BBS Commentary on Quilty-Dunn, Porot, and Mandelbaum

Is core knowledge in the format of LOT?

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 Abstract:

Object individuation provides a test case for the claim that infants already have a pre-linguistic language of thought. By 12 months, infants represent several sort-kinds: object, agent, animate, and perhaps artifact. Infants have also encountered many words for object kinds, animals, people, and artifacts, therefore it remains a viable hypothesis that language learning may play a causal role in the acquisition of sortal-kinds, contra Quilty-Dunn et al.

Quilty-Dunn et al. put forth a strong thesis: that LOTH is the 'best game' in town as far as a computational theory of mind is concerned. They marshal evidence from object perception, deductive reasoning, and other domains to support this claim. I am sympathetic to the view that LOT continues to provide a philosophical and conceptual foundation for modern cognitive science. In this commentary, however, I submit, as I did in Xu (2019), that core knowledge systems in human infants do not satisfy the criteria for being in the format of LOT. Here I focus on the domain of object, in particular object individuation in human infants.

Inspired by an analysis of the logic of common nouns (Macnamara, 1986; Wiggins, 1980), we reported a series of experiments demonstrating that 10-month-old infants failed to use sortal-kind distinctions (e.g., between a duck and a ball) to establish a representation of two objects in an occlusion event; by 12 months, they can do so (the "is-it-one-or-two" task, Xu & Carey, 1996; see Xu, 1997, 2007 for reviews). We argued that it is not until the end of the first year that infants represent basic-level sortal-kinds such as *duck, ball, spoon*, and *cup*, and learning a natural language – specifically words for these sortal-kinds -- may play a causal role in acquiring these concepts. A lot has happened since then.

For the rest of our discussion, it is important to keep in mind that three pieces of evidence are needed to claim that infants represent sortal-kind concepts in a LOT format: (1) success in using between-kind distinctions in object individuation, (2) failure in using within-kind distinctions in object individuation at the same age, and (3) evidence showing that infants detect the perceptual distinctions between sequentially presented objects over occlusion. In support of the claim that infants younger than 12 months do not represent basic-level sortal-kinds, Xu and Carey (1996) and Xu et al. (2004) presented evidence for (1), (2) and (3). Since

then, many published studies have used similar methods (the "is-it-one-or-two" task) to further investigate the ontogenetic origin of sortal-kind concepts, focusing on three other superordinate-level concepts: *agent, animate*, and *artifact* (see Croteau, Cheries & Xu, forthcoming, for a review). For the concept of an agent, Bonatti et al. (2002) found that 10-month-old infants successfully individuated a doll head from an inanimate object (a between-kind distinction, agent vs. object), and a doll head from a dog head, but they failed to individuate a doll head from another doll head (a within-kind distinction). Recent studies by Brody et al. (2022), Taborda-Osorio et al. (2019), and Taborda-Osorio and Cheries (2018) found that 10-, 11-, or 13-month-old infants used preferences, social-moral dispositions, and internal properties to individuate agents. For the concept of animacy, Surian and Caldy (2010) found that 10-month-old infants successfully individuated an animate and an inanimate object (a dynamic caterpillar and a stationery cup; a between-kind distinction) but failed to individuate two animates (a rabbit and a bee; a within-kind distinction). Decarli et al. (2020) provided converging evidence, further disentangling the use of sortal-kind vs. featural information. Lastly, Futó et al. (2010) found that 10-month-old infants successfully individuated an object with a function and another object with a different function, although they did not demonstrate a difference in individuation contrasting between-kind vs. within-kind distinctions. The studies on agent, animacy, and artifact did not present direct evidence that infants encoded the various relevant perceptual feature differences, but given what we know about infant perception in general, most would agree that not encoding perceptual differences between objects was an unlikely explanation for the failures in individuation tasks (though see Kibbe & Leslie, 2019).   It is also important to note that Wilcox, Baillargeon, Lin, Stavans, and their colleagues have conducted many related experiments over the years, with a strong focus on investigating when infants use *featural* information in object individuation and the relationship between object files and physical reasoning. Their studies have not aimed to probe the development of sortal-kind concepts (e.g., Wilcox & Baillargeon, 1998; Lin et al. 2021; Stavans et al. 2019). A review of their studies and the various methodological differences between their methods and the "is-it-one-or-two" task is beyond the scope of this commentary; however, these details are important for interpreting this body of research.

The studies reviewed above support the view that towards the end of the first year of life, infants represent sort-kind concepts: *object, agent, animate*, and perhaps *artifact*. During the first year of life, infants also hear many, many words that refer to basic-level object kinds, people, animals, and artifact kinds. Given the evidence on how words facilitate object categorization, individuation, and inductive inference of non-obvious properties (see Perszyk & Waxman, 2017; Xu, 2002, 2007; and others for reviews), it remains a viable hypothesis that it is language learning that changes the format of early representations into a language of thought.

The core knowledge view (Spelke, 2022) also argues for several other systems of early knowledge besides object. In particular, the number sense presents another strong case that these pre-linguistic representations are incompatible with a LOT format. A rich body of research suggests that pre-linguistic representations of number share very little with the conceptual representations needed for learning number words. It is an open question whether the pre-

linguistic representations of agents, places, or social beings are in the format of a language of thought.

I applaud Quilty-Dunn, Porot, and Mandelbaum for drawing our attention, once again, to the significance of the language of thought hypothesis. If core knowledge systems are indeed not in the format of a language of thought, as I have argued here, cognitive scientists face a major challenge in understanding learning and development in many domains: how does language learning change the format of pre-linguistic representations, or alternatively, how does language learning create new conceptual representations that are in the format of a language of thought?

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