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Most preschoolers don't know most

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Abstract

Recently, researchers interested in the nature and origins of semantic representations have investigated an especially informative case study: The acquisition of the word *most* – a quantifier which by all accounts demands a sophisticated 2nd order logic, and which therefore poses an interesting challenge to theories of language acquisition. According to some reports, children acquire *most* as early as three years of age, suggesting that it does not draw on cardinal representations of quantity (contrary to some formal accounts), since adult-like knowledge of counting emerges later in development. Other studies, however, have provided evidence that children acquire *most* much later – possibly by the age of 6 or 7 – thereby drawing this logic into question. Here we explore this issue by conducting a series of experiments that probed children's knowledge of *most* in different ways. We conclude that children do not acquire an adult-like meaning for *most* until very late in development – around the age of 6 – and that certain behaviors which appear consistent with earlier knowledge are better explained by children's well-attested bias to select larger sets (a “more” bias), especially when tested with unfamiliar words.

Over the past 40 years, a large body of work has documented how children learn and use quantificational language. These studies have focused, in large part, on the subtle difficulties that children encounter in later quantifier acquisition, including their problems with quantifier scope, pragmatic inference, and exhaustivity (e.g., Brooks & Braine, 1996; Caponigro, Pearl, Brooks, & Barner, 2012; Crain & Thornton, 1998; Drozd & van Loosbroek, 1998; Inhelder & Piaget, 1964; Munn, Miller, & Schmidt, 2008; Papafragou & Musolino, 2003; Philip, 1996). Recently, a number of studies have focused attention specifically on children's learning of the quantifier *most* as a case study in the relation between language and cognition in development. From the perspective of linguistics, *most* poses an important challenge because it differentiates between different candidate logics that might underlie the acquisition of quantifiers (Barwise & Cooper, 1981). Whereas certain quantifiers, like *some* and *all*, can be described straightforwardly using a first-order quantificational logic that quantify over individuals, *most* cannot. For example, in (1a), an expression like “*Every A is a B*” is defined as true only if, for every individual that has the property A, that individual also has the property B. Likewise, expressions involving the quantifier *some* can be modeled in a first order logic that describes relations between individuals (1b). However, by contrast, this approach does not work for *most* – no first order logical expressions that describe relations between individuals can capture its meaning, which is fundamentally a relation between sets.

- (1) a. $[[\text{every}]](A)(B) = \text{True iff } \forall \mathbf{x}[A(\mathbf{x}) \rightarrow B(\mathbf{x})]$
 b. $[[\text{some}]](A)(B) = \text{True iff } \exists \mathbf{x}[A(\mathbf{x}) \wedge B(\mathbf{x})]$
 c. $[[\text{most}]](A)(B) = \text{True iff } |A \cap B| > |A - B|$

Concretely, an expression like “Most of the bananas are in the container” is true only if, for a particular set of bananas, the number of bananas inside the container – i.e., $|A \cap B|$ – is greater than the number of bananas that are not in the container – i.e., $|A - B|$ (or the total number of bananas, minus those in the container). Thus, evaluating the semantics of *most* – and therefore acquiring its meaning – requires representing and comparing the relative magnitudes of sets.

With these assumptions in mind, researchers have investigated how children acquire *most*, and how its acquisition might relate to the types of cognitive representations that support the comparison of sets. In one such study, Halberda, Taing, and Lidz (2008) attempted to differentiate two possible hypotheses about the numerical representations that support the acquisition of *most*. By one view, children learn the meaning of *most* by evaluating and comparing via one-to-one correspondence or counting (Pietroski et al., 2009). Alternatively, they might draw on approximate representations of number, like those found in the evolutionarily ancient and imprecise Approximate Number System (ANS), which are present in preverbal infants (Lipton & Spelke, 2003; Xu & Spelke, 2000), and which allow children to compare sets on the basis of the relative magnitudes (e.g., Dehaene, 1997; Gallistel, 1990). According to Halberda et al., evidence that children use approximate number representations when interpreting *most* – or when learning its meaning in development – would provide evidence for a semantics in which its meaning is rooted in comparisons of approximate magnitudes, rather than in one-to-one correspondence or exact number.

To explore this question, Halberda et al. (2008) asked whether children learn the meaning of *most* before or after they acquire an adult-like understanding of counting,

based on the assumption that children must learn to count in order to represent the notion of exact number and one-to-one correspondence. Although children learn to recite the counting routine beginning at around age 2, they learn the meanings of *one*, *two*, and *three* slowly and in sequence over the next year and a half, and aren't able to accurately count larger sets until the age of 3 and a half or 4 years of age (Le Corre & Carey, 2006; Wynn, 1990, 1992). Thus, according to Halberda et al.'s reasoning, if acquiring *most* depends on exact number, then children should not learn its meaning until at least the age of 3 or 4, on average (an assumption we revisit in the General Discussion). To test this idea, Halberda et al. (2008) tested 100 3-year-olds, and showed them collections of objects (e.g., crayons), in which the majority were either blue or yellow. Children were asked on each trial, e.g., "Are most of my crayons yellow or blue?" Using a linear regression including age and counting ability as predictors, they found that although age predicted children's performance on the *most* task, knowing how to count did not. Based on this, they concluded that "that the acquisition of *most* does not depend on full counting ability—and hence, exact numerical concepts—but rather requires linguistic experience and some other source of numerical knowledge" (p. 112). In particular, they concluded that children's evaluation of *most* – and thus its acquisition – must depend upon representations in the approximate number system.

However, several serious problems challenge this conclusion, raising doubts about both the timeline according to which *most* is acquired, and by extension, what information children might draw on when learning it. First, several studies have reported that children fail to exhibit knowledge of *most* until much later in development. In one such study, Barner, Chow, and Yang (2009) asked children to put *most* of a set into a

container (e.g., “Put *most* of the bananas in the circle”), or to answer “yes” or “no” to questions like, “Are *most* of the bananas in the circle?” In each case, children aged 2 to 5 years of age systematically failed, either giving fewer than half of the objects requested, or accepting sets containing fewer than half when answering yes-no questions (for similar results in Japanese children, see Barner, Libenson, Cheung, & Takasaki, 2009). In another study, Papafragou and Schwarz (2006) found similar failures using a truth value judgment task. Children were presented with a situation in which a dwarf lit different numbers of candles (between 0 and 6 out of 6). The youngest group of children, aged 3- to 5 years old, agreed 60% of the time that the dwarf had lit *most* of the candles when he had lit only 1/6, and 93% of the time when he had lit only 2/6. Also, only 10% denied that he had lit *most* when he had lit all of them. Children aged 6 to 8 years old were better, but far from adult-like. They, for example, accepted situations where the dwarf lit 2/6 almost 40% of the time. Together, these studies call into question the claim that *most* is acquired early, and thus whether it is therefore independent of late-learned skills, such as counting.

