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University of California, Berkeley

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Rational constructivism, statistical inference, and core cognition

Fei Xu

University of California, Berkeley, CA

fei_xu@berkeley.edu

Abstract: I make two points in this commentary on Carey (2009). (1) It may be too soon to conclude that core cognition is innate. Recent advances in computational cognitive science and developmental psychology suggest possible mechanisms for developing inductive biases. (2) There is another possible answer to Fodor's challenge —if concepts are merely mental tokens, then cognitive scientists should spend their time on developing a theory of belief fixation instead.

Susan Carey's book, *The Origin of Concepts* (2009), is deep, comprehensive, and provocative. She articulates a view of the starting point of the human infant's conceptual apparatus and its subsequent development through middle childhood. Carey reviews much of her enormously influential research from the last few decades. She also reviews much of the literature on core cognition that focuses on revealing early competences in human infants in a number of core domains such as object cognition, number sense, causality, and agency. Carey takes on both the British empiricists' and Piaget's theory of development – on both counts, I completely agree with her. Carey also takes on Fodor's challenge to cognitive science about learning, by discussing in detail her profound and groundbreaking work on conceptual change in childhood. I make two points in this

commentary. (1) It may be too soon to conclude that core cognition is innate. Recent advances in computational cognitive science suggest possible mechanisms for developing inductive biases in a rational manner; new empirical work is also beginning to uncover the existence of these mechanisms in infants. As such, perhaps a different approach, a “rational constructivist” approach to cognitive development, is called for. (2) There is another possible answer to Fodor’s challenge: that Fodor was wrong about what is interesting for psychologists to study—concepts or belief fixation. Belief fixation is an interesting and legitimate research enterprise. If concepts are merely mental tokens (fixed by a mysterious “nomological hookup” process, as per Fodor 1998), cognitive scientists and developmental psychologists should spend their time and energy on developing a theory of belief fixation. Bayesian belief updating may provide a framework that is potentially productive and fruitful in this regard.

The evidence for infants’ early cognitive competences from the last 30 years of research is staggering. Despite many open issues about the format of the early representations and various methodological quibbles, there seems to be little doubt that the human infant is a completely different kind of creature from what Piaget or Quine or William James had thought. The first year of life, in spite of the fact that infants are still motorically and articulatorily incompetent, is in fact wonderfully rich in intellectual content. But is core cognition innate just because of the early appearance of these rather sophisticated reasoning abilities? Such a claim is based on the dissatisfaction of associationist accounts of learning in infants and children, that is, associative learning mechanisms do not appear to be able to explain the concepts and knowledge acquired by infants in the first year of life. However, there exist inductive learning mechanisms that

may meet this challenge. Recent work in computational cognitive science and developmental psychology (e.g., Dewar & Xu, in press; [Gopnik et al. 2004](#); [Kemp et al. 2007](#); [Schulz et al. 2007](#); [Xu & Garcia 2008](#); [Xu & Tenenbaum 2007](#)) puts forward a proposal based upon principles of Bayesian inference. In various domains (e.g., causal learning, probabilistic reasoning, word learning, social cognition), empirical work now provides evidence for these conjectures. Instead of embracing a strong nativist view of early development, perhaps a different approach to development – a rational constructivist approach – is called for ([Xu 2007](#); [Xu et al. 2009](#)). These inductive learning mechanisms are likely to be domain-general (e.g., [Gweon et al. 2010](#)), and they may provide the foundation for rapid learning in infants.

Fodor famously challenged Piaget in the Piaget–Chomsky debate in 1980 about what it means to be learning something genuinely new. Carey takes on this challenge by pointing to both the existence of conceptual change in childhood – where children acquire new concepts (e.g., the concept of 7, or the concepts of weight and density) and by providing a learning mechanism, namely Quinian bootstrapping. Here I suggest another possible answer to Fodor, namely, that if concept acquisition amounts to some mysterious process of “nomological hookup” ([Fodor, 1998](#)), then we should focus on developing a theory of belief fixation instead – because that is where the interesting psychological work is! Again, recent work on rational models of cognition (e.g., [Chater & Oaksford 2008](#); [Tenenbaum, Griffiths, & Kemp, 2006](#)) provides a new framework for asking and answering questions about how people update their beliefs, that is change the probabilities they assign to different beliefs in light of data. Furthermore, within this new framework, not only do we ask questions about the probabilistic nature of inferences, but

we also ask questions about whether human learners, big and small, represent probability distributions and to what degree our knowledge and representations themselves are probabilistic in nature (e.g., [Vul & Pashler, 2008](#)). The emphasis on uncertainty – both in representations and inferences – departs from the Fodorian view of concepts and beliefs as well. This burgeoning research enterprise focuses on a theory of belief fixation and belief updating, and it has already generated much innovative empirical work with both adults and children.

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