Special Section

INFANTS' CONSTRUCTION OF ACTIONS IN CONTEXT: Piaget's Contribution to Research on Early Development

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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, Raijmakers, & Hartelman, 1994; Reed, 1993; van Geert, 1994; Whiting & Edwards, 1988). An infant is an agent-in-an-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-an-environment, creating his theories from the combination of his own schemes and information from his environment, both personal and historical.

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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* (1936/

1952), *The Construction of Reality in the Child* (1937/1954), and *Play, Dreams, and Imitation in Childhood* (titled in French *The Formation of the Symbol in the Child;* 1945/1951). Most psychologists tend to think of these writings in terms of the stages of development that they describe. In an autobiographical note, however, Piaget (1952) later described the main benefit of these studies as teaching him "in the most direct way how intellectual operations are prepared for by sensorimotor action, even before the appearance of language" (p. 249).

These two distinct framings of the infancy work are key to understanding both the Piagets' contributions to the field and the controversies that have swirled around their work. Besides the stages, Piaget also characterized how the infant builds new structures of action and knowledge through circular reactions in which the baby repeatedly tries out an action with some particular object in a context, learns how to control the action in that context, and then works to generalize it to other contexts. This second constructive mechanism of assimilation and accommodation through circular reaction is typically neglected in serious research, although it is cited in many introductory textbooks on development. Figure 1 illustrates the collaborative, reciprocal roles of person and object that were postulated by Piaget.

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.

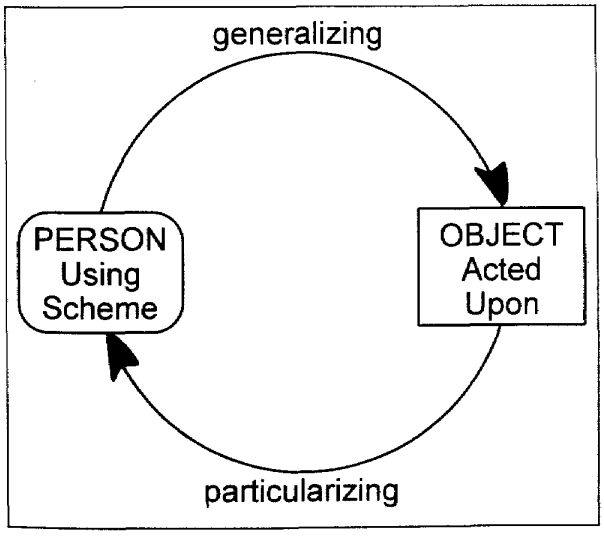

Fig. 1. Piaget's circle of knowledge as adapted activity. Piaget referred to the generalizing effect of a scheme as assimilation and to the particularizing effect of an object or event as accommodation.

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

programming (Baillargeon, 1993; Carey & Gelman, 1991; Spelke, 1988).

INFANT-IN-CONTEXT: INTEGRATING THE TWO VIEWS

Piaget's goal, however, was to integrate the two views, to bring together child and environment into a single framework (Piaget, 1936/1952, 1947/1950). His descriptions often moved back and forth between action schemes and developmental stages, attempting to further the integration. In our view, his work has led to major advances in integrating stage descriptions with the agency of the child-in-context.

A child develops simultaneously along many partly independent pathways forming a developmental web, as shown in Figure 2. Each pathway or strand in the web represents a distinct domain defined by a set of contexts and goals, which mold the child's developing actions. Piaget described a number of these pathways, including object permanence, means-end causality, and vocal imitation. Other researchers, especially Uzgiris and Hunt (1975), built strong standardized measures of these pathways, thus providing effective rulers for assessing infant development and testing Piaget's concepts. Based on this extensive research, many scholars have argued that a child's level or "stage" of development varies powerfully according to both organismic and environmental conditions, including assessment context, task, and, for infants especially, the arousal state of the child (Feldman, 1980; Fischer, 1980; Flavell, 1982; Hunt, Mohandessi, Ghodssi, & Akiyama, 1976; Rogoff, 1990). Research focusing on that variability has helped to move the field toward the integration that Piaget sought.

