Bootstrapping Rebooted

How do children learn the cardinal numbers? One influential response—or rather family of responses—is that children initially learn the meaning of the first few number words and then infer (or 'bootstrap') the meaning of the rest as they learn to count, thereby building an association between 'counting on' (i.e. moving upwards in the number word sequence, word by word) and 'adding one' to an arbitrary collection of items. This general approach has come under attack in a series of papers by Rips, Asmuth and Bloomfield (2006; 2008a,b) on the basis that bootstrapping does not guarantee that children will assign the right (standard) interpretation to the word sequence as opposed to some non-standard (e.g., cyclical) interpretation. According to Rips et al., the sort of inference that children are required to draw needs to be appropriately constrained in order to succeed—but once these constraints are in place, they argue, the inference in question becomes entirely redundant. So much for bootstrapping then.

My aim here is to vindicate bootstrapping against Rips et al.'s criticism by showing that the range of interpretations available to children when they learn the sequence of (cardinal) number words is heavily constrained by the practice in which these number words are deployed: it is thanks to being embedded in the practice of counting that the number word sequence acquires a determinate meaning, which is immune to alternative interpretations of the sort Rips et al. envisage. This, I submit, undercuts the main thrust of their criticism. Once the principles that govern the counting routine have been mastered, no further constraints seem to be required to fix the standard interpretation of count terms.

This is how I plan to proceed:

First, I will present the general account at issue. In the course of development, it's been suggested, children gradually build an association between 'counting on' (reciting the next term in a count sequence) and 'adding one' to an arbitrary collection of items (cf. Hurford 1987; Bloom 1994; Carey 2004). This unfolds in (at least) two different stages. At stage 1, children initially learn the meaning of the first few number words (for instance, that 'one' refers to *one*, that 'two' refers to *two*, and that 'three' refers to *three*). Eventually, at stage 2, they make the following inference: if a word in the counting sequence 'one, two, three…' refers to *n*, then the next word in the counting sequence refers to *one* more than *n*. This developmental process draws on (i) a conventional sequence of number words, (ii) an innate sense of cardinal size, and (iii) a counting procedure linking (i) and (ii). The claim is that nothing else is required to get children's understanding of cardinal numbers off the ground—that's why it's referred to as 'bootstrapping'.

Second, I will rehearse Rips et al.'s criticism to the proposed account. Their main contention is that (i)–(iii) are not stringent enough to constrain the possible meanings that children may assign to number words as they build up the relevant associations through stages 1 and 2. In order to make their case, Rips et al. invite us to imagine a range of alternative interpretations that children could entertain instead. For instance, some such interpretation could be cyclical (cf. Figure 1) or perhaps 'loopy' (cf. Figure 2). Notice that the point at which the denoted properties cycle back is quite arbitrary and may happen very late in the sequence, i.e. at orders of magnitude far removed from the initial segment of the sequence. So, what would prevent an infant from interpreting the sequence of count words in this, or some other non-standard, way? Nothing, Rips et al. would claim, unless further constraints are put into place (such as a tacit—possibly innate—grasp of the principles that govern cardinal arithmetic, see Rips et al. 2008b).