A second problem with the assertion that *most* is acquired early emanates from a much earlier set of studies from the 1960's and 1970's, which repeatedly found that children behave similarly to the children in the Halberda et al. (2008) study even when tested with completely novel quantifiers. For example, several studies found that young children initially treat the quantifier *less* as though it means *more* (Carey, 1978; Donaldson & Balfour, 1968; Gathercole, 1985; Palermo, 1973; Wannemacher & Ryan, 1978; Weiner, 1974). This finding spawned a debate about whether *less* actually had a lexical meaning like that of *more*, or whether instead children just had a “more” bias

when the meaning of the quantifier was uncertain, which raised the further question of whether such children even understood *more*. Critical to the present study, the paradigms used to test this question often resembled the comparative method used by Halberda and colleagues (2008) in their studies of children's comprehension of *most*. For example, when shown two trees and asked, "Which tree has less apples?" 3- and 4-year-old children in these earlier studies frequently pointed to the tree with the greater number of apples (e.g., Palermo, 1973). Although some researchers (e.g., Donaldson & Wales, 1970) concluded that children must therefore think *less* means *more*, others reached a different conclusion, and argued that such behaviors emerged from either a complete lack of lexical knowledge, or a very broad default meaning that is much weaker than *more* (Carey, 1978; Clark, 1970). These studies therefore raise the possibility that, in contexts where selecting the set with "more" is consistent with selecting the set with "most", children might appear to understand *most* even in complete absence of such lexical knowledge.

In his discussion of Donaldson and Balfour's early findings, H. Clark (1970) proposed that all quantifiers start out with similar meanings. Specifically, he proposed that, in the initial stages of acquisition, children interpret both *more* and *less* as existential quantifiers like *some* (see also E.V. Clark, 1973). According to Clark (1970):

"In the first stage, *more* and *less* both mean "a quantity of" or "some." A question people might commonly ask a child is "Do you want more food?"... He would encounter *less* also as "some" since it occurs as a single "adjective" modifying *food*. The senses of "quantity of" and "some," of course, are equivalent to the nominal use of *much*."

Clark continues:

"This would explain why *more* and *less* are treated synonymously, although it would not explain why both mean "more" at this stage.... to predict how children will choose among two sizes of objects, we must assume that the notion of "having extent" is best

exemplified by the object having the most extent. As a consequence, when asked to choose the tree with *more*, or *less*, apples on it, the children will point to the tree with more, because it best exemplifies to him “a tree with some apples on it.” (pp. 272-273)

This view predicts that, initially, children should interpret novel quantifiers similarly to *some*, and that they should prefer larger sets when asked to choose between two.

In a similar vein, Carey (1978) found that many children interpret *less* no differently than they do a novel quantifier like *tiv*, and suggested that experimental context might explain such results. In her study, 3- and 4-year-old children were introduced to a puppet who wanted a specific amount of tea in his cup, and who told children to “make it so I have *more/less/tiv* tea here” (for a similar result, see Klatzky, Clark, & Macken, 1973). Although Carey found many patterns of responses, the upshot of her study was that the lexical item *less* played little role in the interpretation of requests by children, and did not differ systematically from *tiv*. Instead, Carey concluded that other factors determine these *more*-like responses. Specifically, she argued that contextual factors such as the syntactic frame within which a word is used, plus a response bias might explain how children interpret *less*.

In the experiments below, we revisited the logic of this earlier literature to resolve the current debate surrounding children's acquisition of *most*. In Experiment 1, we replicated the findings of Barner, Chow, and Yang (2009) and found that, when asked to “give *most*” of a set, 3- to 5-year-old children do not show evidence of adult-like understanding of *most*. In Experiment 2, we replicated these findings, and also tested older children, to document when children first begin to comprehend *most*. Finally, in Experiment 3, we tested whether, despite being unlike adults, younger children nevertheless have some form of preliminary meaning for *most* (e.g., Clark, 1970) or if they instead based their

interpretation of it purely on syntax and a “more” bias, consistent with Carey (1978). To do this, we compared *most* to *some* and to the novel quantifier *blick*. We found that when asked to “give *most*”, four-year-olds’ behavior was statistically indistinguishable from what they gave for *some* or *blick*. Further, when shown two sets and asked which had *most*, their judgments did not differ from those they made for *more* and *blick*, but did differ from their judgments for *some*. Based on these results, we conclude that young children’s early interpretation of *most*, like their treatment of *blick*, is based chiefly on a preference for larger sets when interpreting unfamiliar words (compatible with the contextual account of Carey, 1978), and that an adult-like meaning for *most* is not acquired until around the 6 years of age or older, well after children have learned to count and compare exact cardinalities.

Experiment 1

The first Experiment tested 4-year-olds’ interpretation of *most* using Barner et al.’s (2009) Give-a-Set task. Specifically, we asked whether 4-year-olds give “more than half” when asked for *most*, and whether they differentiate *most* from other quantity expressions including *a*, *some*, *many*, and *all*. Unlike Barner et al. (2009), we conducted two versions of the task. In one condition, children were presented with 8 objects to choose from, whereas in the second condition they were presented with 16 objects. This allowed us to probe whether children assign a proportional interpretation to *most*, even if they fail to give more than half – e.g., in the event that children’s first meaning for *most* is something like “many”. Also, in order to assess the hypothesis of Halberda et al. (2008) that children learn *most* before learning to count, we tested children with Wynn’s (1990, 1992) Give-a-Number task.

Methods

Participants

Participants were 16 English-speaking 4- and 5-year-old children (aged 42- to 60-months; $M = 53.02$ months), recruited from childcare centers in Comox, British Columbia.

Stimuli and Procedure

Each child was tested in a quiet room at their childcare center in a single session that lasted approximately 15 to 20 minutes (although some children took longer). Each child was tested on all three tasks: (1) 8-object Give-a-Set, (2) 16-object Give-a-Set, (3) Give-a-Number; (4) a Yes/No Task, and (5) a Quantity Judgment task. We report tasks (4) and (5) only in the Supplemental Online Materials. The Yes/No task proved too challenging even for adult controls, and thus did not provide an informative test of children's knowledge. The Quantity Judgment task served only as a control for the Yes/No task. There were two task orders: Order 1: 1, 4, 3, 2, 5; Order 2: 2, 4, 3, 1, 5. Critically, the only difference between these orders was the position of the 8-object and 16-object Give-a-Set trials, which are explained below (the excluded tasks always appeared in the same position in the task order).

The Give-a-Set task. In this task, the experimenter asked the child to put a quantity of a specific fruit into a red flat circle using a target word – e.g. “Could you put [*a, most of the, some of the, many of the, all of the*] oranges into the red circle”. In the 8-object version they were presented with 8 strawberries, 8 bananas, and 8 oranges. In the 16-object version they were presented with 16 objects of each kind. The partitive construction was used for *some, many, most, and all* (e.g., *some of the Xs*, instead of *some*

Xs), to make it clear that a subset of the items presented was being requested. Each quantifier was tested twice for each subject, and the number of objects the child gave for each trial was recorded. Quantifiers were presented in two different orders across participants. The red circle was a small plate approximately 8" in diameter; the fruits were approximately $\frac{3}{4}$ " in diameter, and were separated by type (e.g., strawberries were all together; bananas were all together).