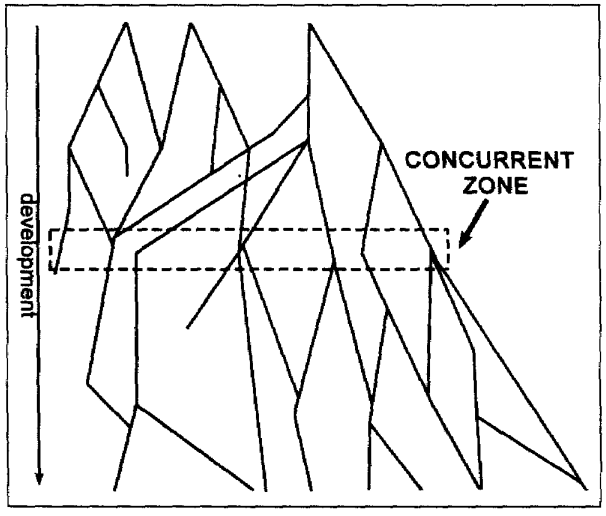

Fig. 2. Developmental web showing a cluster of discontinuities across strands/domains. Discontinuities in development are indicated by branching, joining of strands, and changes in direction. Discontinuities commonly cluster across strands in a stagelike period called a concurrent zone, an example of which is shown by the box.

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—groping 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 bedcover 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. Not finding 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.

Piaget and Infancy

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 still 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 spurts (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 perseverance 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 nondistracting 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. Psychological 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).

Acknowledgments—We thank Thomas Bidell, Gil Noam, Claes von Hofsten, and Sheldon White for their contributions to the arguments presented here. The work on which this article is based was supported by grants from the Rose Foundation, the Spencer Foundation, the National Institute of Mental Health, and Harvard University.

REFERENCES

Baillargeon, R. (1993). The object concept revisited: New directions in the investigation of infants' physical knowledge. In C. Granrud (Ed.), *Visual perception and cognition in infancy* (pp. 317–332). Hillsdale, NJ: Erlbaum.

Baldwin, J.M. (1894). *Mental development in the child and the race*. New York: MacMillan.

Bell, M.A., & Fox, N.A. (1992). The relations between frontal brain electrical activity and cognitive development during infancy. *Child Development, 63*, 1142–1163.

Bell, M.A., & Fox, N.A. (1994). Brain development over the first year of life: Relations between EEG frequency and coherence and cognitive and affective behaviors. In G. Dawson & K.W. Fischer (Eds.), *Human behavior and the developing brain* (pp. 314–345). New York: Guilford Press.

Bertenthal, B.I., & Fischer, K.W. (1983). The development of representation in search: A social-cognitive analysis. *Child Development, 54*, 846–857.

Bidell, T.R., & Fischer, K.W. (1996). Between nature and nurture: The role of human agency in the epigenesis of intelligence. In R. Sternberg & E. Grigorenko (Eds.), *Intelligence: Heredity and environment*. Cambridge, England: Cambridge University Press.

Biggs, J., & Collis, K. (1982). *Evaluating the quality of learning: The SOLO taxonomy (structure of the observed learning outcome)*. New York: Academic Press.

Bronfenbrenner, U. (1993). The ecology of cognitive development: Research models and fugitive findings. In R.H. Wozniak & K.W. Fischer (Eds.), *Development in context: Acting and thinking in specific environments* (pp. 3–44). Hillsdale, NJ: Erlbaum.

Cahan, E. (1984). The genetic epistemologies of James Mark Baldwin and Jean Piaget. *Developmental Psychology, 20*, 128–135.

Carey, S. (1985). *Conceptual change in childhood*. Cambridge, MA: MIT Press.

Carey, S., & Gelman, R. (Eds.). (1991). *The epigenesis of mind: Essays on biology and knowledge*. Hillsdale, NJ: Erlbaum.

Case, R., Bruchkowsky, M., Capodilupo, A.M., Crammond, J., Dennis, S., Fiati, T.A., Goldberg-Reitman, J., Griffin, S., Marini, Z., McKeough, A., Okamoto, Y., Porath, M., Reid, D.T., & Sandieson, R. (1991). *The mind's staircase: Exploring the conceptual underpinnings of children's thought and knowledge*. Hillsdale, NJ: Erlbaum.

Case, R., & Edelstein, W. (Eds.). (1993). The new structuralism in cognitive development: Theory and research on individual pathways. *Contributions to Human Development, 23*.

Case, R., & Griffin, S. (1989). Child cognitive development: The role of central conceptual structure in the development of scientific and social thought. In C.A. Hauert (Ed.), *Advances in psychology: Developmental psychology* (pp. 193–230). Amsterdam: Elsevier/North Holland.

