions and not distinguishing self from other or object from action. "The essence of primitive thought," he said, "is that there is no difference between the self and the world. For the baby, nothing exists apart from himself or, if you prefer, all his desires and feelings are projected onto things. With this stage of affairs, everything is assimilated to subjective desires and tendencies." (Piaget, 1927/1977, p. 205). At this early point, babies cannot distinguish themselves or their actions from their environment or the objects they act upon.

These kinds of global statements have led many researchers to focus on showing that young infants have greater capabilities than Piaget seemed to say (Baillargeon, 1993; Carey & Gelman, 1991; Haith, 1980; Spelke, 1988; von Hofsten, 1984). Because as adults we cannot place ourselves in the minds of children who lack our sophisticated level of knowledge, it is easy to either underestimate or overestimate the degree of understanding reflected in infants' and children's performance on the tasks we design. Despite Piaget's global statements, he tried to avoid these under- and overestimations by providing powerful descriptions of the gradually developing skills of young infants, recognizing that even in the early months infants are moving through specific developmental sequences involving gradual construction of ways of acting on objects and people. Later, he also acknowledged that he had underestimated infants' early abilities (Piaget, 1983). Contemporary researchers would do well to emulate Piaget's differentiated descriptions of infants' early activities rather than his global statements about infants' general lack of knowledge.

For example, for the very first days of life, Piaget detailed adaptations to sucking at the breast—gruping for the breast and the nipple. He also described early orienting to parents' vocalizations, including head and body movements that are precursors of systematic search for sounds. He described early grasping actions, such as opening and closing the fingers on a bed-cover that touches the hand. Within a few months, the precursors have become more clearly differentiated activities. At 2½ months, Piaget's son, Laurent, held a bedsheet in his hand, letting go and then grasping again soon after, and repeating this action many times. At 4 months, Lucienne repeatedly turned away from nursing to look in Piaget's direction and smile after her father greeted her.

These early skills are complex and more sophisticated than Piaget originally thought. Indeed, they may well account for the findings of supposedly innate knowledge in young infants reported in studies of habituation situations, in which looking longer at a "surprising" event that violates object characteristics is taken to reflect advanced object knowledge (Baillargeon, 1993; Spelke, 1988). Mareschal, Plunkett, and Harris (1995) found, for example, that a neural network model can learn to show such looking behavior based only on development of visual search skills, independent of specific object information. This kind of skill is much simpler than the more advanced language and cognitive skills that other researchers have modeled with neural networks (Elman, 1991; Rumelhart & McClelland, 1986) and suggests that infants' early object skills can be based on skill systems simpler than those required for object knowledge in the later stages of development of object permanence.

In addition to depicting developmental sequences of these early activities, Piaget showed how they were strongly affected by context, typically reoccurring only in a narrowly defined situation until the infant could gradually generalize them. Indeed, the absence of generality was one of the main reasons that Piaget declined to classify them as indicating "true" knowledge or skill, such as true searching or true object knowledge. In addition, the activities were not active interventions in the service of a goal, but merely continuations of previous actions.

The early steps of more generalized searching begin at 4 to 5 months of age, according to Piaget, as infants use motor actions such as movement of the head, eyes, and hands to search for an absent object that was formerly present. Piaget described 6-month-old Laurent as showing no reaction to Piaget's dropping a box of matches, but searching briefly with his eyes and head when he himself (Laurent) dropped the box. By 8 months, Laurent "searches on the floor for a toy which I [Piaget] held in my hand and which I have just let drop without his knowledge. Noting it, his eyes return to my hand which he examines at length, and then he again searches on the floor." (Piaget, 1937/1954, p. 15). For Piaget, this was true active searching, heralding the beginning of object permanence. As yet, however, the searching does not continue if the object is removed from sight for long or if the situation is changed.