Give-a-Number task. This task was adapted from Wynn (1992) and used for evaluating children's comprehension of number words. Stimuli consisted of the same red plastic circle and a set of eight plastic fish. Fish were used to avoid the presence of singular-plural agreement on nouns, a possible cue to numerosity. To begin, the experimenter presented the fish to the child and asked, "Do you like to count? Could you count the fish for me?" Then, the experimenter showed the child the red plastic circle and asked the child to put a certain number of fish onto the circle (e.g., "Could you put six fish into the red circle?"). Following Wynn (1992) we used a titration method. When children successfully gave N fish (e.g., 3) they were then asked to give N+1 fish (e.g., 4). When they failed, they were given a chance to count and correct their response. If they continued to provide an incorrect response, they were then tested with N-1 (e.g., 2). There was one exception to this: Testing began with the experimenter asking for 6 fish. If the child failed to give six, they were next tested on 1 (and next 2, if they succeeded with 1). Testing ended when children had given the incorrect number 2 out of 3 times for a given number.

Children were called N-knowers (e.g., two-knowers) if (1) they correctly gave N fish 2 out of 3 times when they were asked for N, (2) for 2/3 of their responses of N, this

amount was given in response to a request for *N*, and (3) they did not meet these criteria for any higher number. Children were called CP-knowers (Cardinal Principle knowers) if they could correctly give six and seven fish at least two out of three times for each.

Results

Give-a-Set task. We tested children's comprehension of *a*, *some*, *many*, *most*, and *all*. As expected, children gave only one object for *a* most of the time (8 item set: 78%; 16 item set: 88%). Likewise, for *all*, children gave all objects most of the time (8 item set: 81%; 16 item set: 88%). For *some*, children gave an average of 3.9 objects on 8-object trials and 5.5 objects on 16-object trials, while for *many* they gave an average of 5.7 and 10.1 items respectively. More informative than these means is the number of children who consistently gave more than half of the available objects when asked for *most*. To test this, we computed the proportion of children who gave more than half of the available objects on *both* 8-object test trials, and the number who gave more than half on both 16-object trials. For 8-item sets, 37.5% (e.g., $n = 6$) of children consistently provided more than half, while for 16-item sets, 18.75% (e.g., $n = 3$) of children provided more than half on both trials. However, these responses included instances when children give "all" items, which, as we show below, often arise when children are uncertain of how else to respond. When responses of giving "all" items were excluded, only three children (Subjects 4, 46, and 47) gave more than half on both 8-object trials, and only one child (Subject 2) gave more than half (but not all) on the 16-object trials. Across the whole experiment, only one child (Subject 4) gave more than half (including all) on all four trials; when responses of "all" were excluded, this Subject gave more than half on 3 trials.

Figure 1. Histograms of responses on the Give-A-Set task for all quantifiers across age groups and experiments. Rows indicate quantifiers, while Columns indicate experiment and age. Responses are coded as the proportion of items given out of the total number of

items (thus, '1' indicates giving all items, '0' indicates giving none, and '.5' indicates giving half); the dashed vertical line represents the cut-off of a *most*-consistent response, such that every response to the right of the dashed vertical line is *most*-consistent.

To corroborate the finding that children did not demonstrate an adult-like understanding of *most*, we next compared their interpretation of *most* to their interpretation of *a*, *some*, *many*, and *all*. We did this in two ways. First, we asked whether children were more likely to give “more than half” of objects for *most*, relative to the other quantifiers tested. To do this, for each child we computed the mean rate of giving “more than half” (once including responses of “all” and again excluding them). Because the resulting dataset was not truly continuous (in that the proportion could take only the values 0, .25, .5, .75, or 1), we conducted nonparametric comparisons using the Steel Method (Steel, 1959). This analysis allowed us to compare the ranked proportion of “more than half” responses for each quantifier to the proportion of “more than half” responses for *most*. Note that this method corrected for multiple comparisons, and therefore did not inflate the likelihood of a Type I error. In analyses that included responses of “all”, we found that, relative to *most*, children gave significantly fewer “more than half” responses for *a* ($z = 2.87, p = .01$), and significantly more such responses for *all* ($z = -3.80, p = .0006$). More critically, there was no difference between *most* and either *many* or *some* (all $z < |2.10|$, all $p > .10$). Thus, to the extent that children ever gave “more than half” for *most*, this did not differ from what they did for other quantifiers that did not have a “more than half” meaning, like *some*. This conclusion was further supported in an analyses that excluded responses of “all”. Here, the proportion of *most*-consistent responses was higher for *most* ($M = .224$) than for *a* ($M = .016, z = 2.48$,

$p = .048$), but not did not differ for *most* vs. *some* ($M = .16$), or *most* vs. *many* ($M = .52$; all $|z| < 2$, all $p > .15$). Only 3 participants ever gave non-all responses when asked for *all*, and therefore we could not compare *most* to *all*.

Second, we asked whether children's mean responses differed across quantifiers. To do this, we computed the mean number of objects each child gave for each quantifier, separately for the 8- and 16-object trials. We then compared performance across quantifiers using Dunnett's Mean comparison (an analysis that accounts for multiple comparisons). For 8-object trials, the mean number of items given for *most* ($M = 4.84$) did not differ from the mean given for *many* ($M = 5.66$, $p = .55$) or *some* ($M = 3.91$, $p = .42$), but did differ from *all* ($M = 7.41$, $p = .0008$) and *a* ($M = 1.78$, $p < .0001$). For the 16-object trials, we found the same pattern of results. The mean number of items given for *most* ($M = 6.97$) did not differ from that of *many* ($M = 10.13$, $p = .11$) or *some* ($M = 5.50$, $p = .70$), but did differ from *all* ($M = 14.31$, $p < .0001$) and *a* ($M = 1.38$, $p = .0009$).

The results reported thus far indicate that children in our sample had not yet acquired the adult-like "more than half" meaning of *most*, and that only one child consistently gave more than half of objects across all four *most* trials. Nevertheless, it remains possible that although children lacked the "more than half" component of *most*'s meaning they nevertheless had acquired other aspects of its meaning, like the fact that it receives a proportional interpretation, much like *many* (i.e., that what counts as "most" increases as a function of the size of the domain in question, unlike, e.g., *a* or *some*). To test this, we first compared the amount they gave on 8-object trials to the amount they gave on 16-object trials when asked for *most*. We did this by constructing a linear mixed effects model using the lme4 package in R (Bates et al., 2015) predicting the number of items

given from the number of available items, with subject as a random factor. We found that children gave significantly more on 16-object trials than on 8-object trials overall ($B=.27$, $SE = .08$, likelihood ratio test, $p=.002$). However, this analysis alone is not especially meaningful, since responses on the 8-object version of the task were capped at 8, such that even random responding would predict a difference. Thus, we next conducted the same analysis on *some*, for which no proportional meaning is expected, and *many*, for which a proportional meaning is expected. For *some*, we again found that children gave significantly more on 16-object trials than on 8-object trials ($B=.19$, $SE = .07$, likelihood ratio test: $p=.009$). Likewise, for *many* they also gave more items on 16-object trials than on 8-object trials ($B = .56$, $SE = .08$, $p < .0001$).

