Does recursion in language trigger recursion in natural numbers?

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Children's acquisition of natural number knowledge has been a central question for at least half a century. In recent years, a new type of number acquisition theory assumes that children possess/acquire a generative mental mechanism that can produce discrete representations that are structurally isomorphic to the number words in the counting sequence (Barner, 2017; Carey, 2004; Carey & Barner, 2019; Le Corre & Carey, 2007; Leslie, Gelman, & Gallistel, 2008). These theories suggest that children possess a recursive mental mechanism equivalent to Peano's recursive successor function (Peano, 1977). Three "origins" of the successor function are proposed. First, the successor function is part of the innate mental architecture (Leslie et al., 2008). Second, the successor function is acquired via inductive inference triggered by a perceptual mechanism and language competence (Carey, 2004; Le Corre & Carey, 2007). Third, the successor function is developed from the recursive regularities of the cardinal numbers (Barner, 2017; Carey & Barner, 2019; Cheung, Rubenson, & Barner, 2017; Wagner, Chu, & Barner, 2018; Wagner, Kimura, Cheung, & Barner, 2015). This paper aims to discuss recursion in linguistics theories to explore the third origin of the successor function in natural numbers. In linguistic studies, there is no consensus about the definition or the interpretation of what qualifies as recursion (Lobina, 2011, 2014, 2017; Tomalin, 2006, 2011). Two main definitions were found. The first definition states that Merge is a self-referential function that licenses the building of hierarchically structured expressions (Chomsky, 2014; Fukui, 2017; Ohta, Fukui, & Sakai, 2013). The second definition considers that categorical recursion occurs when a syntactic object of type α is embedded in a syntactical object of the same type α (Hollebrandse & Roeper, 2014; Li et al., 2020; Pérez-Leroux, Castilla-Earls, Bejar, & Massam, 2012; Pinker & Jackendoff, 2005; Thomas Roeper & Snyder, 2005; Tom Roeper & Oseki, 2018; Terunuma & Nakato, 2018). Both definitions will be used to analyze cardinal numbers that belong to number

systems with different levels of complexity. Starting with numeration systems that do not represent exact numbers, such as the Mundurucu (1), passing through numeration systems that only represents small quantities like the isolated Brazilian language Aikanã (2) to numeration systems that are indefinitely combinatorial as in English and many other modern languages (Hurford, 2007). Our analysis shows that one feature common in non-developed numeration systems is that they used one-to-one correspondence to represent sets. Mundurucu's number system used reduplication to establish a one-to-one correspondence between the number of syllables and quantity (Pica & Lecomte, 2008). Aikanã system consists of two lexical elements corresponding to 1 and 2, and additive compositions of it to build numbers up to 5 (Da Silva-Sinha, Sampaio, & Sinha, 2017). The capacity to generate large numbers is limited because the syntactic operation used to build numerals is iteration, and there is no evidence of recursion. In contrast, developed number systems include multipliers as a lexical category, and complex cardinal number's representation is hierarchical with self-embedded categories. The analysis suggests that Merge and categorical recursion are necessary to build numeration systems. However, neither Merge nor categorical recursion is isomorphic to the recursive successor function in natural numbers.

1) Pũg (± one)
   Xep-xep (± two)
   E-ba- Pũg (± three)
   E-ba-dip-dip (± four)

2) Amẽmẽ (one)
   Atuca (two)
   Atuca amẽmẽ (two one)
   Atuca atuca (two two)
   Atuca atuca amẽmẽ (two two one)

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