

## Methodological and Epistemological Issues in the Interpretation of Infant Cognitive Development

Ulrich Müller and Gerald Giesbrecht

*University of Victoria*

This commentary on J. Kagan (2008) addresses 2 issues. The first concerns the importance of studying developmental sequences and processes of change. The second concerns epistemological differences between contemporary neonativist approaches and classical theories of development. The commentary argues that classical theories of infant cognition and contemporary neonativist theories fundamentally differ in terms of how they conceptualize the workings of the mind. These differences affect the meaning of terms such as representation and reasoning. Also discussed are implications of epistemological differences for developmental explanations. The commentary concludes that epistemological differences must be articulated more fully in order to improve understanding of different theories and in order to evaluate the relative merits and shortcomings of those theories.

Kagan (2008) joins the chorus of recent critics who have argued that the rich interpretation of infant looking-time data is not warranted (e.g., Bremner & Mareschal, 2004; Cohen & Cashon, 2006; Newcombe, 2002; Rakison, 2007). Kagan challenges the rich interpretation of looking-time data on two grounds. First, he points out that the evidential basis for a rich interpretation is not as clear cut as one might wish. This is due to methodological problems with the interpretation of looking time data as well as the fact that conclusions about infant cognition rest on looking-time data only. To put the interpretation of findings on more solid ground, Kagan makes valuable suggestions regarding the use of a greater variety of measures in studies of infant cognition. The second challenge follows from the epistemological distinction between different knowing levels. Kagan distinguishes between a perceptual-sensorimotor level of knowing (“schemata”) and a conceptual level of knowing (“semantic form”). He argues that findings generated in the looking-time (i.e., violation of expectation) paradigm do not require a rich interpretation but are consistent with a perceptual-level explanation. Kagan provides numerous excellent examples that we think convincingly drive this message home.

In our commentary, we address two issues. The first issue concerns the importance of studying developmental sequences and processes of change. The second issue concerns some epistemological differences between contemporary neonativist approaches

and classical theories of development. We are skeptical that methodological refinements alone will settle the issue concerning the interpretation of findings from looking time experiments (and of infant cognition in general). This is because theories operate within different epistemological frameworks that make different assumptions about the workings of the mind. We will draw mostly on work by Baillargeon (on the neonativist side) and Piaget (on the classical side) to highlight these differences, but we could as well have used other theorists such as, on the one hand, Wynn and Leslie, and on the other hand, Baldwin, Stern, Werner, and Vygotsky.

### **The Importance of Studying Developmental Sequences and Processes of Change**

An important point raised by Kagan (2008; see also Werner, 1957) is that similar behaviors and performances may be mediated by different cognitive operations or mechanisms. Despite similarities in performance over time, the underlying process by which outcomes are achieved may vary dramatically (Siegler, 1995), and these variations are indicative of similarities and differences in the cognitive abilities at different developmental levels. One way of disambiguating the cognitive basis of infants’ performance is to place the performance at earlier developmental levels in the context of an extended developmental sequence and to interpret the initial steps in this sequence in the light of the last steps. Piaget terms

---

We would like to thank Jeremy Carpendale for helpful comments on an earlier draft of this article.

Correspondence concerning this article should be addressed to Ulrich Müller, Department of Psychology, University of Victoria, PO Box 3050 STN CSC, Victoria, BC, Canada V8W 3P5. Electronic mail may be sent to [umueller@uvic.ca](mailto:umueller@uvic.ca).

© 2008, Copyright the Author(s)  
Journal Compilation © 2008, Society for Research in Child Development, Inc.  
All rights reserved. 0009-3920/2008/7906-0008

this the method of recurrence, which consists “in extending in the opposite direction the lines of the genetic process revealed by the study of the last stages. The ground for interpretations relating to the point of departure of a concept can only be shown a posteriori by the probability of the explanation based on the total evolution of that concept” (Piaget, 1937/1954, p. 221).

Studies of developmental sequences assist in determining whether a particular behavior at an earlier point in time is a precursor or prerequisite of behavior at a later point (Campbell & Richie, 1983). Furthermore, by designing studies of developmental sequences in a way that captures the processes involved in the transformation of abilities over time, constraints can be placed on the interpretation of the cognitive basis of behavior because understanding the mechanisms of change helps in determining the cognitive organization that characterizes behavior at different levels of development.

