Climbing the highest mountain:
Children's knowledge of absolute and relative readings of superlatives[*]

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Abstract

Sentences containing superlative expressions, such as "Donkey climbed the tallest tree", are ambiguous between an ABSOLUTE interpretation and a RELATIVE interpretation (Szabolcsi 1986; Heim 1999). The two readings differ in their comparison sets, i.e. which set of individuals are to be compared against each other. Corpus studies reveal that child and caregiver productions of superlatives involve the ABSOLUTE interpretation (Tieu & Shen 2015). In line with this finding, previous experimental data suggest that children have difficulty accessing RELATIVE readings, instead preferring ABSOLUTE readings (Arii 2011). We present two experiments revealing that when the relevant comparison sets for the two interpretations are made salient, children as young as 3 years of age can access both ABSOLUTE and RELATIVE interpretations of superlatives.

1 The ABSOLUTE-RELATIVE ambiguity

The sentence in (1), which contains the superlative expression "the tallest tree" in object position, is ambiguous between two possible readings (Szabolcsi 1986; Heim 1999). On one reading, termed the ABSOLUTE reading, the sentence is true in the scenario depicted in Figure 1(a), where Donkey has climbed the tallest of the set of salient trees. On the alternative reading, termed the RELATIVE or COMPARATIVE reading, the sentence is true if Donkey has climbed higher than any other salient climbers, for example as depicted in Figure 1(b). These readings can be paraphrased as in examples (1a) and (1b), respectively.
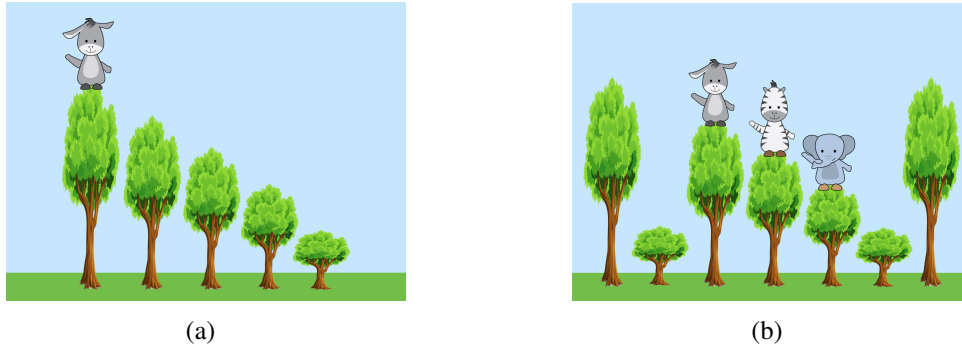
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Figure 1: (a) A scenario that makes (1) true on the ABSOLUTE reading. (b) A scenario that makes (1) true on the RELATIVE reading.

(1)   Donkey climbed the tallest tree.

    a.   Donkey climbed a tree that was taller than the other trees.   ABSOLUTE

    b.   Donkey climbed a taller tree than the other climbers.   RELATIVE

The ambiguity of sentences like (1) has traditionally been subjected to two kinds of analyses: a pragmatic context-based analysis (Heim 1999; Farkas & Kiss 2000; Sharvit & Stateva 2002) and a syntactic movement-based analysis (Szabolcsi 1986; Heim 1999; Aihara 2009). In both analyses, what sets the ABSOLUTE and RELATIVE readings apart is the comparison set of candidates to be compared. For the ABSOLUTE reading of (1), the comparison set contains all five trees in Figure 1(a): among the five trees, the one that Donkey climbs is tall to a degree that no other tree in the set is. For the RELATIVE reading of (1), the syntactic analysis takes the comparison set to be the set of tree-climbers in Figure 1(b), while the pragmatic analysis takes the comparison set to be the set of trees that are climbed in Figure 1(b).

Our study will not bear on the differences between the two theories. What we are interested in is whether children are actually able to access the two possible interpretations of the superlative.

2   Children's acquisition of superlatives

Most developmental studies of superlatives have focused on the emergence of superlative morphology in children's spontaneous production, comparing it to other degree constructions (Hohaus & Tiemann 2009; Berezovskaya 2013) or to other grammatical suffixes like plural marking (Warlaumont & Jarmulowicz 2012).[1] Corpus studies reveal that superlatives emerge relatively late in spontaneous production. For instance, Hohaus & Tiemann (2009) report that superlatives emerged between 4;01 and 4;08 for three English-speaking children, and between 3;07 and 4;05 for three German-speaking children, while Berezovskaya (2013) reports the emergence of superlatives at 4;06 and 5;04 for two Russian-speaking children. These studies also find that superlatives emerge after comparative morphology has already been acquired, and that there are generally few errors in children's spontaneous production of superlatives.