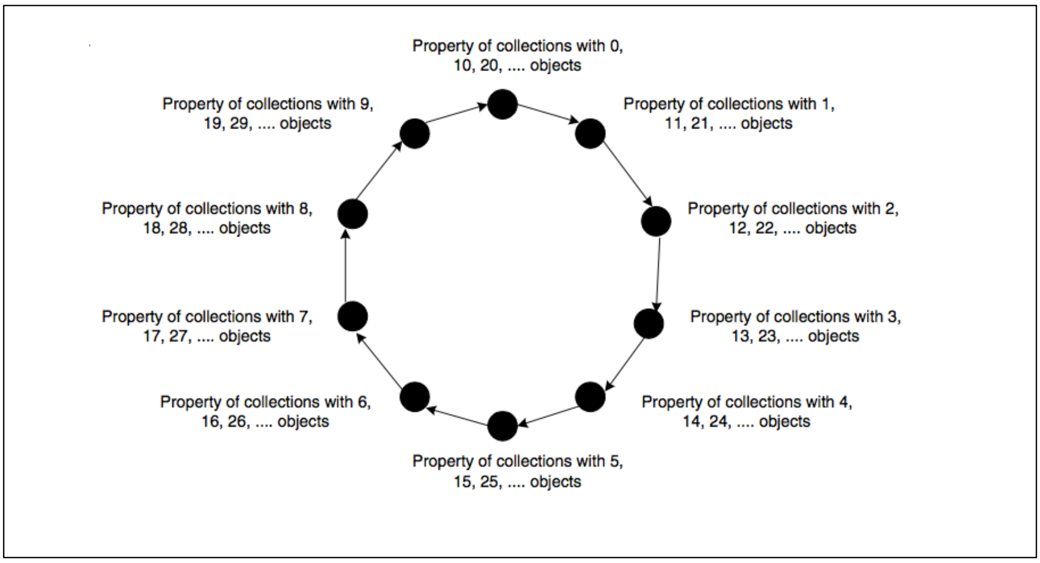

Figure 1

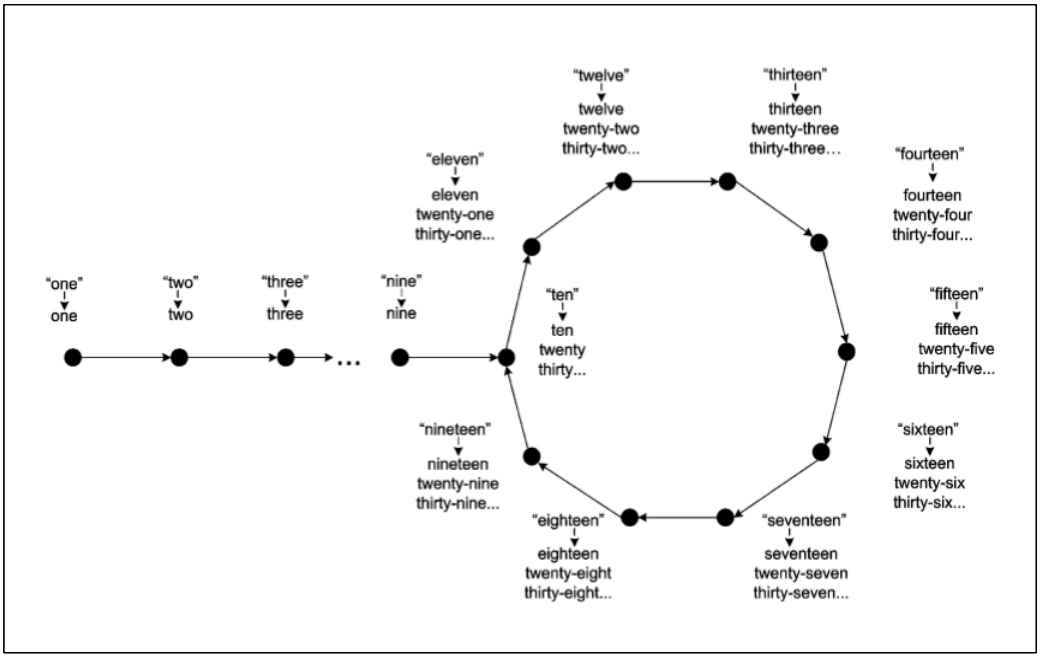

Figure 2

Third, I will offer a response to Rips et al.'s fundamental objection by taking a closer look at the principles that govern the use of number words in counting, and which fix their standard meaning (cf. Gelman and Gallistel 1978):

1. The one-one principle: one and only one tag is used for one and only item in a count.
2. The stable-order principle: the tags used in counting must be applied in a fixed order.
3. The cardinal principle: the final tag in a count gives the cardinality of the set of items being counted.
4. The abstraction principle: principles 1–3 apply to any collection of entities.
5. The order-irrelevance principle: the order in which items are counted is irrelevant.

I shall argue that the first three principles are responsible for ruling out the sort of scenarios that Rips et al. invite us to imagine (where one number word could refer to different cardinalities), since these principles restrict the application of one and the same number word to one and only one cardinality.

Fourth, and by way of conclusion, I will examine Rips et al.'s contention that the meaning of number words is innately constrained (and do so on independent grounds, quite apart from the fate of their general criticism). How would they explain our ability to entertain the kind of wild scenarios that they ask us to imagine? What would account for our ability to interpret the meaning of an arbitrary sequence of terms as requested, if our representational capacities are innately constrained in the way they suggest they are? And if, indeed, we are able to frame such alternative interpretations, how is it that we manage to favour one interpretation over another in the course of learning the meaning of the sequence of number words? In fact, the crucial question is whether there is any gain in supposing that the hypothesis space for learning the meaning of number words is innately constrained. Ultimately, we have to account for how, in the course of individual development, one interpretation is favoured over another, an account that will most likely run along the lines of the general approach that Rips et al. set out to criticise.

References

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