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What Exactly Do Numbers Mean?

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The correct semantics for number words has been a topic of much dispute in linguistics. This controversy bears directly on our understanding of the development of numerical concepts. The Neo-Gricean theory (Horn, 1989) posits that number words, like other scalar terms, possess a lower-bounded semantics and only receive exact interpretations pragmatically via scalar implicatures. For example, “two” would mean AT LEAST TWO and would only be interpreted as referring to exactly two entities because the speaker could use stronger terms such as “three” or “four” to refer to larger quantities. A second theory (Koenig, 1991) states that numbers have an exact semantics (“two” means EXACTLY TWO) that can generate both a set reading (“two” establishes numerosity of the set) and a distributed reading (“two” predicates the existence of two individuals of a given type). Situations that are compatible with the set readings of a number are also typically compatible with the distributed readings of all smaller numbers, leading to what appear to be lower-bounded interpretations of number words (e.g. if the number of fish in the bowl is four, then there are also three/two/one fish that are in the bowl). The salience of these distributed readings will depend heavily on the context in which the number word occurs. But critically the meaning of number words remains the same across contexts.

To test these theories we examined children’s early interpretation of numbers words. Children acquire number words in a gradual and predictable sequence (Wynn, 1990) providing ample opportunity to test the initial semantics of each term. Previous research (Noveck, 2001) demonstrates that scalar implicatures appears relatively late in development. Therefore, if numbers are semantically lower bounded, we would expect to find evidence for this in children’s interpretation prior to implicatures.

In Experiment 1, we presented 10 children (2;6 to 3;5) who have demonstrated knowledge of “two” but not “three” (i.e. “2-knowers”) with a card displaying 1 fish and another with 3 fish and asked them to select the card with two fish. A similar procedure was repeated for 3-knowers (2;8 to 3;7) and 4-knowers (2;9 to 3;9) using their most recently acquired number. 2-knowers overwhelmingly chose the card with 3 fish, an interpretation that is consistent with lower-bounded semantics without implicatures. While these results support the Neo-Gricean account, two pieces of evidence lead us to refrain from that conclusion. First, according to an Exact Semantics account, 2-knowers in this task may assign “two” to mean EXACTLY TWO but simply select out a subset of two fish from a card with three fish

using a distributive reading. Consistent with this idea, 7 out of 10 2-knowers pointed specifically to two fish on the three fish card. In addition, 4-knowers, who did not differ in age from 2-knowers, rejected both card choices, consistent with exact semantics.

In Experiment 2, we minimized the possibility of a distributive reading by pushing for the perception of stimuli as a bounded set. We also provided a way for children to demonstrate an exact interpretation without having to reject both choices. First, we taught 10 2-knowers (2;6 to 3;5) to find target animals that were located in uncovered or covered boxes. Then, in the test phase, we asked them to find the box with two fish when presented with uncovered boxes with one fish and three fish and a covered box (see figure 1). 2-knowers overwhelmingly selected the covered box, suggesting that they interpreted “two” as “exactly two” and inferred that this quantity must be in the covered box. A Neo-Gricean theory would have to provide an account for why children failed to select the visible option compatible with lower bounded semantics (3 fish) when they fail to show evidence of scalar implicatures for other terms until 7-9 years of age. The Exact Semantics account provides the most natural and parsimonious explanation of these results.

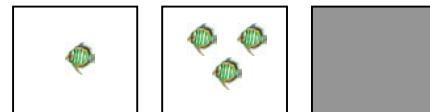


Figure 1: Experiment 2 Stimuli

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