To assess whether evidence for a proportional meaning differed across quantifiers, we constructed two separate models predicting the number of items given from quantifier (Model A: *Some* vs. *Most*; Model B: *Many* vs. *Most*), Set Size (8 vs. 16), and their interaction. We then compared each model to one that did not include the interaction term. We found that the interaction of quantifier and set size provided additional explanatory value to the model when comparing *most* to *many* ($p = .014$), but not when comparing *most* to *some* ($p = .54$). In other words, there was a bigger difference in the number of items the child gave on 16-item trials vs. 8-item trials for *many* (a proportional quantifier) relative to *most*. There was no evidence that *most* was interpreted more proportionally than *some*. To the extent that children treated *most* as proportional at all, this behavior does not suggest special knowledge of its adult proportional meaning, but instead a tendency to give more objects when more are available.

Give-a-Number task. Using the Give-a-Number task, we found that almost all children in the study were “Cardinal Principle Knowers” by Wynn’s criteria. In other words, when asked to give 6 or 7 fish children correctly counted the requested amount and gave them to the experimenter. There were 11 CP-knowers, two “one-knowers” (who gave one object when asked for *one*, but not when asked for other quantities), one “two-knower”, one “three-knower”, and one “four-knower”. Following the convention of previous studies, we called these non-CP knowers “subset knowers” because they knew the meanings of only a subset of the numbers in their count list. On average, CP-knowers gave at least twice as many correct responses for *most* relative to subset knowers on 8-object trials (23% vs. 10%) and 16-object trials (20% vs. 0%). At first gloss, this would appear to be at odds with the conclusion of Halberda et al. (2008) that learning to count is unrelated to knowledge of *most*. However, since there was so little variability in knower level (only 5 subset knowers), and only one child ever consistently gave adult-like responses on questions related to *most*, it remains unclear whether knowledge of counting influences children’s interpretation of *most*. Thus, although we cannot say that learning *most* depends on first learning to count, we can say that an adult-like understanding of *most* does not emerge before children learn how counting represents number, which is consistent with previous reports that *most* is acquired relatively late in acquisition (Barner et al., 2009a; Papafragou & Schwarz, 2006), but not with experiments that suggest children know *most* before they learn to count (Halberda et al., 2008)

Experiment 1 Discussion

Experiment 1 revealed three findings. First, replicating Barner et al. (2009), we found that when children were asked to give a set of objects – e.g., *most of the bananas* –

they always gave some amount of the appropriate kind, but rarely gave adult-like responses that reflect a “more than half” meaning. In fact, only one child did so consistently across four trials. Second, children did not appear to differentiate *most* from either *some* or *many* with respect to how often they gave “more than half”. Third, we found no evidence that children assigned *most* a proportional interpretation. When tested with 8 and 16 objects, children gave slightly more for 16, but not to a greater degree than when tested with *some*, despite clearly giving more for *many*, another proportional quantifier. Finally, we found that almost all of the children in our sample were Cardinal Principle knowers. This suggests that, at least in our sample, almost no children learned *most* before learning to count.

Experiment 2

Experiment 1 showed that 4-year-old children do not yet have an adult-like interpretation of *most*. In Experiment 2 we had two goals. First, to corroborate this result, we introduced an additional test of *most*. In this test, children were presented with two characters, each of whom began with a set of objects, a subset of which were removed in some way (e.g., balloons were popped), such that one character lost most (more than half but not all) of their objects. On half of trials, the character who lost most of their objects also lost more than the other character, whereas on the other half of trials the character who lost most of their objects lost fewer than the other character. This manipulation provided a first test of the idea that children's sometimes adult-like responses to *most* may sometimes be driven by a “more” bias.

The second goal of Experiment 2 was to test the age at which children first begin to provide adult-like responses for *most* on the Give-a-Set task. To do so we tested 4-, 5-,

and 6-year-olds. As part of this, we also tested adults, to confirm the validity of the methods used. Also, we added two new trial types, not present in Experiment 1, in which we asked children to give either *more* or *the most*. The first trial type was included to test whether children differentiate *most* from *more*, to test the possibility that children might initially assign both words the same meaning (for discussion of a related idea, see Hackl, 2009). The second trial type explored the possibility that children initially favor a superlative interpretation of *most* akin to *the most* (potentially explaining a failure to assign the word a “more than half” reading). We predicted that if children conflate either set of meanings, then their behaviors on the Give-a-Set task may be similar, in contrast to behaviors for adults, who should always differentiate these forms.

Method

Participants

Participants were 57 English-speaking children (20 4-year-olds: $M_{\text{age}} = 4;5$, Min = 4;0, Max = 4;11; 20 5-year-olds: $M_{\text{age}} = 5;5$, Min = 5;0, Max = 5;11; 17 6-year-olds: $M_{\text{age}} = 6;6$, Min = 6;1, Max = 6;11) and 24 adults. One four-year-old only completed 2 out of 3 tasks, but was still included in final analyses. Children were recruited from San Diego area daycares, preschools, and museums, and from a recruitment database maintained at UCSD. An additional 14 children participated but were outside of our target age range and were not analyzed further. Adults were recruited using a departmental study pool.

Stimuli and Procedure

Each participant was tested in a single session that lasted approximately 15 minutes, though some participants took longer. Each participant was tested on three tasks. They first were tested on (1) 8 object Give-a-Set, and the (2) Most Comparison Task, always in

this order. Then, as in Experiment 1, they were also tested on one additional task that we report in the SOM only, since it proved too difficult even for adults and therefore cannot be used to draw conclusions about children's comprehension of *most*.

The Give-a-Set task. As in Experiment 1, the experimenter asked the participant to put a quantity of a specific fruit into a red flat circular plate (approximately 8" in diameter) using a target word (e.g. "Could you put [*a, some of the, blick of the, many of the, more of the, most of the, the most*] [*bananas, strawberries, oranges*] into the red circle?").¹ Fruits were approximately ¾" in diameter, and were separated by type. Each quantifier was tested twice for each participant, and the number of objects the participant gave for each trial was recorded. Quantifiers were presented in two different orders across participants.

Most Comparison task. In this task, the participant was introduced to two characters (Amanda and John). They were then told a short story, accompanied by pictures that depicted characters with two sets, a subtraction event, and then the final amounts each character had (see Figure 2).

