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ı as *dog*, has an argument place. By substituting a represen-
ɔn of a particular object into that place, we can form a
ıle thought, such as that Fido is a dog. An iconic represen-
ɔn does not have an argument place. There could be a kind
hinking in pictures in which a mental image of a collie did
work of the concept *dog* in forming the sorts of thoughts
express in English with the word "dog." But in that case,
mental image of a collie would cease to be an iconic represen-
ɔn of a particular collie. There are iconic representations of
ects, but no iconic representation is the concept *object*.

arey frequently infers that a representation is conceptual on
grounds that it cannot be defined in terms of sensory and
tiotemporal qualities and has an "inferential role" (pp. 97,
, 171, 449). Infants' representations of objects are not
ely representations of statistical relations between sensory
lities (p. 34), and they are intermodal (p. 39). In saying that

The case for continuity

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Abstract: This article defends a continuity position. Infants can abstract numerosity and young preschool children do respond appropriately to tasks that tap their ability to use a count and cardinal value and/or arithmetic principles. Active use of a nonverbal domain of arithmetic serves to enable the child to find relevant data to build knowledge about the language and use rules of numerosity and quantity.

Carey's book is an outstanding contribution to cognitive development (Carey 2009). It reviews and updates findings that infants and young children have abstract or "core" representations of objects, agents, number, and causes. The number chapters feature the argument for discontinuity between infant and later cognitive development. They include evidence that infants use two separate number abstraction systems: an object-file, parallel system for the small numbers of 1 to 3 or 4; and a ratio-dependent quantity mechanism for larger numbers. This contrasts with adults, who use a ratio-dependent mechanism for all values (Cordes et al. 2001).

Further, Carey argues that verbal counting is first memorized without understanding and that the meaning of counting and cardinality is embedded in the learning of the quantifier system. She cites Wynn's (1990; 1992) "Give X" and LeCorre and Carey's (2007) tasks that children aged 2 years, 8 months to 3 years, 2 months typically fail as well as analyses on quantifiers, including *some* and *many*.

An alternative account runs as follows. Infants possess a core domain for arithmetic reasoning about discrete and continuous quantity, necessarily including both mechanisms for establishing reference and mechanisms for arithmetic reasoning. The nonverbal domain outlines those verbal data and uses rules that are relevant to its growth. The development of adult numerical competence is a continuous and sustained learning involving the mapping of the cultural system for talking about quantity into the inherited nonverbal system for reasoning about quantity. Counting principles constitute one way to establish reference for discrete quantity because they are consistent with and subservient to the operations of addition and ordering, that is, they are consistent with basic elements of arithmetic reasoning. In this view, the Carey account focuses too much on reference and almost ignores the requirement that symbols also enter into arithmetic reasoning. The well-established ability of infants and toddlers to recognize the ordering of sequentially presented numerosities, including small ones, requires a counting-like mechanism to establish reference. If the symbols that refer to numerosities do not enter into at least some of the operations that define arithmetic (order, addition, subtraction), then they are not numerical symbols. However, there is evidence that beginning speakers recognize that counting yields estimates of cardinality about which they reason arithmetically.

1. Infants can represent numerosity in the small number range. Cordes and Brannon (2009) show that, if anything, numerosity is more salient than various continuous properties in the 1–4 number range. Converging evidence is found in VanMarle and Wynn (in press).

2. Cordes and Brannon (2009) also show that 7-month-old infants discriminate between 4:1 changes when the values cross from small (2) to larger (8) sets. These authors conclude that infants can use both number and object files in the small N range, a challenge to the view that there is a discontinuity between the small number and larger number range for infants.

3. Two-and-a-half-year-olds distinguish between the meaning of "a" and "one" when tested with the "What's on the card WOC?" task (Gelman 1993). When they reply to the WOC question with one item, they often say "a __". When told "that's a one-x card", the vast majority of $2\frac{1}{2}$-year-olds both counted and provided the cardinal value on set sizes 2 and 3 and young 3-year-olds ($\leq$3 years, 2 months) provide both the relevant cardinal and counting solution for small sets as well as some larger ones. Syrett et al. (in press) report comparable or better success rates for children in the same age ranges. The appearance of counting when cardinality is in question is good evidence that these very young children, who can be inconsistent counters, nonetheless understand that counting renders a cardinal value.

4. Arithmetic abilities appear alongside early counting. Two-and-a-half-year-old children transferred an ordering relation between 1 versus 2 to 3 versus 4 (Bullock & Gelman 1977). When these children encountered the unexpected change in numerosities, they started to use count words in a systematic way. This too reveals an understanding of the function of counting well before they can do the give-N task. Carey's claim that "originally the counting routine and the numeral list have no numerical meaning" (p. 311) is simply false.

5. Gelman's magic show was run in a number of different conditions and with 3-year-old children. Children this age distinguished between operations that change cardinal values (numerosities) and those that do not, across a number of studies. Moreover, when the cardinality of the winner comes into question, they very often try to count the sets, which are in the range of 2–4, and occasionally 5.

6. Further evidence that 3-year-olds understanding of cardinality comes from the Zur and Gelman (2006) arithmetic–counting task. Children started a round of successive trials with a given number of objects, perhaps doughnuts, to put in their bakery shop. They then sold and acquired 1–3 doughnuts. Their task was to first predict – without looking – how many they would have, and then to check. Their predictions were in the right direction, if not precise. They counted to check their prediction and get ready for the next round. They never mixed the prediction–estimation phase and the checking phase. Counts were extremely accurate and there was no tendency to make the count equal the prediction. Totals could go as high as 5.

7. The idea that understanding of the exact meaning of cardinal terms is rooted in the semantics of quantifiers is challenged in Hurewitz et al. (2006). They found that children in the relevant age range were better able to respond to exact number requests (2 vs. 4) than to "some" and "all."

8. An expanded examination of the Childes database with experiments with the partitive frame (e.g., *zav of Y*) and modification by the adverb *very* (e.g., *very zav*) reveal that the Bloom and Wynn analysis of semantics is neither necessary nor sufficient to accomplish the learnability challenge (Syrett et al., in press).

The preverbal arithmetic structure can direct attention to and assimilate structurally relevant verbal data and their environments.

Language and analogy in conceptual change

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Abstract: Carey proposes that the acquisition of the natural numbers relies on the interaction between language and analogical processes: specifically, on an analogical mapping from ordinal linguistic structure to ordinal conceptual structure. We suggest that this analogy in fact requires several steps. Further, we propose that additional analogical processes enter into the acquisition of number.

How humans come to possess such striking cognitive abilities and rich conceptual repertoires is perhaps *the* question of cognitive science. Susan Carey has explored this question in part by identifying specific areas – such as number – in which humans demonstrate unique and impressive ability, and exploring their development in great depth (Carey 2009). In her treatment of number, Carey argues that children gain an understanding of the natural numbers through a process of mapping the ordinal structure of the number list to quantity. We agree with this proposal, but we suggest (1) that analogy interacts with language in several additional and distinct ways to support the acquisition of number; and (2) that arriving at the analogy from ordered numerals to ordered quantities probably requires more than a single leap (Gentner 2010).