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[1]Though see Wellwood et al. (2012) and Wellwood et al. (2016) for research on how children acquire the quantity-based meanings of superlative determiners such as *most*.

Focusing in particular on the possible ambiguity of superlatives, Tieu & Shen (2015) examined a sample of children's and caregivers' spontaneous productions of superlatives in the Brown corpus (Brown 1973, CHILDES database, MacWhinney 2000). They took into account the preceding and subsequent discourse context in order to determine the most likely intended interpretation, and reported finding instances only of the ABSOLUTE interpretation, for example, *he's the funniest baby I ever had*, produced by the child Adam at age 4;02,17. The sample of caregiver input was consistent with the children's productions in containing only instances of the ABSOLUTE reading.

This state of affairs could be consistent with ABSOLUTE readings emerging prior to RELATIVE readings. Indeed, Arii (2011) reports an experimental study of superlatives in Japanese that revealed that even 6-year-old children struggle to access the RELATIVE interpretation of superlatives. Arii used a truth value judgment task to investigate participants' interpretation of two kinds of sentences in Japanese that can exhibit the ABSOLUTE/RELATIVE ambiguity:[2]

(2)   a.   Usagi-ga itiban takai yama-ni   nobot-ta.
               rabbit-NOM most high mountain-to climb-past
               'A rabbit climbed the highest mountain.'
      b.   Itiban usagi-ga   takai yama-ni   nobot-ta.
               most rabbit-NOM high mountain-to climb-PAST
               'The rabbit climbed the highest mountain.'

Arii presented the test sentences in three kinds of scenarios. The first kind of scenario made the ABSOLUTE reading true and felicitous: the rabbit would climb the tallest of three pictured mountains. The second kind of scenario made the ABSOLUTE reading felicitous, but false: the rabbit would climb not the tallest of the three mountains, but rather the second tallest of the three pictured mountains. Crucially, the third kind of scenario allowed for a RELATIVE reading. This condition made the RELATIVE reading felicitous and true, and the ABSOLUTE reading false: no animal climbed the absolute tallest mountain, while the rabbit climbed the second tallest of four pictured mountains, and two other animal climbers each climbed shorter mountains. Acceptance of the sentences in (2) in this latter scenario would indicate access to the RELATIVE interpretation of the superlative.

When the ABSOLUTE reading was made true in the context (i.e. in the first two scenarios described), the 5 adult participants and 15 child participants that Arii tested accepted the sentences in (2). In the scenario that made the RELATIVE interpretation true and the ABSOLUTE reading false, however, adult participants accepted the sentences 100% of the time but children only accepted (2a) 33% of the time and (2b) 40% of the time. Importantly, Arii reports that the child participants often justified their rejections by pointing out, e.g., that the rabbit had not climbed the tallest of the pictured mountains, seeming to disregard the contextually provided comparison set of other animal climbers. Arii concludes from her data that children had difficulty accessing the RELATIVE reading, compared to adults: in the latter scenario, adults defined the relevant comparison set as that of the mountains *that were climbed*, whereas children appeared to take the comparison set to contain all of the pictured mountains, despite the provided competition context. Indeed, Arii suggests that the single unclimbed mountain in the latter scenario appeared to draw the children's attention.

We will now turn to two experiments designed to test for ABSOLUTE and RELATIVE interpretations of superlatives in English. Using a modified version of the truth value judgment task, we show that when conditions are set up to make the relevant comparison sets highly salient, children as young

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[2]While both are ambiguous, the RELATIVE reading is reportedly more prominent than the ABSOLUTE reading in (2b).

as 3–4 years of age are able to access both ABSOLUTE and RELATIVE readings of superlatives.

3 Experiment 1

3.1 Methods

3.1.1 Participants

24 English-speaking children (3;02–6;01, M=4;05) participated in the experiment. 24 adult native speakers of English were recruited online through Amazon Mechanical Turk and were paid $1 for their participation in the study.

3.1.2 Procedure

We used a prediction mode 'guessing game' version of the Truth Value Judgment Task (Crain & Thornton 2000) in which participants were told a series of short stories presented through cartoon images. The game involved a puppet who would make guesses about what would happen in each story. On each trial, participants were presented with a context image containing either a set of objects to be climbed, e.g., mountains (ABSOLUTE condition) or a set of cartoon animal climbers (RELATIVE condition). The experimenter described the context and then posed a question to the puppet, e.g., *Which mountain will Donkey climb?* or *Who will climb the highest mountain?* Before the outcome was revealed, the puppet made her guess (through a pre-recorded videoclip). The outcome image was then revealed, and participants were asked to judge whether the puppet's guess had been right or wrong.

