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The logic in language: How *all* quantifiers are alike, but *each* quantifier is different

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ABSTRACT

Quantifier words like EACH, EVERY, ALL and THREE are among the most abstract words in language. Unlike nouns, verbs and adjectives, the meanings of quantifiers are not related to a referent out in the world. Rather, quantifiers specify what relationships hold between the sets of entities, events and properties denoted by other words. When two quantifiers are in the same clause, they create a systematic ambiguity. "*Every kid climbed a tree*" could mean that there was only one tree, climbed by all, or many different trees, one per climbing kid. In the present study, participants chose a picture to indicate their preferred reading of different ambiguous sentences – those containing EVERY, as well as the other three quantifiers. In Experiment 1, we found large systematic differences in preference, depending on the quantifier word. In Experiment 2, we then manipulated the choice of a particular reading of one sentence, and tested how this affected participants' reading preference on a subsequent target sentence. We found a priming effect for all quantifiers, but only when the prime and target sentences contained the same quantifier. For example, ALL-A sentences prime other ALL-A sentences, while EACH-A primes EACH-A, but sentences with EACH do not prime sentences with ALL or vice versa. In Experiment 3, we ask whether the lack of priming across quantifiers could be due to the two sentences sharing one fewer word. We find that changing the verb between the prime and target sentence does not reduce the priming effect. In Experiment 4, we discover one case where there is priming across quantifiers – when one number (e.g. THREE) is in the prime, and a different one (e.g. FOUR) is in the target. We discuss how these findings relate

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to linguistic theories of quantifier meaning and what they tell us about the division of labor between conceptual content and combinatorial semantics, as well as the mental representations of quantification and of the abstract logical structure of language.

1. Introduction

All languages have systematic rules of interpretation, allowing listeners to derive complex sentence meanings from combinations of words. The simplest hypothesis is that the rules that govern semantic and syntactic composition are perfectly coupled, so that every different meaning is expressed by a unique natural language sentence (Montague, 1970). Semantic ambiguities – cases where the same sentence has two different meanings – challenge this simple hypothesis, and thus are central to our understanding of the relationship between meaning and form. A particularly systematic type of ambiguity, known as a scope ambiguity, has been studied extensively by semanticists. Scope ambiguities arise in certain sentences that contain two quantifiers in the same clause (like EVERY and A). For example, take the sentence:

(1) Every kid climbed a tree

This sentence could mean either that there is a single tree that every kid climbed, or that, for every kid, there is a (potentially different) tree that they climbed. The ambiguity in this sentence does not reflect an ambiguity in the speaker's mind, who surely knows which meaning she wants to convey. Thus we must have some format of representation that is less ambiguous than the English sentence and which precedes language production. In many semantic theories (see Heim & Kratzer, 1998; Hornstein, 1984; May, 1985, inter alia), this is captured by positing a level of representation, Logical Form (LF), separate from the surface form of the sentence, where the two interpretations are distinct. The two LFs for (1), ignoring tense, are presented below, with corresponding paraphrases:

(2a) $\forall x[\mathrm{Kid}(x) \rightarrow \exists y[\mathrm{Tree}(y) \wedge \mathrm{climbed}(x,y)]]$
For every *x*, if *x* is a kid, then there exists a *y*, such that *y* is a tree and *x* climbed *y*

(2b) $\exists y[\mathrm{Tree}(y) \wedge \forall x[\mathrm{Kid}(x) \rightarrow \mathrm{climbed}(x,y)]]$
There exists a *y*, such that *y* is a tree, and for all *x*, if *x* is a kid, then *x* climbed *y*

These LF representations are not ambiguous the way the English sentence (1) is because they specify the order in which the two quantifiers bind their variables. (2a) has the universal quantifier EVERY taking the widest possible scope. This is the interpretation with every kid climbing a potentially different tree. We refer to this as a "Universal-wide" or "U-wide" interpretation. (2b) is the interpretation where there is a single tree that every kid climbed. This sort of LF has the existential quantifier, A, taking wide scope, and we refer to it as an "Existential-wide" or "E-wide" interpretation.[1] Sentences like (1) are called 'scopally ambiguous' because the two possible meanings arise from the relative scope of the two quantifiers EVERY and A in LF.

[1] Note that the E-wide reading in (2b) entails the U-wide reading in (2a). We discuss this in Section 3.2.4.