At any given step in the development of search skills, a child constructs stable skills for acting in a given context in certain ways. For instance, skills that map one action onto another (which begin with what Piaget, 1936/1952, called secondary circular reactions) involve controlling one action in relation to another one, such as using one action as a means to produce the other. An infant who hits a rattle (first action is hitting the rattle) and hears the resulting sound (second action is listening to the rattle) can repeat the hitting action when the rattle is accessible and thus reproduce the listening action. Or an infant whose babbling has just elicited a desirable vocalization from a parent can repeat the babbling activity to hear more of the parent's vocalization. In both cases, the organization of the infant's activities provides a specific type of knowledge about some objects (including people) and their stable characteristics.
Through this type of sensorimotor activity infants begin to act as if objects exist independently of their bodies and can be influenced by their actions. At the same time, this organization of their activity also limits their knowledge. Infants do not know how to grasp an object that is no longer directly observable, as when it is hidden by a barrier. This kind of knowledge will be acquired as infants gradually construct new forms of organized activity with displaced and hidden objects.

In addition, infants still control grasping and visual search skills separately because they involve different actions and contexts. From the adult viewpoint, the skills all involve permanent characteristics of objects, but from the infants' perspective, they are not yet coordinated. Infants must actively construct the coordination of these skills. As complex coordinations are built in the second half of the 1st year, according to Piaget, a broader sense of permanent objects dawns on the infant.

When infants are 7 to 10 months old, a new action scheme integrates grasping and visual search for objects. Eye-hand coordination is central to most of Piaget's object permanence tasks, which demonstrate sharp spurs (discontinuities) in growth curves, with many infants starting to grasp for hidden objects where they see the objects disappear (Bell & Fox, 1992, 1994; Uzgiris, 1976). Piaget (1937/1954, pp. 45–46) described Laurent, at 9 months, picking up the pillow under which his parent hid his toy. The search behavior was inconsistent at first, but by 10 months Laurent reliably searched for his toy regardless of which screen his father or mother had hidden it under.

This searching for hidden objects is built on the infants' own actions, as evidenced by the famous A/not-B error. Piaget hid a toy parrot from Jacqueline under his hand several times, and then while she was watching he hid it elsewhere. Even though she watched him move the parrot, she continued to search only under his hand for a number of trials. This deficit in the searching scheme is a kind of sensorimotor perseveration in which search is restricted to the last location of the missing object. For Jacqueline, Piaget (1937/1954, pp. 49–51) said, the parrot was not yet an object in the adult sense of the word, but a series of potential actions that she could carry out.

Piaget noted that searching for hidden people shows some important differences from searching for objects. In peekaboo, babies look for hidden people to reappear, and many infants enjoy this game from a relatively early age. Piaget's daughter Jacqueline played peekaboo skillfully at 8½ months, earlier than she showed logically comparable object-search skills. "The object searched for... is a person, and persons are obviously the most easily substantiated of all the child's sensorial images" (Piaget, 1937/1954, pp. 46–47).

The difference Piaget observed between person and object permanence is a strong example of his careful observation of context effects. His argument that logic organizes the mind led him to expect that these two similar forms of search would develop simultaneously for the two objects, toy and father, but he noted that effective search developed earlier for the latter than the former. Further research was required to untangle the several different contextual factors contributing to this difference, including the specifics of the search task and the thing searched for (Jackson, Campos, & Fischer, 1978), but Piaget first pointed to the important contribution of contextual factors.

Piaget did not see object permanence as emerging at 8 to 10 months, as some interpretations of his findings imply. Instead, he described a developmental sequence extending from the first months of life through 18 to 24 months of age. This sequence forms a series of increasingly complex forms of object search embodying increasingly complex understandings of the self-object distinction in actions.

By about 1 year of age, infants begin to show more sophisticated search schemes, at least in familiar situations: They correct their earlier error by reaching where they saw the object hidden most recently instead of where they found it before. But still a deficit remains—one on which Piaget placed great emphasis. Infants cannot yet successfully search for objects if the displacements are invisible to them, which for Piaget meant that they do not truly understand the logic of object permanence: Objects cannot simply disappear; they must go somewhere. At 1½ years, both Jacqueline and Lucienne successfully searched for a gold coin hidden in a variety of locations by their father. The persistence of their efforts indicated to him that they had a permanent representation of the object, independent of their sensorimotor schemes, and thus that they understood the concept of object permanence. Piaget suggested that they could mentally represent the invisible displacements of the object.

