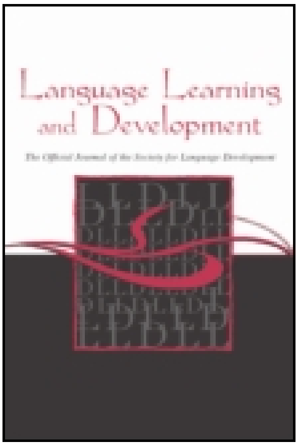

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Commentary on "How Can Syntax Support Number Word Acquisition?" by Kristen Syrett, Julien Musolino, and Rochel Gelman

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What role does language play in developing the concept of number? This question is at the center of an important current debate. To try to answer it, let us consider what is needed to learn number words and their meaning. First, the learner has to be able to identify number words as such, that is, to distinguish them from other sorts of word. Second, the learner has to have number meanings available. Third, the learner has to be able to map the words on to their meanings. The question addressed in the paper by Syrett, Musolini, and Gelman (SMG) is the first one: How does a child identify number words? In particular, can the child generalize from other words, especially nonnumerical quantifiers? In particular, it is assessment of the claim by Bloom and Wynn (1997) that a collection of "linguistic cues [in the input] may play a significant role in children's acquisition of number word meaning" (p.514) and that "sensitivity to these different linguistic cues brings children to their initial stage of number word acquisition (knowledge that number words pick out numerosities)" (p. 515).

It has been argued by Carey that "the ease of mastering determiners and other quantifiers, as well as evidence for prelinguistic availability of the singularity/plurality distinction, suggests that the meanings that underlie the quantifiers of natural language are also part of the human innate endowment" (Carey, 2009, p. 238). However, she also notes that these cannot be the basis for constructing representations of what she calls "integers" (meaning cardinals), since "they do not express exact cardinal values of sets" (p. 241). In fact, English quantifiers, such as *some, all, many, several*, and so on, do not denote a specific number of objects, whereas the counting words *one, two, three,* etc., do. (An added complication is that quantifiers such as *some* and *all*, not to mention determiners such as *the*, can denote continuous quantities rather than sets and subsets, as in the expression *some cake*, *some of the cake, the flour weighs two kilos*.)

So the issue here is, can the child get from quantifiers to counting words without the help of pre-existing concepts of cardinality? Carey argues for "bootstrapping," that is, pulling oneself up by one's bootstraps. This, of course, is impossible (as a simple experiment will demonstrate), even in its Quineian version. So one must look elsewhere for an account.

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It is important to understand the role of the counting words a child will experience. Of course, the words are used for counting, but the practice of counting involves the integration of two separate meanings: cardinality and ordinality. Cardinality is an abstract property of a set — how many things there are in a set. This is in contradistinction to ordinality — the order of the number words. In the former, the cardinality *fourness* includes the cardinalities of the *threeness*, *twoness*, and *oneness*, while in the latter “four” is the next element after “three” in a well-ordered sequence but does not include “three.” Of course, the fact that in English the words for the cardinal four and ordinal four are the same, poses a problem for the learner that takes some unravelling, as many authors have noted (e.g., Fuson, 1988, 1992).

This question has become a divisive issue in studies of the development numerical competence. On the one hand, it has been widely claimed that knowing the vocabulary of number words is a necessary condition for developing concepts of cardinality (sometimes misleadingly called “exact number,” since both cardinals and ordinals are exact (e.g., Carey, 2004; Le Corre & Carey, 2007; Pica, Lemer, Izard, & Dehaene, 2004). On the other hand, as we will see, the cardinal concepts are independent of language, and the child’s task is to learn the mapping between the words and concepts (Gelman & Gallistel, 1978).

The focus of SMG is the prior issue of how the child comes to be able to identify words as referring to numbers, which of course is necessary on either type of account, but in the former is necessary for the development of cardinal concepts.

CARDINALITY

There are two aspects to a grasp of the cardinal meanings of number words. First, the learner has to understand that “four” mean *fourness* and, second, that cardinals have well-defined properties. Piaget (1952) identified an important one in his conservation tasks, namely, that some transformations affect cardinal value and some do not. In particular, he differentiated transformations that change cardinality, for example, by adding or taking away a member, from transformations that do not change cardinality, such as rearrangement of members. He also stressed that if two sets have the same (cardinal) number, then their members could be put into one-to-one correspondence. In coming to understand the “concept of [cardinal] number,” knowledge of the counting words seemed to be largely irrelevant.