¹ While the request "Can you put more of the bananas into the circle" is strange in isolation, it is felicitous when uttered after a previous request to give bananas (where "more" can be interpreted as "additional"). Therefore, requests for "more" were never presented as the first trial in this experiment.

Figure 2. Example stimuli for the Most Comparison task (participants heard the description of the pictures narrated).

For example, on one trial the participant heard (and saw), “Amanda had 9 paintings. John had 4 paintings. Amanda sold 4 of her paintings. John sold 3 of his paintings”. The critical question was, “Who sold *most* of their paintings”. Here, Amanda sold *more* paintings than John, and also sold *the most* paintings. However, she sold fewer than half of her paintings (meaning that she did not sell *most* of her paintings). Instead, while John sold fewer paintings than Amanda, he sold *most* of his paintings. We reasoned that if participants comprehend *most* then they should select John when asked “who sold *most* of their paintings”. However, if children instead treat *most* like *more* (Clark, 1970; Carey, 1978) they may instead choose the character who sold more items. Each participant (children and adults) completed 8 trials of this task. On four control trials, the character

who sold *more* items also sold *most* of their items (congruent trials); on four critical trials, the character who sold fewer items overall sold *most* of their items (incongruent trials).

Results

Give-a-Set task.

As in Experiment 1, we tested participants' comprehension of *a*, *some*, *many*, *most*, and *all*. As expected, children gave only one object for *a* most of the time (4 YOs: 85%; 5 YOs: 85%; 6 YOs: 91%; Adults: 100%). For *some*, children tended to give just over half of the available items, and adult participants tended to give just under half of the available items (see Table 1), and the same pattern was evident for *blick*. For *more*, *many*, and *the most*, participants tended to give over half of the available items. Finally, for *most*, participants, on average, gave more than half of the items (see Table 1).

Table 1. Mean number of items given, by age and quantifier, in Experiment 2.

	Age (Years)	A	Some	Blick	Many	More	The Most	Most
Mean Number Given (out of 8)	4	1.8	4.3	4.7	6	6.6	5.9	5.1
	5	1.8	4.5	4.7	5.9	6.4	6.4	5.5
	6	1.3	4.6	3.7	5.7	6.1	6.5	5.6
	Adult	1	3.7	2.3	5.5	5.3	7.3	6

We next computed the proportion of participants who gave more than half of the objects on both test trials when ask for *most*. We found that while our youngest participants appeared to not consistently give more than half of the items when asked about *most*, performance improved modestly with age (4 YOs: 33%; 5 YOs: 50%; 6 YOs: 59%; Adults: 100%). When excluding trials on which the child responded with “all”, we still did not find universal success at any age in childhood (4 YOs: 22%; 5 YOs: 43.75%; 6 YOs: 56.25%; Adults: 100%).

As in Experiment 1, we next calculated the mean rate of giving “more than half” (and another for giving “more than half but not all”) for each participant. Again, we conducted nonparametric comparisons using the Steel Method, comparing the rate of *most*-consistent responses for *most* to each quantifier (*a*, *some*, *blick*, *more*, *many*, *the most*). We found that for all age groups, the proportion of “more than half” responses was lower for *a* when compared to *most* (4 YO: $z = 3.87$, $p = .0006$; 5 YO: $z = 3.70$, $p = .0012$; 6 YO: $z = 3.27$, $p = .006$; Adults: $z = 6.84$, $p < .0001$), and the same pattern of results held when responses of “all” were excluded (all $z > 3.2$, all $p < .01$). For 4- and 5-year-olds, no other quantifiers differed from *most* (all $|z| < 2.2$, all $p > .10$). For 6-year-olds the proportion of *most*-consistent responses was lower for *blick* compared to *most*, whether responses of “all” were included ($z = 3.27$; $p = .006$) or excluded ($z = 3.83$, $p = .0007$). Beside *a* and *blick*, no other quantifier differed from *most* in terms of the frequency of more-than-half responses. This suggests that 6-year-olds may be starting to differentiate *most* from completely novel words, though additional tasks below suggest that, if this is so, their knowledge even at this age remains quite fragile. To summarize, we found no evidence that children provided *most*-consistent responses at different rates for *most* relative to *some*, *more*, *many*, or *the most*. In contrast, adults provided *most*-consistent responses more for *most* than for *blick* ($z = 6.72$, $p < .0001$), *some* ($z = -6.41$, $p < .0001$), *many* ($z = 2.57$, $p = .048$), and *more* ($z = 3.69$, $p = .001$). For them, the only expression that did not differ from *most* was *the most* ($z = -.96$, $p = .85$). When responses of “all” were excluded, the only quantifier affected was *many* ($z = 2.57$, $p = .051$), resulting in no difference from *most*.

Next, we asked whether participants differentiated their interpretations of *most* from other quantifiers. To do this, we computed the mean number of objects given for each participant for each quantifier, and then used Dunnett's Mean Comparison to compare the mean number given for each quantifier to *most*. We first consider adults. Adults differentiated their interpretation of *most* ($M = 6.04$) from *the most* ($M = 7.33$, $p < .0001$), *more* ($M = 5.33$, $p = .02$), *some* ($M = 3.67$, $p < .0001$), *a* ($M = 1.00$, $p < .0001$), and *blick* ($M = 2.29$, $p < .0001$). The only quantifier that they did not differentiate from *most* was *many* ($M = 5.48$, $p = .09$). Thus, adults differentiated *most* from every quantifier tested except for *many*.

In contrast, children's performance on this task indicated a general failure to differentiate *most* from other quantifiers. Four-year-olds differentiated their interpretation of *most* ($M = 5.12$) from *a* ($M = 1.76$, $p < .0001$) and from *more* ($M = 6.59$, $p = .023$), but not from any of the other quantifiers (all $p > .30$). Five-year-olds differentiated their interpretation of *most* ($M = 5.0$) from *a* ($M = 1.78$, $p < .0001$), but not from any other quantifier (all $p > .20$). Six-year-olds differentiated their interpretation of *most* ($M = 5.56$) from *a* ($M = 1.32$, $p < .0001$) and *blick* ($M = 3.71$, $p = .004$), but not from any other quantifier (all $p > .25$). Together, these data suggest that children up to age six do not have an adult-like interpretation of *most*, and fail to differentiate most quantifiers from one another. This is in sharp contrast to adults, who differentiated *most* from *a*, *some*, *blick*, *more*, and *the most*.

Table 2. Give-a-Set results across experiments and ages. "Yes" vs. "No" indicates whether participants differentiated a quantifier from *most*, using Dunnett's Mean

Comparison.