We reasoned that posing an explicit question to the puppet might help children by highlighting the relevant comparison set (by asking either about the mountains to be climbed or about the climbers of the mountains), as opposed to them having to infer the relevant question under discussion. We also reasoned that because the test sentences containing the superlatives were uttered *before* the final outcomes were revealed, children would be less likely to search for or be distracted by the absolute biggest or smallest object in the visual array. This would give them the opportunity to formulate an interpretation for the superlative without being influenced by the visual array.

The experiment was implemented on the Qualtrics platform. Children were administered the experiment individually either in their childcare centre or in the lab, while adults completed the task online in their own time.

3.1.3 Materials

The experiment included four target conditions. There were two ABSOLUTE conditions, one which made the ABSOLUTE reading of the superlative true ('Absolute-True') and one which made the ABSOLUTE reading false ('Absolute-False'). There were also two RELATIVE conditions, one in which the RELATIVE interpretation was made true ('Relative-True'), and one in which the RELATIVE interpretation was made false ('Relative-False'); in both RELATIVE conditions, the ABSOLUTE reading was falsified. Having both true and false targets for each possible interpretation allowed us to investigate whether participants were indeed accessing the target interpretations, rather than, for example,

simply showing a 'yes' or a 'no' bias. Each participant saw three repetitions of each target condition, for a total of 12 target trials.

An example of an ABSOLUTE target is provided in (3) and Figure 2. Participants would hear the context and question in (3a) and (3b), paired with the context image in Figure 2(a). They would then hear the puppet's guess in (3c), followed by either the true outcome image in Figure 2(b) or the false outcome image in Figure 2(c).

(3)   Example of ABSOLUTE target

    a.   *Context:* Look! Donkey's going to climb a tree!

    b.   *Question:* Which tree will Donkey climb?

    c.   *Puppet's guess:* Donkey will climb the tallest tree.

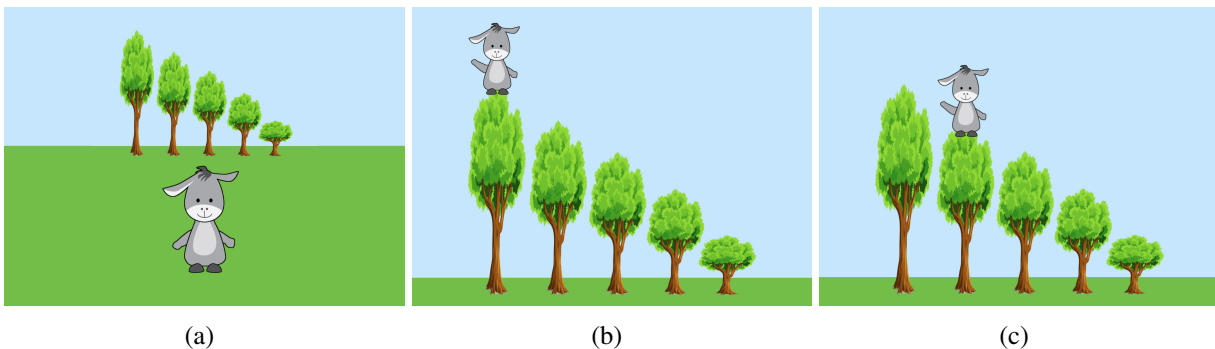| (a) | (b) | (c) |

Figure 2: ABSOLUTE target (*Donkey will climb the tallest tree*). (a) Context image. (b) True target image. (c) False target image.

An example of a RELATIVE target is provided in (4) and Figure 3. Participants would hear the context and question in (4a) and (4b), paired with the context image in Figure 3(a). They would then hear the puppet's guess in (4c), followed by either the true outcome image in Figure 3(b) or the false outcome image in Figure 3(c).[3]

(4)   Example of RELATIVE target

    a.   *Context:* Look! Owl, Duck, and Cat are going to compete to see who can climb the highest mountain!

    b.   *Question:* Who will climb the highest mountain?

    c.   *Puppet's guess:* Cat will climb the highest mountain.