### **Epistemological Issues: It Is Not Just About What Is Innate Versus Learned**

Neonativists (Baillargeon, 2008; Spelke, 1998) place their findings in the context of long-standing controversy between rationalism and empiricism. We are told that rationalist philosophers such as Descartes and Leibniz endorsed innate ideas, whereas empiricist philosophers such as Locke, Hume, and Mill rejected innate ideas and explained the acquisition of knowledge in terms of experience and domain-general processes operating on experience (Baillargeon, 2008). Contemporary findings are then claimed to shed light on this old epistemological controversy (Spelke, 1998). Leaving aside the issue that the epistemological controversy concerns the sources and techniques by means of which claims to knowledge are to be justified (which is a matter quite different from identifying the developmental origins of knowledge), a more careful reading of these philosophers suggests that their claims about innate ideas are more complex and cannot that easily be divided along the lines of nativism versus learning (Gorham, 2002; Greenlee, 1972; Saville, 1972). For example, Locke’s theory of language does not refute innate ideas and is, in terms of theoretical assumptions, surprisingly similar to Pinker’s theory of language (Proudfoot, in press). Overlooked in the fixation on the innate versus learning issue are deeper epistemological differences in terms of how the working of the mind is conceptualized in different theories. Next, we briefly illustrate some of these differences and show how they

affect the meaning of terms such as representation and reasoning. Finally, we suggest that these epistemological differences have implications for (a) what different theories consider to be in need of explanation and (b) what form such explanations should take (Overton, 2006; Samuels, 2002).

Contemporary neonativism is based on a causal representational or mechanist theory of meaning, which itself is rooted in the empiricist tradition (Goldberg, 1991; McDonough, 1989). According to such theories, meaning and behavior are explained through internal representations that mediate between input and output. These representations are causally produced by input (e.g., perceptual information) and, in turn, effect some output (e.g., bodily movements). One’s mental contents, or ideas, are just the effects of stimuli external to the mind and the mechanical operations or computations triggered by those stimuli. In this sense, these representations are not intentional, and there is no active agent producing them. Representations become entities that take on a life of their own. As a result, the “person as agent becomes superfluous” (Judge, 1985, p. 51).

Arguably, Baillargeon’s (2008) account of infants’ physical reasoning instantiates a causal (empiricist) representational theory of meaning. According to Baillargeon, infants are born with the principle of persistence. This principle holds that “objects persist, as they are, in time and space” (Baillargeon, 2008, p. 3). This principle is part of a physical reasoning system, which is characterized “as an abstract computational system designed to monitor events as they unfold and to interpret and predict their outcomes” (Baillargeon, 2008, p. 3). When infants observe a pertinent event, the physical reasoning system is activated and it builds a representation of the event. For example, “while watching a red ball being alternately lowered behind and lifted above a screen, infants would represent the information ‘inert closed object being alternately lowered behind and lifted above inert closed object’” (Baillargeon, 2008, p. 4). The representation becomes enriched as, with experience, infants include—through a process of association—more and more information in the representation of the event.

Baillargeon’s account of the development of physical reasoning exemplifies a causal representational theory of meaning because the representations of events are triggered by some input and run through some computations that are performed by the physical reasoning system, which then produces an output (e.g., increased attention to the physically impossible event). The representations are unintentional in the same way as, say, the patellar reflex: It is not the infant who is doing the reasoning but some device inside the

infant's head computes the representation. The computation and representation are happening to the infant; the infant is herself passive. For that reason, it is somewhat a misnomer to speak in this instance of "infant reasoning" because these processes are subpersonal and performed by some device, as Baillargeon (2004, p. 422) explicitly states: "It seems very unlikely that infants possess explicit beliefs about anything. What they do possess is an abstract computational system, a physical reasoning system that monitors physical events and flags those that do not unfold as expected for further scrutiny." In this sense, these processes might also be likened to, for example, computational processes that are performed by the visual system to achieve perceptual constancies.