Experiment #	Age (Years)	A	Some	Blick	Many	More	The Most	All
Experiment 1	4	Yes	No	-	No	-	-	Yes
Experiment 2	4	Yes	No	No	No	Yes	No	-
	5	Yes	No	No	No	No	No	-
	6	Yes	No	Yes	No	No	No	-
	Adult	Yes	Yes	Yes	No	Yes	Yes	-
Experiment 3	4	Yes	No	No	-	No	-	Yes

Most Comparison Task

In this task, we asked whether children interpret *most* as “more than half” or instead just as “more”. On *most/more* congruent trials, in which, e.g., 2/5 of John’s balloons popped while 6/9 of Amanda’s balloons popped, four-year-olds correctly selected the character who had popped the larger quantity 82.5% of the time, five-year-olds did so 82% of the time, 6-year-olds did so 99% of the time, and adults 100% of the time. Thus, when *most* and *more* were confounded, all groups performed well on the task. On critical, incongruent, trials, in which the character who had, e.g., popped most of the balloons did not pop more, children rarely chose the adult-like response: Four-year-olds selected the character who had popped *most* of their balloons 21% of the time; five-year-olds did so 26% of the time, and six-year-olds 13% of the time. Adults, in contrast, provided *most*-consistent responses 87.5% of the time. A Dunnett’s Mean Comparison showed that each age group differed from adults (all $p < .0001$). This suggests that children’s interpretation of *most* is not yet adult-like, even by age 6.

Experiment 2 Discussion

In Experiment 2, we once again demonstrated that 4-year-olds do not have access to adult-like interpretations of *most*. New to Experiment 2, we also showed that 5-year-olds struggled to interpret *most* in an adult-like way, and that about half of 6-year-olds consistently gave more than half when asked for *most*. Thus, while children showed

developmental improvement in the interpretation of *most*, it appears that even by age 6, a substantial number of children are still in the process of learning *most*. Critically, even these older children failed to differentiate *most* from *some* or *more*. The Most Comparison Task corroborated children's difficulties with *most*, though this task may have been more difficult for children, given that it required them not only to identify whether *most* was true for each particular character, but also to override any bias they might have to prefer large sets (which may persist even as children's "more than half" meaning is first emerging at around the age of 6). Compatible with the worry that this task was slightly harder than the others used in this paper, although adults did well on the task they also weren't perfect. Thus, results regarding this particular task should be interpreted with caution, and in the context of the results from the other data presented here, which provide a stronger case for the claim that most young children lack a "more than half" meaning for *most*.

Experiment 3

In Experiment 2, we provided evidence that, by some metrics, children begin to interpret *most* in an adult-like fashion by around the age of 6. However, we also showed that even these older children continued to struggle to interpret *most*, and, across two tasks, failed to differentiate *most* from "more".

In Experiment 3, we further explored this "more" bias, and in particular whether it might explain results from Halberda et al.'s (2008) study. In their study, 3-year-old children responded correctly when shown two sets and asked, "Are *most* of my crayons yellow or blue?" Results from Experiments 1 and 2 suggest that these young children do not comprehend *most*, but instead interpret it similarly to *more* by default. To explore

this, we contrasted children's interpretation of *most* with their treatment of *some*, and also a novel quantifier, *blick*. This allowed us to contrast two different ideas concerning children's treatment of *most*. First, Clark's (1970) hypothesis that children initially interpret all quantifiers as existentials (e.g., like *some*) predicts that they should not differentiate *most* from *some* or a novel quantifier *blick*, but that they should select larger sets in comparative contexts, since they constitute better exemplars of "some". A second possibility is that children's interpretation of *most* does not reflect a meaning like *some*, but instead is fully determined by contextual factors, like a preference for larger sets (Carey, 1978). On this hypothesis, children should differentiate *most* from *some*, but not from unfamiliar or novel quantifiers, like *blick*. To test these predictions, we assessed children's interpretation of *some*, *blick*, *most*, and *more* using both the Give-a-Set task and a new task: The Quantity Judgment task.

Method

Participants

We tested 105 English-speaking children, recruited from San Diego area daycares, preschools, and museums, and from a recruitment database maintained at UCSD (mean age: 4;6, range: 4;0-4;11). A total of 71 children participated in the Quantity Judgment task, and 34 children participated in the Give-a-Set task (an additional 3 children participated in a non-standard version of the Give-a-Set task and were not included in our participant count). Participants who were outside of our target age range (Quantity Judgment $n = 5$; Give-a-Set $n = 3$) or whose age could not be determined (Quantity Judgment: $n = 1$; Give-a-Set: $n = 1$) were excluded. Two children were excluded from the Quantity Judgment task due to experimenter error. Two children were excluded from the

Give-a-Set task for failure to provide the correct number of items on trials requesting *two*, which we included to make sure children were attending to the task; an additional three subjects were excluded from the Give-a-Set task for being non-native speakers of English. Five participants were excluded from the Give-a-Set task for failing to complete enough trials to be analyzed. These exclusions resulted in a final *N* of 20 participants for the Give-a-Set task, and a final *N* of 63 for the Quantity Judgment Task.

Stimuli and procedure

Participants were assigned to *either* complete the Give-a-Set task *or* the Quantity Judgment task.

Give-a-Set. Children completed 21 test trials: three trials each of seven words (*two, a, some, more, most, all, blick*). Children were seated at a table with an experimenter, and were presented with 16 small plastic fruit. The experimenter asked the child, “Can you give me *X* [of the] fruit?”, where *X* was one of the seven words listed above. Trial order was counterbalanced, and the type of fruit was varied across trials.

Quantity Judgment task. In this task, children were randomly assigned to a quantifier condition. The words *some, most, and blick* were tested between subjects to preclude order effects or perseveration, and each child was given only one critical trial. The study was designed to be brief in order to permit testing in a museum, and also because pilot studies in the lab found little variability in children's responses when more trials were included. Children were presented with two characters, Farmer Brown and Captain Blue. The experimenter placed an unequal number of fruits (bananas, oranges, or strawberries) in front of the two characters and asked the child one of three possible test questions, e.g., “Who has [*most, some, blick*] of the bananas?”. Each child received one critical trial

where the characters had 7 vs. 14 fruits (thus 21 total fruits visible), and two filler trials (10 or 1 vs. 0) to check whether children were attending to the task.

Results

Give-a-Set task.

As in Experiments 1 and 2, we tested children's comprehension of *a*, *some*, *blick*, *more*, *most*, and *all*. As expected, children gave only one object for *a* most of the time (81.7% of the time). Likewise, for *all* children gave all objects most of the time (90%). As in previous experiments (Table 2), we found that participants did not differentiate *most* from the majority of other quantifiers. Specifically, using Using Dunnett's Mean Comparison, we found that participants did not provide a different number of items for *most* ($M = 6.8$) relative to *blick* ($M = 7.7$), *some* ($M = 6.3$), or *more* ($M = 9.5$; all $p > .10$). Participants did, however, differentiate *most* from *all* ($M = 15.3$, $p < .0001$) and *a* ($M = 3.0$, $p = .007$).