Chapman, M. (1988). *Constructive evolution*. New York: Cambridge University Press.

Chess, S., & Thomas, A. (1987). *Know your child: An authoritative guide for parents*. New York: Basic Books.

Corrigan, R. (1981). The effects of task and practice on search for invisibly displaced objects. *Developmental Review, 1*, 1–17.

Corrigan, R. (1983). The development of representational skills. In K.W. Fischer (Ed.), Levels and transitions in children's development. *New Directions for Child Development, 21*, 51–64.

Corrigan, R., & Fischer, K.W. (1985). Controlling sources of variation in search tasks: A skill theory approach. In H. Wellman (Ed.), *Children's searching: The development of search skill and spatial representation* (pp. 287–318). Hillsdale, NJ: Erlbaum.

Darwin, C., & Darwin, F. (1887). *The life and letters of Charles Darwin, including an autobiographical chapter*. London: John Murray.

DeLoache, J.S. (1986). Memory in very young children: Exploitation of cues to the location of a hidden object. *Cognitive Development, 1*, 123–137.

Diamond, A. (1991). Neuropsychological insights into the meaning of object concept development. In S. Carey & R. Gelman (Eds.), *The epigenesis of mind: Essays on biology and knowledge* (pp. 67–110). Hillsdale, NJ: Erlbaum.

Elman, J.L. (1991). Incremental learning, or the importance of starting small. In *Proceedings of the Thirteenth Annual Conference of the Cognitive Science Society* (pp. 443–448). Hillsdale, NJ: Erlbaum.

Feldman, D.H. (1980). *Beyond universals in cognitive development*. Norwood, NJ: Ablex.

Fischer, K.W. (1980). A theory of cognitive development: The control and construction of hierarchies of skills. *Psychological Review, 87*, 477–531.

Fischer, K.W., Bullock, D., Rotenberg, E.J., & Raya, P. (1993). The dynamics of competence: How context contributes directly to skill. In R.H. Wozniak & K.W. Fischer (Eds.), *Development in context: Acting and thinking in specific environments* (pp. 93–117). Hillsdale, NJ: Erlbaum.

Fischer, K.W., & Hogan, A. (1989). The big picture for infant development: Levels and variations. In J. Lockman & N. Hazen (Eds.), *Action in social context: Perspectives on early development* (pp. 275–305). New York: Plenum Press.

Fischer, K.W., & Jennings, S. (1981). The emergence of representation in search. *Developmental Review, 1,* 18–30.

Flavell, J. (1982). On cognitive development. *Child Development, 53,* 1–10.

Gardner, H. (1983). *Frames of mind: The theory of multiple intelligences.* New York: Basic Books.

Gesell, A. (1928). *Infancy and human growth.* New York: MacMillan.

Gibson, J.J. (1979). *The ecological approach to visual perception.* Boston: Houghton-Mifflin.

Haith, M.M. (1980). *Rules newborns look by.* Hillsdale, NJ: Erlbaum.

Hunt, J.M., Mohandessi, K., Ghodssi, M., & Akiyama, M. (1976). The psychological development of orphanage-reared infants: Interventions with outcomes (Tehran). *Genetic Psychology Monographs, 94,* 177–226.

Jackson, E., Campos, J.J., & Fischer, K.W. (1978). The question of decalage between object permanence and person permanence. *Developmental Psychology, 14,* 1–10.

Keil, F.C. (1986). On the structure-dependent nature of stages of cognitive development. In I. Levin (Ed.), *Stage and structure: Reopening the debate* (pp. 144–163). Norwood, NJ: Ablex.

Locke, J. (1794). *An abridgment of Mr. Locke's essay concerning human understanding.* Boston: Manning and Loring.

Mareschal, D., Plunkett, K., & Harris, P. (1995). Developing object permanence: A connectionist model. In J.D. Moore & J.F. Lehman (Eds.), *Proceedings of the Seventeenth Annual Conference of the Cognitive Science Society* (pp. 1–6). Mahwah, NJ: Erlbaum.

McCall, R.B., Eichorn, D.H., & Hogarty, P.S. (1977). Transitions in early mental development. *Monographs of the Society for Research in Child Development, 42*(3, Serial No. 171).