To highlight the importance of epistemological frameworks, let us contrast Baillargeon's empiricist theory with Piaget's constructivist sensorimotor theory. Somewhat ironically, Baillargeon (2008) classifies Piaget as an empiricist, even though Piaget's critical stance toward empiricist theories should be well known (Piaget & Inhelder, 1969). For Piaget (1936/1963), the basic functions with which the infant interacts with the world are assimilation and accommodation. Piaget's notion of assimilation, at the psychological level, particularly highlights the active, intentional nature of the mind. Specifically, assimilatory schemes (e.g., grasping, pushing) comprise a need and are directed toward specific goals; that is, they refer to the particular elements or objects toward which human activity, and consciousness more specifically, is directed. By assimilating objects to preexisting behavioral or cognitive schemes, the individual confers some kind of meaning on these, whether it be simply of a functional sort or (later on) more abstract in nature. Accommodation, on the other hand, is the aspect of the activity that provides the particular content for assimilation. Piaget holds that by accommodating to the environment, an organism's existing schemes are differentiated and modified. To illustrate, by assimilating different objects to the grasping scheme, these objects acquire the functional meaning "graspable" while at the same time, the infant learns to adjust her grasp to the specifics of different objects (accommodation). Meaning is created by the infant casting a web of intentionality onto the world. In fact, Piaget's action-based approach to knowledge acquisition and the working of the mind was designed to overcome the problems inherent in empiricist causal representational theories of mind such as Baillargeon's (see Bickhard, 1999; Bickhard & Terveen, 1995).

Even our necessarily cursory discussion of this matter should make it clear that there are fundamen-

tal differences in the way in which contemporary neonativist theories (exemplified by Baillargeon's theory) and classical approaches (exemplified here by Piaget's theory) conceptualize the working of the mind. Basically, in the tradition of empiricist causal representational theories, Baillargeon's theory conceptualizes the mind as passive and nonintentional, whereas Piaget's theory conceptualizes the mind as active and intentional (for a more detailed treatment, see Müller & Newman, 2008; Müller, Sokol, & Overton, 1998).

It is not surprising that, given these different epistemological frameworks, the same terms take on different meanings in Baillargeon's and Piaget's theories. Whereas for Baillargeon, representation is the effect of some input, this cannot be the case for Piaget. Furthermore, Piaget (1936/1963, pp. 242–243) distinguishes between two different meanings of representation. In one meaning, Piaget (1936/1963, p. 242) refers to representation as nonsymbolic meaning. This type of representation is evident in "the capacity to confer upon things a meaning before the action which this meaning permits. . . . The act of looking under a shawl for a shoe in order to strike it with a piece of wood (Obs. 129) is the prototype of this behavior pattern." Representation in the sense of nonsymbolic meaning is thus evident in anticipation, but nonsymbolic meaning can be traced back to the very beginning of mental life (Piaget, 1936/1963, p. 38).

In the second meaning, representation refers to the capacity to use symbols and signs to evoke an absent object. To our knowledge, neonativist have not yet spelled out whether the representations their experiments unveil are located at the level of nonsymbolic meanings or symbolic-representational meanings. Part of the reason for this is, we suspect, that Piaget's and neonativist theories operate with fundamentally different concepts of representation, whereas within Piaget's theory, it makes sense to distinguish between nonsymbolic and symbolic-representational meaning, this distinction does not make much sense when representation is conceived as an operation of a computational device.

Reasoning is another term that takes on a very different meaning in Baillargeon's and Piaget's theories. As we have seen, for Baillargeon (2008) reasoning is a subpersonal process that runs off in a computational device. Piaget (1936/1963, pp. 239–240, 267–268), too, wrote about reasoning in infancy. Specifically, he drew a functional analogy between particular sensorimotor action patterns that subordinate one scheme as means (e.g., pushing away an obstacle) to another scheme (e.g., grasping an object) as end and the

subordination of premises to conclusions at the level of verbal intelligence.

Piaget thus ascribes reasoning to infants when their actions put objects into a hierarchical relation. For Piaget, sensorimotor “reasoning” is thus not a sub-personal process but rather indicated by a certain level of complexity of infants’ actions in pursuit of their goals. Of course, it should be noted that for Piaget (1936/1963, p. 240; 1947/1950, pp. 220–223), sensorimotor reasoning is qualitatively different from reasoning on the symbolic, reflective plane. In fact, Piaget uses some of the same criteria to distinguish practical sensorimotor intelligence from reflective, symbolic intelligence as Kagan does for demarcating schematic knowledge and semantic-conceptual knowledge.