We next calculated the proportion of participants who gave more than half of the objects on all three test trials and found that, when asked for *most*, only one participant consistently provided "more than half", and this was true whether or not trials on which they gave "all" items were excluded. As in Experiments 1 and 2, we computed the mean rate of giving "more than half" (and another for giving "more than half, excluding all") for each participant. We then used the Steel Method to non-parametrically compare the proportion of *most*-consistent responses provided for *most* to the proportion of *most*-consistent responses given for the other quantifiers (*a*, *some*, *blick*, *more*, *all*). We found that, when compared to *most*, the proportion of more-than-half responses was higher for *all* ($z = -5.79$, $p < .0001$) than for *most*, and the proportion of more-than-half responses

did not differ for *most* vs. any other quantifier (all $|z| < 2$, all $p > .2$). When excluding responses of “all”, no quantifier differed from *most* ($M_a = .06$; $M_{\text{blink}} = .24$; $M_{\text{more}} = .21$; $M_{\text{most}} = .18$; $M_{\text{some}} = .09$; all $|z| < 2.3$, all $p > .10$). As before, only 2 participants ever gave non-all responses when asked for *all*, so we could not compare *most* to *all* in an analysis that excludes responses of all.

Forced Choice Quantity Judgment task

On 85% of all trials and on 73% of critical (7 vs. 14) trials, children selected the character with more items. However, their judgments differed as a function of the quantifier tested. Overall, participants in the *most* and *blink* conditions preferred to select the character with more items more often than would be expected by chance. On the critical trials (7 vs. 14), all children (19/19) selected the larger set when asked about *most* (binomial $p < .0001$). Similarly, 17/22 children (77%) tested with *blink* selected the character with more items (binomial $p < .01$). Fisher's exact test revealed that the frequencies of selecting the larger set differed marginally between *blink* and *most* ($p = .051$). In contrast, children tested with *some*² did not show such a preference, and only 10/22 (45%) chose the larger set (binomial $p > .8$); this differed significantly from *most* ($p < .0001$) and marginally from *blink* ($p = .06$). An analysis that removed children who made at least one error on filler trials ($n=6$) found the identical pattern of results.³

Consistent with the results from the Give-a-Set task, participants performed similarly for

² Note that, for *some*, both characters had “some”, and thus children performed equivocally on this trial type.

³ In the *most*-condition, 19/19 selected the character with more. In the *blink*-condition, 15/17 selected the character with more. In the *some*-condition, only 10/20 selected the character with more.

blick and *most*. However, in contrast to the findings of that task, children treated these words like *more*, and differently from *some*.

Experiment 3 Discussion

On two tasks, children failed to exhibit adult-like comprehension of the word *most*. First, on the Give-a-Set task, children gave similar quantities for *blick*, *some*, and *most*, and thus did not give “more than half” for *most* more frequently than predicted by random responding. Second, when *blick* and *most* were used in a comparative context, children interpreted them both as though they meant *more*. Because *blick* is a novel word and therefore has no lexical meaning, children’s interpretation of *most* on this task, while perhaps compatible with an adult-like meaning, is also compatible with having no meaning at all, and a preference for larger sets when interpreting unfamiliar words. Consequently, this type of task cannot in isolation provide positive evidence for adult-like comprehension of *most*.

Critically, children exhibited a different pattern of responses when presented with *some* on the comparative task. Specifically, they did not have a “more” bias. This suggests that when children have a specific lexical meaning, this meaning, rather than a bias, determines their judgments. Further, it suggests, contrary to Clark (1970), that children’s interpretation of novel quantifiers does not result from a meaning like *some*, or a simple preference for larger sets. It does not appear that novel quantifiers are always interpreted like *more*. When asked to give a set (i.e., put things into a container), children gave reliably larger amounts for *more* than for either *blick*, *most*, or *some*. Therefore, rather than relying on fixed meanings children appear to interpret these words based

chiefly on contextual factors like the syntax of an expression, or a preference for larger sets when interpreting unfamiliar words (Carey, 1978).

General Discussion

The purpose of this study was to investigate when children first acquire a “more than half” meaning of *most*, and whether this comes before children learn to count. We were also interested in understanding whether, before children acquire its adult-like meaning, children initially assign *most* a stable, default, meaning like “some” (e.g., Clark, 1970) or whether, compatible with Carey (1978), children’s behaviors might instead be driven by a response bias (e.g., a preference for larger sets) and other contextual factors like the syntax of the experimenter’s request. One recent study (Halberda, Taing, & Lidz, 2008) presented evidence that children acquire the meaning of *most* by as early as 3 years of age, and that, because this learning occurs before children learn to count, it must not depend on a prior understanding of exact cardinality, but instead on approximate number representations (see also Lidz, Pietroski, Hunter, & Halberda, 2011; Pietroski, Lidz, Hunter, & Halberda, 2009). Other studies, however, have found that children acquire *most* much later (Barner, Chow, & Yang, 2009; Papafragou & Schwarz, 2006). Here, we hypothesized that this disparity is due to differences in methodology, and that, in particular, earlier estimates of knowledge are due to the use of a two-alternative forced choice task, in which children are known to have a bias to select larger sets, even for totally novel quantifiers (Carey, 1978).

To show this, we conducted three experiments. In Experiment 1, we replicated the findings of Barner et al. (2009), that 4- and 5-year-old children do not give more than half when asked to put, e.g., “*Most of the oranges in the circle*”, despite reliably giving a

single item for *a*, all items for *all*, and a subset of items for *some* (see Fig. 1). This result was found when children selected from a small set of 8 objects, or a larger set of 16 objects, which showed that children do not assign a proportional meaning to *most*, despite treating *many* proportionally. Critically, almost all of the children in Experiment 1 were competent counters and could count and give large sets of objects upon request, and succeeded robustly on our control trials. Thus, as least in this sample, children likely learned *most* after learning to count.

In Experiment 2, we asked at what age children begin to give “more than half” when asked for *most* and found that this behavior began to emerge at around 6 years of age – a full 2 to 2 and a half years after children generally become competent counters in the US (Wynn, 1990, 1992). However, even at this point, children’s interpretation of *most* was far from adult-like. Not only did many children still fail to give “more than half”, but Experiment 2 also provided evidence that many continued to interpret *most* to mean “more”. When presented with two characters who each gave a proportion of their possessions, and asked “Who gave *most* of their things?” children of all ages, but not adults, overwhelmingly chose the person who gave a greater absolute number (i.e., *more*), not the person who gave more than half of their things (i.e., *most*). However, this particular measure may have been more difficult than others used in this study, because it required children to determine whether each of two characters had, e.g., popped most of their balloons, and to then compare these outcomes, rather than just determining which of the characters had the largest set of items. Thus, it not only required comprehending *most* but also overriding any potential bias to simply choose large sets. It’s possible that during the earliest moments of children’s comprehension of *most* (around the age of 6) that their

emerging knowledge of the word's meaning is swamped by this "more" bias in tasks such as this that cannot be solved by simply picking the largest set. Critically, however, such considerations cannot explain why children fail to give more than half in the Give-a-Set task.

