Rumelhart Symposium:
The Child as Scientist: In Honor of Susan Carey

Symposium organizer:
Fei Xu (fei_xu@berkeley.edu)

Symposium presenters:

Frank Keil (frank_keil@yale.edu)
Department of Psychology
Yale University

Elizabeth Spelke (spelke@wjh.harvard.edu)
Department of Psychology
Harvard University

Dedre Gentner (gentner@northwestern.edu)
Department of Psychology
Northwestern University

Fei Xu (fei_xu@berkeley.edu)
Department of Psychology
University of California, Berkeley

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Introduction

The David E. Rumelhart Prize is awarded to an individual for “making a significant contemporary contribution to the theoretical foundations of human cognition.” Susan Carey is a fitting recipient for this prize.

Susan Carey has had a profound impact on the study of cognition and cognitive development. Through elegant, innovative, and provocative theoretical and empirical work, Carey has shed light on foundational questions about human cognition, including the nature of learning, representation, and development. She is one of the few developmental psychologists to have articulated a view of early development from infancy through early childhood, and to have done so from the interdisciplinary perspective of a cognitive scientist. Her research on cognition and development has had a major impact on cognitive neuroscience, linguistics, computational modeling, and science education.

Overview of presentations

**Frank Keil**
The Feasibility of Folk Science

If folk science means individuals having well worked out mechanistic theories of the workings of the world, then it is not feasible. Lay people’s explanatory understandings are remarkably coarse, full of gaps and often full of inconsistencies. Even worse, most people grossly underestimate their own understandings. Yet in the realm of real science, more recent views suggest that individual scientists may not be so different. Their understandings can be surprisingly incomplete as well, and can also harbor inconsistencies. Yet, science somehow works and its success may offer some hope for the feasibility of folk science as well. The success of science arises heavily from the ways in which scientists learn to leverage understandings in other minds and to systematically outsource a great deal of explanatory work through sophisticated methods of deference and simplification of complex systems. Six studies are described that ask whether analogous processes might be present not only in lay people, but also in young children and thereby form a foundation for supplementing explanatory understandings almost from the start of our first attempts to make sense of the world. The results support this developmental account and thus suggest how folk science might be feasible.

**Elizabeth Spelke**
Beyond core knowledge: natural geometry

Philosophers from Socrates to Kant have viewed Euclidean geometry as a parade case of an innate system of knowledge. Contrary to this view, studies of animals from ants to humans suggest that biological organisms have multiple systems for representing the shape of the surrounding world, each with a restricted range of application and none with the full power of Euclidean geometry. Humans, however, go beyond the limits of these systems and forge a single, abstract system of geometric representation. The construction of
natural geometry may follow principles like those that Carey (2009) appeals to in her account of the construction of natural number.

Dedre Gentner, Stella Christie, Nina Simms and Florencia Anggoro

Analogical Bootstrapping in Cognitive Development

Relational knowledge -- whether of causal regularities, mathematical principles, or spatial invariants -- is critical to higher-order cognition. But relations are typically learned in a context-bound, situated manner. We propose that comparison via structure-mapping processes is the major mechanism by which relational knowledge is extracted from experience. We further propose that language contributes to this process, both by inviting comparison and by preserving the relational insights thereby revealed.

Comparing two situations renders their commonalities—especially common relational structure—more salient, thereby fostering relational abstraction (and thus transfer to dissimilar situations). Structure-mapping operates over both object similarity and relational similarity and is used for overall (literal) similarity as well as for analogy. Although young children may lack the requisite relational knowledge to carry out pure analogy, they can carry out literal similarity matches, in which the (obvious) object matches support the (nonobvious) relational alignment. Because of a tacit preference for systemativity (connectivity and depth) in the structure-mapping process, even such literal matches can promote relational insight.

We present studies to illustrate three claims inherent in this account: (1) carrying out a comparison renders commonalities—especially common relational structure—more salient; (2) this effect can be heightened by the use of language, in part because a common term is an invitation to compare; and (3) even literal comparisons can heighten relational insight, as evidence by greater ability to carry out a subsequent analogy based on the same relational structure. Thus close comparisons bootstrap far comparisons, paving the way to conceptual insight.

One implication of this research is that most instances of cross-situational learning—a phenomenon invoked in many developmental accounts—depend on comparison. We will show evidence that the same factors that predict whether comparison will occur also predict whether cross-situational learning will occur.

Fei Xu

Rational Statistical Inference in Cognitive Development

Cognitive scientists are interested in the nature of human learning. In particular, many are interested in whether we are rational learners. In recent years, several computational cognitive scientists have argued that principles of Bayesian inference provide a fruitful framework for investigating the nature of human learning. What are the developmental origins of these rational statistical inference abilities? Are rapid inductive learning mechanisms available to infants and young children that may guide their learning early on in domains such as word learning, physical reasoning, and psychological reasoning? I will discuss several studies with infants and children. Our results suggest that 1) during the second half of the first year, infants are able to use the statistical properties of samples to make inferences about larger populations, and vice versa; 2) these inferential mechanisms can integrate domain-specific knowledge from the physical and psychological realm; 3) infants can use non-representative samples as evidence to infer a psychological cause; 4) infants’ looking time patterns in these studies provide some preliminary evidence that they might be Bayesian learners; 5) domain-specific learning may be the result of rapid inductive learning early on. Young human learners may be child scientists both in terms of the structure of their knowledge and in terms of the kinds of inferential mechanisms they employ.

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