Unfortunately, however, he did not follow his own best strategy for testing this hypothesis—investigating extensively how different tasks and different contexts affect performance and going beyond the single criterion of persistent search to examine other criteria relevant to understanding invisible displacements. It is always dangerous to rely on a few observations and a single criterion to infer a general capacity. If Piaget had explored his interpretation further, he would have found what other researchers have since discovered. Children of 1½ to 2 years cannot represent multiple invisible displacements. In fact, they do not even show systematic serial search based on the visible displacements they have seen (Bertenthal & Fischer, 1983; Corrigan & Fischer, 1985; Fischer & Jennings, 1981). In this case, the problem is not the underestimation of infants' capacities that characterized Piaget's depictions of early development but instead an overestimation.

Success on hidden displacement tasks must stem from some simpler form of representation than that suggested by Piaget. The most that 2-year-olds seem to grasp is that the adult has performed a surreptitious hiding act (Bertenthal & Fischer, 1983). They represent another person as acting independently of what they perceive. The coordination of representations that is needed for systematic serial searching with a few hiding places does not typically develop across diverse tasks until around 3 to 4 years of age (Case et al., 1991; Corrigan, 1981; DeLoache, 1986; Fischer & Jennings, 1981).

This research correcting Piaget's overestimation of object-permanence skills in 1- and 2-year-olds grew out of the framework and methods that Piaget established for describing development and inferring knowledge: The essence of any developing capacity is defined by a developmental sequence for a domain, with the capacity becoming gradually more complex, differentiated, and general as the sequence proceeds. A number of neo-Piagetian developmental theories are based on this Piagetian framework for developmental research and explanation (Biggs & Collis, 1982; Case et al., 1991; Fischer, 1980; Flavell, 1982; Siegler, 1981).
CONCLUSION: A NEW VIEW OF INFANCY

Between nature and nurture stands the human agent whose activities and integrative capacities drive the epigenesis of intelligence and organize individual and environmental contributions to development (Bidell & Fischer, 1996). Piaget began the effort to explain human action and thought by starting with a focus on children’s agency and relating that agency to a description of regularities in developmental sequences. His research and theory on infant development provided a powerful beginning for this integration.

Infants gradually construct their skills by acting in context and working to extend their activities across contexts. Only descriptive developmental sequences can capture the reality of their construction of skills and knowledge through activity in context. Infants’ performance along any such sequence varies according to not only task complexity, but also contextual support and priming, supportiveness of the social environment, and, especially for infants, state of arousal. Piaget recognized these many influences, and research building on his insights has supported and elaborated how they function. Optimal behavior can be expected only when infants are in a quiet, alert state, participating in an engaging task, with a familiar adult, in a non-distracting environment, in a body position that facilitates performance. Moreover, for each individual infant, variations in developmental level are routine and pervasive, and they need to be explained, not ignored.

Piaget’s theory and research on infancy have permanently altered the understanding of infant action and thought. Indeed, the field has still not fully assimilated his arguments. Despite certain weaknesses, such as inconsistency in recognition of the importance of environmental conditions in enabling the child to construct his or her reality and an overly universalist emphasis on stages of development, Piaget remains the single most influential developmental theorist and researcher of this century. Psychologist historian Sheldon White (personal communication, November 14, 1990) summed up Piaget’s influence as being due to the fact that his ability to “constantly move back and forth between observations and broader intellectual traditions of discussion of mind and adaptation... above all thinking about the meaning of what he has seen with all his knowledge and intelligence and his influence... has encouraged developmental psychologists to transcend ritualized scientific procedures, to see children more clearly and to think more deeply about what is seen.” Piaget provided a new way of looking at infants and children, and thus guaranteed that his influence will continue well into the next century; for as the variety of articles about Piaget in this issue of Psychological Science demonstrates, “once you’ve been given permission to connect the dots in a different way, you see new constellations in the sky” (McIntosh, 1988, p. 12).