Finally, in Experiment 3, we again replicated the finding that preschoolers almost never give "more than half" when asked for *most*, and also found that they give similar amounts when asked to give *blick* or *some* of the objects, suggesting that they have little idea what *most* means. Also, against the hypothesis of Clark (1970), a quantity judgment task ruled out that children think *most* means "some". Children were shown two characters, one of whom had twice as many objects as the other, and asked, e.g., "Who has *most/blick/some* of the bananas?". We predicted that, in the absence of item-specific knowledge of a quantifier, any unfamiliar word (like *blick*) used within the argument structure of *most* would lead to a "more" bias (as was found in Halberda et al., 2008). Consistent with this, for both *most* and *blick*, but not for *some*, children generally chose the character with the larger set. This again suggests that children's interpretation of *most* is consistent with a complete lack of knowledge of its meaning. Importantly, even though Experiments 2 and 3 used nonsense words (which may have introduced some difficulty for some children), the overall pattern of our data across all three experiments suggests children performed well for familiar quantifiers, and had selective difficulty with the word *most* until at least 6 years of age. Across three experiments, only 9/57 (15.8%) of four-year-old children consistently gave a response of more than half (including responses of giving all objects), and only 6/54 (11%) children consistently gave a response of more than half when responses of giving "all" were excluded, neither of

which differed significantly from how children responses to the words *some* and *blick*, suggesting that even the small number of adult-like responses we found may not have resulted from adult-like lexical knowledge of *most*.

Consistent with early work by Carey (1978), who explored why children appear to interpret *less* like *more* in early acquisition, our experiments suggest that children have a “more” bias when asked to make comparative judgments, and also that they do not have a stable, contextually invariant assumption about what unknown quantifiers mean – e.g., they don't simply assume that novel quantifiers mean “some”. Also children in our study treated *most* and *blick* alike on quantity judgment task, and revealed a “more” bias for both, despite the fact that *blick* was entirely novel. This result is especially significant, since it not only conforms to a consensus reached in the 1970's and 1980's regarding children's understanding of *more* and *less*, but also explains how children could lack a meaning for *most* yet still perform as they did in the Halberda, Taing, and Lidz (2008), which used a comparative method similar to ours (and earlier studies) and found similar results.

In their study, Halberda et al. (2008) argued that children learn *most* before they learn to count, sometime around age 3, and that they do so by mapping the word to approximate, non-linguistic number representations. However, the results from the current study suggest a different conclusion. Rather than testing how children evaluate a “more-than-half” meaning, these previous experiments may have instead tested how children verify unknown words in comparative contexts. As noted in the Introduction, the Halberda et al. (2008) study required children to interpret *most* as one might interpret *more* – i.e., in comparative contexts containing two sets. Although choosing the larger of

two sets is indeed consistent with adult-like knowledge of *most*, it is also consistent with a “more” bias. Importantly, when our methods were similar to those in Halberda et al. (2008) – i.e., when we allowed children to make judgments about *most* in comparative contexts – we found similar results: Children in our study chose the larger set 100% of the time. However, when we introduced new methods that required judgments about *most* in non-comparative contexts, children failed to comprehend *most*. Thus, we conclude that most 4-year-olds do not, in fact, know the meaning of *most*. Instead, it appears that children interpret *most* and other unknown quantifiers as though they are comparative quantifiers whenever they are used in comparative contexts.

Why might *most* be acquired so late in development? We see at least two (mutually compatible) possibilities. First is the problem of input. It is perhaps unsurprising that *most* is acquired late given to its very low frequency in children's input and output, which we assessed by analyzing data from the Manchester corpus (Theakston, Lieven, Pine, & Rowland, 2001) in the CHILDES database (MacWhinney, 2000). In this corpus, 12 children (starting at or around their 2nd birthday) were recorded twice every three weeks for a year for a total of 344 hours of data. Across this corpus, the word *most* was used by the 12 children a combined total of five times (all by a single child, and all in the construction “eating a most delicious yum yum”), and by parents only 65 times. Of these 65 utterances, only about half were potentially consistent with a more-than-half interpretation (e.g., “most frogs jump”) while the remainder were clearly not (e.g., “I am most uncomfortable”; “That really is most horrible”; “I don't know that it's the most effective way of transport”, or idioms like “Let's make the most of it”). This is in contrast to the input received for other quantifiers like *some* and *more*. Over the same period,

children heard *some* a total of 5,219 times and produced it 2,800 times; they heard *more* a total of 2,339 times and produced it 2,146. Thus, while it is not possible to draw strong conclusions about the frequency of particular utterances in naturalistic speech from a single CHILDES analysis, it seems unlikely that young children are getting rich linguistic input about the meaning of *most* early in development.

A second possible explanation for the late acquisition of *most* relates to the cognitive and logical demands involved in verifying its conditions of application. Given children's relatively late acquisition of *most* – around 6 years of age – it seems possible, contrary to Halberda et al. (2008), that counting ability does in fact play a role in the acquisition of an adult-like meaning for *most*. However, while this is possible, we see two problems with the logic of attempting to link the acquisition of *most* to counting. First, counting is a behavior that depends on culturally constructed symbolic systems that are not universal among humans and depend heavily on formal instruction, whereas quantifiers can generally be learned without formal instruction, and presumably existed before most humans became numerate (Corbett, 2000; Epps, 2006; Frank et al., 2008; Gordon, 2004; Ifrah, 2000; Menninger, 1969; Pica et al., 2004). Thus, unless we assume that *most* can only be acquired by numerate children, this general line of inquiry seems implausible on its face. Second, although counting ability emerges late, it is unlikely that counting is required for understanding exact equality, as indicated by a number of recent studies, which suggest that (1) children's developing understanding of equality and one-to-one correspondence is uncorrelated with learning to count (Jara-Ettinger, Piantadosi, Spelke, Levy, & Gibson, 2016), and (2) before learning to count children across multiple cultures learn meanings for number words up to *three* or *four* that rely on an implicit

understanding exact equality, and do so beginning just after their second birthday (Almoammer et al., 2013; Marušič et al., 2016; Le Corre & Carey, 2007; Le Corre et al., 2016; Piantadosi et al., 2014; Sarnecka et al., 2007; Wynn, 1990, 1992). While counting is one way to compare exact numerosities, it is not the only way, and certainly not the only method available to young children. Consequently, it is unlikely that children's late acquisition of *most* is due to the fact that counting is also late-learned. Most likely is that *most* is relatively infrequent in children's input, and unlikely to be used to represent a "more than half" meaning.

In sum, across three studies we provided evidence that most preschool aged children do not yet have an adult-like meaning for *most*, that behaviors compatible with comprehending *most* can be explained by a well-attested "more" bias that arises in comparative contexts, and that acquisition arguments premised on its early emergence are therefore unlikely to be valid. Instead, most children appear acquire an adult-like meaning for *most* sometime around or after the age of 6, likely because *most* is very infrequent in caregiver speech.

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