Epistemological frameworks have implications for the types of things that different theories consider to be in need of explanation. In Baillargeon’s theory, the infant is essentially a spectator, or “couch potato,” as Willatts (1997) termed it, who takes a reflective, contemplative attitude to the events she is presented with, reasons about them, and searches for explanations of unexpected events (Baillargeon, 2008). What Baillargeon’s (2008) theory aims to explain, then, is how infants initially impoverished representations become gradually richer. Baillargeon’s view of the infant differs markedly from that of classical theories, which argue that the contemplative attitude is secondary and develops out of a pragmatic, unreflective attitude. Objects are originally perceived as *things of action* (Werner & Kaplan, 1963): They are imbued with affect, closely tied to the current situation and the satisfaction of immediate needs. As a result, classical theories of development aim at explaining how the infant gradually comes to distance herself and detach meaning from the immediate situation such that the infant is no longer dominated by immediate impressions and impulses (Piaget, 1936/1963; Vygotsky, 1933/1978; Werner & Kaplan, 1963). This notion of distancing is nicely captured in the following remarks by Gehlen (1940/1988):

The things in our world thus have the essentially human character of *acquired neutrality*. This is not the indifference toward anything that does not appeal directly to instincts, as is the case in the environments of the higher animals. In contrast, the things around us are thoroughly known and “worked through,” but remain “undecided” for the most part, available for interaction at any time. This is how man masters the overwhelming barrage of impressions, this is how he obtains relief: He *actively “checkmates” the forcefulness of the*

*world’s impressions, making the world potentially available at any time.* (pp. 162–163, emphases in original)

It is difficult to see how the notion of distancing could have a place in Baillargeon’s theory. Given that representations are computed and interpreted by a physical reasoning system, there is no place for a distancing process. The objectivity of the world is built into the modular device and, as such, vanishes.

Finally, it should come as no surprise that epistemological differences affect the form that explanations take in different theories (for a detailed discussion, see Overton, 2006). Although in Baillargeon’s (2008) theory, explanations invoke quantitative changes in the efficiency of computations and the type of information that is processed, classical theories (e.g., Piaget, 1936/1963; Werner, 1957) invoke processes such as differentiation and integration as explanations of the distancing processes.

## Conclusions

Kagan makes numerous excellent points and provides several excellent suggestions that, if heeded, will undoubtedly help provide the field of infancy research with a better evidential basis. However, we are skeptical that the controversy over the interpretations of empirical findings on infant cognition will be settled by more methodological sophistication alone. In fact, it is not clear to us that the distinction between different knowing levels suggested by Kagan could even be meaningfully applied to the computational devices outlined in neonativist theories. Furthermore, deeper lying epistemological differences color the meaning of the terms being used, the goal of the explanations, and the very types of explanations thought. We believe that more effort must be put into articulating these epistemological differences. Only in this way will it be apparent that terms (e.g., representation) have meanings in one theory that are very different from their meanings in another theory. Eventually, such effort will also help us to better understand and evaluate the merits and shortcomings of different theories.

## References

- Baillargeon, R. (2004). Can 12 large clowns fit in a Mini Cooper? Or when are beliefs and reasoning explicit and conscious? *Developmental Science*, 7, 422–424.
- Baillargeon, R. (2008). Innate ideas revisited: For a principle of persistence in infants’ physical reasoning. *Perspectives on Psychological Science*, 3, 2–12.