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Piaget and Infancy


Once upon a time, thanks to Jean Piaget, the field of cognitive development had a coherent, interesting, testable, and widely accepted theory. Now, alas, we are back in the preparadigmatic boat with our colleagues in the rest of psychology, with theory fragments, almost-theories, and pseudotheories bobbing about around us. Fortunately, though, we are not doomed to this postapocalyptic chaos forever. In this article, I try to differentiate several distinct possibilities for future theories, though in a necessarily brief and oversimplified way. Most probably, each of these theories will turn out to be true of different aspects of development; I would advocate a kind of developmental pluralism. As in politics, however, being a pluralist does not mean being a wimp. For any particular developmental phenomenon, one theory or another will be true, and we want to know which one it is. So I also try to indicate the ways that developmental evidence could discriminate between these theoretical possibilities.

New theories often spring from the failures of the old theories. Piaget’s thesis that there are broad-ranging, general stages of development seems increasingly implausible. Instead, cognitive development appears to be quite specific to particular domains of knowledge. Moreover, children consistently prove to have certain cognitive abilities at a much earlier age than Piaget proposed, at least in some domains. Also contra Piaget, even newborn infants have rich and abstract representations of some aspects of the world. Moreover, Piaget underestimated the importance of social interaction and language in cognitive development. Finally, Piaget’s account of assimilation and accommodation as the basic constructivist mechanisms now seems too vague.

Some developmentalists have reacted to these failures of the theory by rejecting the whole project of constructivism. Many have returned to one version or another of the classical philosophical alternatives of nativism and empiricism. However, other developmentalists would prefer to revise Piagetian constructivism rather than to replace it.

THEORIES

The most influential contemporary constructivist theory is the theory theory, the idea that cognitive development is the result of the same mechanisms that lead to theory change in science (Carey, 1985, 1988; Gopnik, 1984, 1988; Gopnik & Wellman, 1992, 1994; Karmiloff-Smith & Inhelder, 1974, 1988; Keil, 1989; Perner, 1991; Wellman, 1990; Wellman & Gelman, 1992). One way to think about the theory theory is in terms of the rules and representations of cognitive science. Theories are representations of the world that have particular distinctive features, and they include rules that allow the generation of new representations. Over time, theories change in particularly characteristic ways. The theory theory proposes that these distinctive representations and rules are responsible for at least some kinds of cognitive development and are also responsible for theory changes in science (see Gopnik & Meltzoff, in press; Gopnik & Wellman, 1994).

What are these representations and rules like? Theories are systems of abstract entities and laws that are related to one another in coherent ways. These entities and laws underlie the evidential phenomena they explain, but are quite different from those phenomena. Causal claims are especially important in theories; theories typically appeal to some underlying causal structure that is responsible for the superficial regularities in the data.

These features of theories have a number of functional consequences. A theory makes predictions about a wide variety of evidence, including evidence that played no role in the theory’s initial construction. Theories also produce interpretations of evidence, not simply descriptions of evidence. Finally, and perhaps most distinctively, theories provide explanations of evidence.

There are also characteristic processes involved in the transition from one theory to another. These dynamic processes are where the constructivist character of the theory theory is most obvious. As in Piagetian theory, development proceeds through the interaction between an existing wide-ranging abstract representation (i.e., a theory) and new empirical input. The most significant factor in theory change is the accumulation of counterevidence to the theory. However, initially, the interpretive mechanisms of the theory simply reject or reinterpret the evidence. At a slightly later stage, the theory may develop ad hoc auxiliary hypotheses designed to account specifically for the counterevidence. Such auxiliary hypotheses, however, often appear to undermine the coherence that is one of a theory’s strengths. A next step requires the availability or formulation of some alternative model. Eventually, the old theory is replaced by the new and more adequate theory, and the child generates a new and quite different set of predictions, interpretations, and explanations. Many of these dynamic features of theories are similar to the dynamic mechanisms of Piagetian theory. Thus, the interpretive effects of theories seem much like assimilation, and the processes of falsification and counterevidence, which lead to theory change, are reminiscent of accommodation.