McIntosh, P. (1988). Lost one soul. In I. Linthwaite (Ed.), *Ain't I a woman?* (p. 12). New York: Bedrock Books.

Molenaar, P.C.M., Raijmakers, M.E.J., & Hartelman, P. (1994, June). *Some extensions of the paradigm for non-linear epigenetic process.* Paper presented at the Twenty-Fourth Annual Symposium of the Jean Piaget Society, Chicago.

Noam, G.G. (1990). Beyond Freud and Piaget: Biographical worlds—Interpersonal self. In T.E. Wren (Ed.), *The moral domain* (pp. 360–399). Cambridge, MA: MIT Press.

Piaget, J. (1950). *The psychology of intelligence* (M. Piercy & D.E. Berlyne, Trans.). London: Routledge & Kegan Paul. (Original work published 1947)

Piaget, J. (1951). *Play, dreams, and imitation in childhood* (C. Gattegno & F.M. Hodgson, Trans.). New York: Norton. (Original work published 1945)

Piaget, J. (1952). Autobiography. In E.G. Boring, H. Werner, H.S. Langfeld, & R.M. Yerkes (Eds.), *A history of psychology in autobiography* (Vol. IV, pp. 237–256). Worcester, MA: Clark University Press.

Piaget, J. (1952). *The origins of intelligence in children* (M. Cook, Trans.). New York: International Universities Press. (Original work published 1936)

Piaget, J. (1954). *The construction of reality in the child* (M. Cook, Trans.). New York: Basic Books. (Original work published 1937)

Piaget, J. (1977). The first year of life of the child. In H.E. Gruber & J.J. Vonèche (Eds. and Trans.), *The essential Piaget: An interpretative reference and guide* (pp. 198–214). New York: Basic Books. (Original work published 1927)

Piaget, J. (1983). Piaget's theory. In P.H. Mussen (Series Ed.) and W. Kessen (Vol. Ed.), *Handbook of child psychology: Vol. 1. History, theory, and methods* (pp. 103–126). New York: Wiley.

Reed, E. (1993). The intention to use a specific affordance: A conceptual framework for psychology. In R.H. Wozniak & K.W. Fischer (Eds.), *Development in context: Acting and thinking in specific environments* (pp. 45–76). Hillsdale, NJ: Erlbaum.

Rogoff, B. (1990). *Apprenticeship in thinking: Cognitive development in social context.* New York: Oxford University Press.

Rumelhart, D.E., & McClelland, J.L. (1986). On learning the past tenses of English verbs. In D.E. Rumelhart & J.L. McClelland (Eds.), *Parallel distributed processing* (Vol. 2, pp. 216–271). Cambridge, MA: MIT Press.

Sameroff, A.J., & Chandler, M. (1975). Reproductive risk and the continuum of caretaking casualty. In F.D. Horowitz (Ed.), *Review of child development research* (Vol. 4, pp. 187–244). Chicago: University of Chicago Press.

Siegler, R.S. (1981). Developmental sequences within and between concepts. *Monographs of the Society for Research in Child Development, 46*(2, Serial No. 189).

Spelke, E.S. (1988). Where perceiving ends and thinking begins: The apprehension of objects in infancy. In A. Yonas (Ed.), *Perceptual development in infants* (Minnesota Symposia on Child Psychology, Vol. 20, pp. 191–234). Hillsdale, NJ: Erlbaum.

Uzgiris, I.C. (1976). Organization of sensorimotor intelligence. In M. Lewis (Ed.), *Origins of intelligence: Infancy and early childhood* (pp. 143–163). New York: Plenum Press.

Uzgiris, I.C., & Hunt, J.M.V. (1975). *Assessment in infancy: Ordinal scales of psychological development.* Urbana: University of Illinois Press.

van Geert, P. (1994). *Dynamic systems of development: Change between complexity and chaos.* London: Harvester Wheatsheaf.

von Hofsten, C. (1984). Developmental changes in the organization of prereaching movements. *Developmental Psychology, 20,* 378–388.

Watson, J.B. (1925). What the nursery has to say about instincts. In C. Murchison (Ed.), *Psychologies of 1925* (pp. 1–22). Worcester, MA: Clark University.

Watson, J.B. (1928). *Psychological care of infant and child.* London: Allen & Unwin.

Whiting, B.B., & Edwards, C.P. (1988). *Children of different worlds: The formation of social behavior.* Cambridge, MA: Harvard University Press.