- Bickhard, M. H. (1999). Interaction and representation. *Theory and Psychology, 9*, 435–458.
- Bickhard, M. H., & Terveen, L. (1995). *Foundation issues in artificial intelligence and cognitive science: Impasse and solution*. Amsterdam, Netherlands: Elsevier.
- Bremner, A. J., & Mareschal, D. (2004). Reasoning . . . what reasoning? *Developmental Science, 7*, 419–421.
- Campbell, R. L., & Richie, D. M. (1983). Problems in the theory of developmental sequences: Prerequisites and precursors. *Human Development, 26*, 156–172.
- Cohen, L. B., & Cashon, K. H. (2006). Infant cognition. In W. Damon & R. Lerner (Series Eds.) & D. Kuhn & R. Siegler (Vol. Eds.), *Handbook of child psychology: Vol. 2. Cognition, perception, and language* (6th ed., pp. 214–251). New York: Wiley.
- Gehlen, A. (1988). *Man, his nature and place in the world*. New York: Columbia University Press. (Original work published 1940)
- Goldberg, B. (1991). Mechanism and meaning. In J. Hyman (Ed.), *Investigating psychology* (pp. 48–66). London: Routledge.
- Gorham, G. (2002). Descartes on the innateness of all ideas. *Canadian Journal of Philosophy, 32*, 355–388.
- Greenlee, D. (1972). Locke and the controversy over innate ideas. *Journal of the History of Ideas, 33*, 251–264.
- Judge, B. (1985). *Thinking about things: A philosophical study of representation*. Edinburgh, Scotland: Scottish Academic Press.
- Kagan, J. (2008). In defense of qualitative changes in development. *Child Development, 79*, 1606–1624.
- McDonough, R. (1989). Towards a non-mechanistic theory of meaning. *Mind, 98*, 1–21.
- Müller, U., & Newman, J. L. (2008). The body in action: Perspectives on embodiment and consciousness. In W. F. Overton, U. Müller, & J. L. Newman (Eds.), *Developmental perspectives on embodiment and consciousness* (pp. 313–341). New York: Taylor Francis.
- Müller, U., Sokol, B., & Overton, W. F. (1998). Reframing a constructivist model of the development of mental representation: The role of higher-order operations. *Developmental Review, 18*, 155–201.
- Newcombe, N. S. (2002). The nativist-empiricist controversy in the context of recent research on spatial and quantitative development. *Psychological Science, 13*, 395–401.
- Overton, W. F. (2006). Developmental psychology: Philosophy, concepts, methodology. In W. Damon & R. Lerner (Eds.), *Handbook of child psychology: Vol. 1. Theoretical models of human development* (6th ed., pp. 18–88). New York: Wiley.
- Piaget, J. (1950). *The psychology of intelligence*. Totowa, NJ: Littlefield. (Original work published in 1947)
- Piaget, J. (1954). *The construction of reality in the child*. New York: Basic Books. (Original work published in 1937)
- Piaget, J. (1963). *The origins of intelligence in children*. New York: Norton. (Original work published in 1936)
- Piaget, J., & Inhelder, B. (1969). The gaps in empiricism. In A. Koestler & J. Smythies (Eds.), *Beyond reductionism* (pp. 118–159). Boston: Beacon.
- Proudfoot, D. (in press). Meaning and mind: Wittgenstein's relevance for the "Does language shape thought?" debate. *New Ideas in Psychology*.
- Rakison, D. H. (2007). Is consciousness in its infancy in infancy? *Journal of Consciousness Studies, 14*, 66–89.
- Samuels, R. (2002). Nativism in cognitive science. *Mind & Language, 17*, 233–265.
- Saville, A. (1972). Leibniz' contribution to the theory of innate ideas. *Philosophy, 47*, 113–124.
- Siegler, R. S. (1995). How does change occur: A microgenetic study of number. *Cognitive Psychology, 28*, 225–273.
- Spelke, E. S. (1998). Nativism, empiricism, and the origins of knowledge. *Infant Behavior & Development, 21*, 181–200.
- Vygotsky, L. S. (1978). The role of play in development. In L. S. Vygotsky (Ed.), *Mind in society* (pp. 92–104). Cambridge, MA: Harvard University Press. (Original work published in 1933)
- Werner, H. (1957). The concept of development from a comparative and organismic point of view. In D. B. Harris (Ed.), *The concept of development: An issue in the study of human behavior* (pp. 125–148). Minneapolis: University of Minnesota Press.
- Werner, H., & Kaplan, B. (1963). *Symbol formation*. New York: Wiley.
- Willatts, P. (1997). Beyond the "couch potato" infant: How infants use their knowledge to regulate action, solve problems, and achieve goals. In G. Bremner & A. Slater (Eds.), *Infant development: Recent advances* (pp. 109–135). Hove, UK: Psychology Press.