Underlying these particulars, however, is the most important dynamic feature of theory change: Theory change is, ultimately, caused by evidence. The evidence may take the form of explicit falsifications of the predictions of the theory or may be the result of less structured experimental fishing expeditions. Moreover, the causal sequence by which evidence leads to theory change may be very complex and indirect, and is heavily

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Influenced by the nature of the child's earlier theories. Nevertheless, evidence is what makes theories change. Theory theorists point to particular cases in development in which children's rules and representations seem to have these characteristics. The details of theory theory accounts of the development of intuitive biology, physics, and psychology are almost always very different from the classic Piagetian proposals. In particular, theory formation is specific to a particular domain; there is no reason to expect the same underlying logical structures in a 5-year-old's folk psychology and folk physics. Moreover, the theory theory proposes that fundamental capacities for induction and logical and causal reasoning are in place very early, possibly innately, and certainly at a much earlier age than Piaget proposed. However, the general patterns of development that support the theory theory are often rather similar to those Piaget emphasized. Theory theorists point to children's consistent incorrect predictions and to their experimental explorations of evidence, stressing the way that the failure of those predictions leads to change, and detailing the sequence of successively more adequate theories, each going beyond the immediate evidence.

**MODULES**

A more radical alternative to Piagetian theory is the idea that cognitive structures are the consequence of innate modules. According to modularity theories, representations of the world are not constructed from evidence in the course of development. Instead, representations are produced by innate structures, modules, or constraints. These structures may need to be triggered, but if once they are triggered, they create mandatory representations of input (Fodor, 1983).

The classic examples of modularity theories involve perception and syntax. However, similar accounts have also been proposed to explain the origins of other kinds of knowledge. Pinker (1989) proposed a modular account of semantic development; Spelke, Breinlinger, Macomber, and Jacobson (1992) suggested such a model for at least some aspects of our intuitive physics; and Leslie (1988) and Fodor (1992) argued for an innate theory-of-mind module. Spelke et al. (1992) described their account as "neo-Kantian," and this seems an accurate term for this trend in cognitive science, in general. Like Kant, these authors propose that certain particularly important conceptual structures are innately given and cannot be overturned by evidence.

Often, the contrast between modularity accounts and other accounts is phrased in terms of a more general contrast between nativism and empiricism. But this general contrast does not capture the distinction accurately. Although modules are innate, not all innate structures are modular. We can distinguish between two types of nativism, modularity nativism and starting-state nativism (Aston & Gopnik, 1991; Gopnik & Wellman, 1994; Melzoff & Gopnik, 1993). According to the starting-state view, the infant is innately endowed with a particular set of representations of input and rules operating on those representations. However, these initial structures will be defeasible; any part of them could be, and indeed will be, altered by new evidence. This starting-state nativism would be quite compatible with the theory theory. We might think of the initial states as innate theories that may be revised later.

Modularity nativism implies a stronger set of claims. In Fodor's analysis, the representations that are the outcome of modules cannot be overturned by new patterns of evidence. In Chomsky's (1980) theory of syntax acquisition, the existence of an innate universal grammar means that only a very limited set of possible grammars will be developed. It constrains the final form of the grammar in the strong sense that grammars that violate it will never be learned by human beings.

Like theories, modular representations involve abstract entities and rules that are related to sensory input only in very indirect ways. Also like theories, modules allow predictions that go beyond the input. Moreover, modules allow, indeed mandate, the mind to represent input in a particular way. In fact, one of the most interesting and important discoveries of cognitive science is that quite automatized, unconscious, indefeasible representational systems, like the syntactic or perceptual systems, have very complex internal structures that look like the complex structure of an inferential system.