The critical point here is that in this account, knowledge of counting words contributes little to coming to an understanding of cardinality. Several authors have also taken this view. For example, Fodor (1975) argues that learning a language essentially means learning to express concepts already present in their prelinguistic systems for representing the world. Gelman and Gallistel (1978) have also stressed that learning to count using counting words consists of mapping the words on to prelinguistic concepts of cardinality (“numerons”).

One might have assumed that a commitment to a nativist account of concepts would lead to a nativist account of cardinal concepts. Bloom and Wynn (1997) as well Carey and her colleagues take a nonnativist position here. They are essentially arguing, as SMG note, for Skills before Principles approach not too different from an essentially empiricist position of the acquisition of number concepts advocated by some developmental psychologists (Briars & Siegler, 1984; Mix, Huttenlocher, & Levine, 2002) or philosophers such as Kitcher (1984). See (Butterworth & Reeve, in press) for a discussion of this issue.

NOTICING AND APPLYING

The criteria for crediting children with knowledge are different for Gelman and Piaget. While Piaget focused on the application required to solve problems, Gelman focused on noticing numerical events. Gelman (1972) was among the first researchers to use so-called noticing tasks to demonstrate children's reactions to number events.

In the last 20 years, it has become something of a developmental game to show that younger and younger children are *sensitive to* particular concepts to illustrate the basis of specific competencies. That is, children *notice* systematicities or violations of systematicities.

We need to consider, though, the epistemological status of noticing indices, including, for example, the relationship between noticing and later application indices of number and the developmental sequence(s) that characterize the transition from noticing to action. Of course, these are not new questions; however, they are worth revisiting as a way of examining claims about the development number competencies (Butterworth & Reeve, in press).

SMG tackle the question of whether children notice the syntactic context of quantifiers. The second question is, can they apply that knowledge in interpreting counting words as having a quantificational meaning? Even if the answer to both questions is yes, there is still the question of getting from the nonspecific quantificational nature of words such as *some*, *many*, and *several* to the specific cardinal meanings of *one, two,* and so on.

As noted above, it is true that *many* and *several* denote properties of sets of discrete objects. Other quantifiers such as *some* and *all* can also denote quantities that are not sets or subsets of them. *May I have some cake* and *Please give me all the cake* denote continuous quantities, not members of a set of cakes. Even the partitive *of*, which is crucial in this study, can denote both continuous quantity, *some of the cake*, as well as a subset of a previously mentioned or presupposed set, *some of the cakes.* Also, these quantifiers are not intrinsically ordered, unlike the counting words.

EVIDENCE OF THE INDEPENDENCE OF NUMBER AND LANGUAGE

The original position taken by (Gelman & Gallistel, 1978) entailed an innate capacity for cardinality that was independent of counting words. There is now extensive evidence from comparative studies that human infants (Antell & Keating, 1983; Wynn, 1992) and other species (Davis & Pérusse, 1988; Gallistel, 1990; Nieder & Dehaene, 2009), lacking counting words, notice changes in numerosity and can sometimes apply this knowledge in guiding behavior.

Moreover, cultures without counting words can nevertheless have a sense of the exact equality of sets (Izard, Pica, Spelke, & Dehaene, 2008) and even carry out enumeration and simple arithmetical tasks (Butterworth & Reeve, 2008; Butterworth, Reeve, Reynolds, & Lloyd, 2008). Even though the Amazonian Mundurucu use their few counting words in a rather approximate way, some members do use body-part counting for exact enumeration (Pica et al., 2004, supplementary information), again suggesting the independence of a concept of cardinality from the language resources.

Now these languages do have quantifier words. Warlpiri and other central desert languages of Australia have grammatical markers for dual and trial (typically meaning *a few*) (Bittner & Hale, 1995). If the claim is that the syntax of quantifiers drives an understanding of cardinality and cardinalities, then one might have thought that the Warlpiri would use these quantifiers in a systematic way to enumerate, for example *singular definite, dual, trial, several,* and *many*. But there is no evidence that these quantifiers are used in this way in these cultures.

SMG demonstrate quite clearly that even the first step, being able to use syntactic context to identify words that could have cardinal meanings for the early learner, lacks convincing support. It seems more plausible to me that counting words are learned in counting contexts, contexts that are specifically cardinal, as in games and activities where the adult or older child says, *Here are three dinosaurs and* [adding one] *now there are fours dinosaurs*.

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