The dynamic features of modules, however, are quite unlike those of theories. In a module, relevant experience can trigger use of a privileged representational system (or not), but the experience does not reshape or reconstruct the privileged representations themselves, or alter future relations between inputs and representations. Modular representations do not lead to predictions because of some set of inductive or deductive generalizations, or through a process of theory testing, confirmation, and disconfirmation. Modular representations lead to predictions because they are designed by evolution to do so.

There is, in principle, a simple experiment that could always discriminate modularity and theory theory accounts. Place some children in a universe that is radically different from our own, keep them healthy and sane for a reasonably long period of time, and see what they come up with. If they come up with representations that are an accurate account of our universe, modularity is right. If they come up with representations that are an accurate account of their universe, the theory theory is right. Unfortunately, given the constraints of the federal budget, not to mention the constraints of conscience, this experiment is impossible. We can, however, try to obtain similar data by looking at patterns of development in this universe.

Modularity theories are, in an important sense, antidevelopmental (see, e.g., Pinker's, 1984, discussion of "the continuity assumption"). These theories receive their strongest support when the conceptual structures we see in infancy and childhood are very similar to those we see in adulthood. This is, of course, quite a different developmental prediction than the prediction of Piagetian theory. According to modularity theories, apparent changes in representation occurring over time can be accounted for only by processes outside the representational system itself.

One possibility is that these changes reflect the maturation of another innate structure, a later module. A second possibility is that changes in information processing ability explain development. This second possibility, however, also implies that development is not the result of internal conceptual changes, as it is in the theory theory, but rather is the result of external and nonconceptual changes in information processing. (For two good recent examples of this sort of argument, see Fodor, 1992, and Marcus et al., 1992). There is also a third way in which
modular systems can account for development. In some theories, there are several alternative branching routes, so to speak, that determine the eventual form the module may take. These are generally described as parameters set by the input (Chomsky, 1986). Parameters allow for a somewhat richer developmental story than one in which a module is simply turned on or off. The relation between input and the setting of the parameter is still, however, a relation of triggering.

**EMPIRICAL GENERALIZATIONS: SCRIPTS, NARRATIVES, AND NETS**

Recently, modular alternatives to constructivism have been more monolithic than empiricist alternatives (indeed, sometimes rather terrifyingly so). Rationalists agree more among themselves than empiricists do. There are a wider variety of accounts of cognitive development that are more in the empiricist tradition. These accounts explain cognition in terms of the accumulation of particular associated pieces of information about the world (what we might call empirical generalizations).

For example, Nelson (1986) has argued that much of the child’s early knowledge is organized into scripts. Similarly, Bruner (1990) suggested that much of our ordinary knowledge is organized in terms of narratives. Scripts or narratives are cognitive structures that are supposed to have some predictive or generalizing force, but they are very different from theories. Rather than organizing knowledge in terms of a relatively small set of theoretical entities and explanatory principles, they organize knowledge more loosely into sequences of events. It is likely that some of our representations of the world have this character. Such a representation consists of a set of relatively narrow and context-bound generalizations about which events typically follow which. For example, there is no theoretical necessity for tooth brushing to precede story time, which in turn precedes bed, or for eating in restaurants to come before paying. Nevertheless, these sequences are things we know, and knowing them enables us to act intelligently.

Scripts and narratives often may depend on implicit theoretical assumptions about causal relations among events. Nevertheless, the cognitive force of these accounts does not stem from their causal or explanatory necessity. As someone once said about history, a narrative is one damn thing after another. Someone who “explains” why her marriage broke up by telling an autobiographical story may draw on implicit causal assumptions, but such an account at least seems different from the theoretical account a social scientist would provide.

These theories propose that children develop by combining primitive representations of events into more complicated ordered structures. This process of combination is often quite context-specific, and factors like familiarity and repetition play an important role.

A rather different empiricist account comes from some psychologists working with connectionist computational models (Bates & Elman, 1993; Clark, 1993; Karmiloff-Smith, 1993) and with dynamic systems models (Thelen & Smith, 1994). There are two aspects to connectionist modeling. Connectionist systems can be thought of as (somewhat) more neurologically realistic implementations of representations and rules than classical architectures are. In principle, though, we could implement all sorts of representations and rules in a connectionist network. More substantively, however, connectionist modelers have suggested that some sorts of representations, and some sorts of representational change, are particularly well suited to these models. In particular, in many connectionist views, knowledge is a distributed collection of quite particular and concrete pieces of information. These views suggest a picture of cognition in which particular inputs are compared and weighted to form a single network. There are no broader and more abstract representations that would correspond to the entities and laws of a theory, or the innate inferential schemes of a module. Rather, connectionist representations are designed to detect patterns in the input to them.

How can we tell when we have an empirical generalization, as opposed to a module or a theory? Like theories, but unlike modules, empirical generalizations (scripts, narratives, and nets) will change as a consequence of new evidence. However, empirical generalizations contrast with both theories and modules on the structural and functional dimensions. Empirical generalization accounts typically do not posit separate representations of abstract entities and laws. Rather, the abstract structures in many connectionist accounts, and in scripts, are seen as implicit in the structure of the data.

Both modularity theory and theory theory are more domain-specific than Piagetian theory. Both propose, however, that within a given domain of knowledge, there will be a substantial amount of stability and generality. Moreover, both propose that when conceptual changes take place, either through maturation or through theory formation, these changes should affect a wide range of behaviors in a consistent way. In contrast, the empiricist theories receive more support when it can be shown that change is highly specific to particular contexts. This pattern is quite different from the classic Piagetian pattern.

**INFORMATION PROCESSING AND SOCIAL CONSTRUCTION**

Piaget cared about children’s development because he wanted to answer epistemological questions. His task was not to explain why children change, but to determine what those changes could tell us about the origins of knowledge. If, like Piaget, we are fundamentally trying to explain how minds come to know the world, it seems to me that our theorizing must include some variant of the theories I have just described. These are the only currently plausible accounts of how we derive substantive, accurate representations of the world from the information of our senses. There are two other plausible accounts which propose mechanisms that can explain other types of development and that might contribute to these more central cognitive engines. They are often called information processing accounts and social constructivist accounts.

**Information Processing**

For Piaget, cognitive development, and cognitive psychology, was fundamentally an attempt to explain how minds come...
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to have veridical representations of the world outside them. However, as Siegler points out (this issue), this view of cognition is, curiously enough, not the dominant view in contemporary research into the cognitive psychology of grown-ups. Rather, much cognitive psychology concerns the ways in which we put representations to use, the ways they are attended to, remembered, used to solve problems, and so on. The common term for this is information processing.

Undoubtedly there are interesting and important questions about how these information processing abilities develop, and there has been some progress in recent years in charting these developments. By itself, however, this enterprise is orthogonal to the Piagetian one. Such work does not typically address the central epistemological question of Piagetian theory; it does not deal with the origins of knowledge, with the relation between the concrete input of our senses and the abstract representations of the world that we end up with.

A more Piagetian application of these ideas comes in proposals that changes in information processing abilities might be responsible for higher level cognitive development. A school that is commonly called neo-Piagetian suggests that the development of hierarchical skills or memory abilities may be responsible for Piagetian phenomena (Case, 1985; Demetriou, Efklides, & Platsidou, 1993; Fischer, 1980; Halford, 1982; Pascual-Leone, 1970). More generally, some theorists have proposed that changes in the child’s ability to meta-represent (Karmiloff-Smith, 1993; Perner, 1991) or to deploy problem-solving strategies (Siegler, 1991) might underlie conceptual changes.

In contrast to the domain-specificity of the accounts I described earlier, some of these information processing approaches preserve some of the Piagetian ideas of general stage changes. These approaches, however, interpret these general stage changes by considering the general properties of the child’s information processing system (e.g., how many elements the child can hold in memory, or how many levels of representation the child can embed) rather than by focusing on the content of the child’s particular beliefs about the world.

Perhaps because of an interesting ambiguity in Piaget’s work, both some of what one might call content-based theories, like the theory theory, and some of the more structure-based information processing theories lay claim to the Piagetian inheritance. Piaget thought that the best way of describing the child’s knowledge was in terms of its logical structure and that changes in that logic led to changes in development. Logical structures are interesting because they exactly straddle the line between the content of thought and the structure of thought. We can think of logical truths as abstract beliefs, things we know about the world. Or we can think of them as rules of thought, procedures we use for getting from one representation to another. Few contemporary theories give logic the central role it had for Piaget. However, construing Piaget in the first way leads to views like the theory theory, whereas construing Piaget in the second way might lead to a more information-processing-like view.

The relation between information processing changes and conceptual changes in childhood may be analogous to the relation between technological changes and theory changes in science. Technological innovations, by themselves, are notori-ously inadequate for scientific progress. Buying a telescope does not make you Galileo. Nevertheless, we might argue that without the telescope, Galileo’s advances in astronomy could not have been made. Technological advances enable us to gather new types of evidence or perform new types of calculations that we were unable to perform before. In the same way that technological advances enable or facilitate change in science, information processing advances might enable or facilitate genuine conceptual change in children.

Social Construction

A similar argument applies to the role of social interaction in cognitive development. A number of theorists have argued for a much more central role for social interaction in cognitive development than Piaget proposed (e.g., Bruner, 1990; Rogoff, 1990). Here the analogy to science is even more evident. At least for realists, social interaction by itself cannot be a mechanism for cognitive change in science. Science gets us closer to the truth, but social interaction, by itself, can as easily lead to the internalization of radically false conceptions of the world as of true ones. However, social interactions could be important enabling (or disabling) conditions in the development of a scientific theory.

Social interactions might play a similar role in development. Such interactions, by themselves, cannot answer Piaget’s fundamental epistemological question. Nevertheless, they may play an important, even crucial, contributing role in answering that question. We can imagine many ways in which participation in a social community might enable or facilitate other mechanisms of conceptual change. As in science, social interaction may be particularly important as a way of gathering evidence. Other people might structure the child’s life in such a way that particular kinds of evidence are particularly salient. A child who plays with mixing bowls will be gathering evidence about different sorts of phenomena than a child who plays with toy spears and arrows.

Adults may also use linguistic devices to draw the child’s attention to particular phenomena. Although parents, unlike scientists and professors, do not lecture, they do talk, and that talk embodies their own implicit conceptions of the world. Changes and differences in that talk can have important consequences for children’s cognitive development.

As in the case of science, however, social interaction, by itself, cannot produce genuine conceptual change, any more than merely attending our lectures can, alas, instill an understanding of cognitive development in our students. All such interactions can do is to provide information to some other cognitive mechanism.

Of course, there are areas of development in which social interaction plays a much more central role than this. In arenas where there is no fact of the matter, children may indeed develop by simply internalizing the structures that are provided to them by the people around them. There are a wide variety of distinctively human normative and conventional practices for which there is no fact of the matter; there is simply a way that people behave. Learning those practices involves a very com-
plicated and interesting developmental process of socialization. Moreover, there are some domains, such as theory-of-mind understanding, in which the line between cognition and socialization may sometimes be quite difficult to draw. Do we learn that people fall in love, or how to fall in love?

Assimilating all of cognitive development to the model of socialization, however, seems to be a mistake. It is the same mistake that currently haunts the humanities in the guise of postmodernism. The fact that social interaction plays a role in cognition does not mean that cognition is nothing but social interaction. This view leaves out a centrally important part of cognitive development, which is that it enables us to get at the truth about the outside world.

CONCLUSION

Piaget explored the same classic epistemological dilemmas and quandaries that had engaged thinkers from Socrates to Kant. His greatest contribution, and his most enduring legacy, is the idea that these grand questions can actually be answered by paying attention to the small details of the daily lives of our children. However confusing and depressing our current theoretical interregnum may sometimes seem, we should take heart from the continued beauty and fertility of this central insight, and give thanks to the mind that conceived it.

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