In addition to the ABSOLUTE and RELATIVE targets, participants also received two adjectival controls containing an adjective like "big", such as "Fox will climb the big rock", paired with both a true outcome story and a false outcome story. These were meant to ensure that children correctly understood the basic adjectival forms we were testing, and could accept and reject them appropriately (see Figure 4). Participants also received two comparative controls containing the compara-

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[3]The outcome pictures in the RELATIVE conditions always included two absolute largest objects and two absolute smallest objects, along with three intermediate objects that varied in size. This was to decrease the likelihood that children might focus on a single salient object – likely the largest one or the unclimbed one, as suggested in Arii (2011); indeed we also observed this kind of behavior in pilot versions of our own experiment.
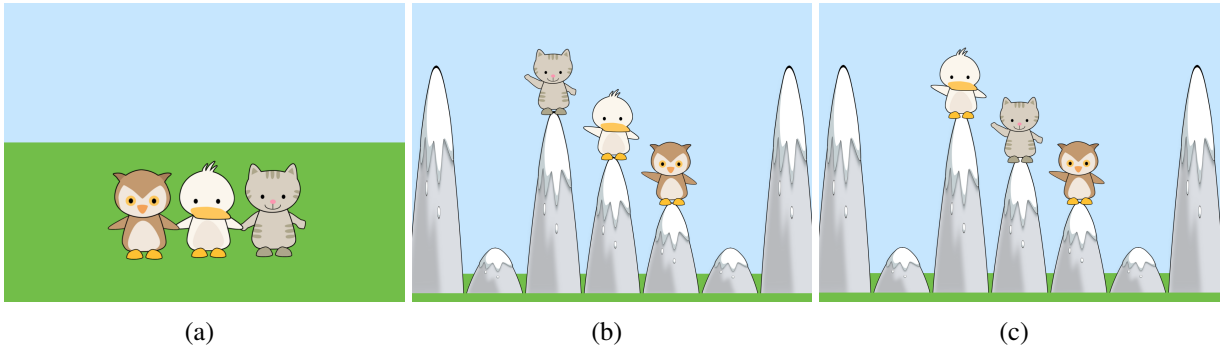
Figure 3: RELATIVE target (*Cat will climb the highest mountain*). (a) Context image. (b) True target image. (c) False target image.
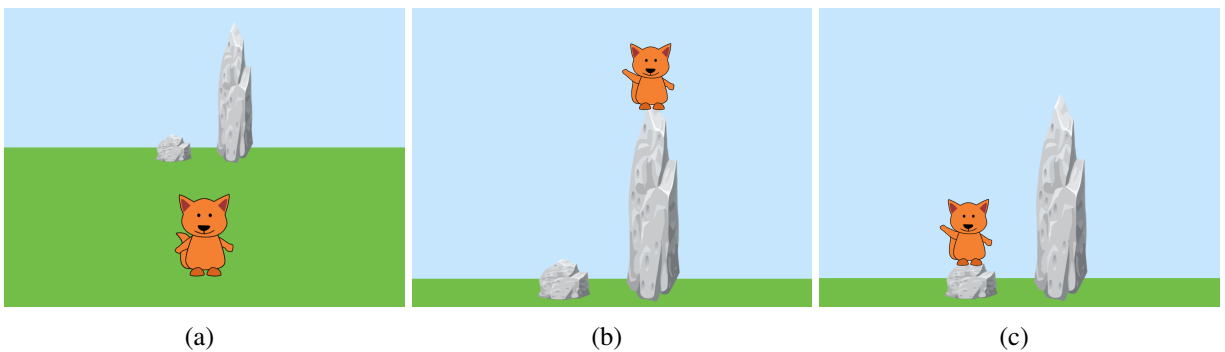

Figure 4: Adjectival control (*Fox will climb the big rock*). (a) Context image. (b) True target image. (c) False target image.

tive form of the adjective of interest (e.g., "Rabbit will climb a bigger rock than Elephant"), paired with both a true outcome scenario and a false outcome scenario (see Figure 5).

To maintain interest and keep children engaged in the task, we varied climbers and objects (e.g., trees, mountains, mushrooms) across trials.

In all, participants received two practice trials, followed by 16 test trials: 3 'Absolute-True' and 3 'Absolute-False' targets, 3 'Relative-True' and 3 'Relative-False' targets, and the four comparative and adjectival controls. The order of the trials was automatically randomized across all participants. A complete list of all test sentences is provided in the Appendix.

3.2 Results

All 48 participants correctly answered at least 3/4 unambiguous control trials and were included in the analysis. Both groups scored 100% accuracy on the adjectival controls, and scored above 87% accuracy on the comparative controls.

The proportion of *yes*-responses to the ABSOLUTE and RELATIVE targets are plotted in Figure 6.
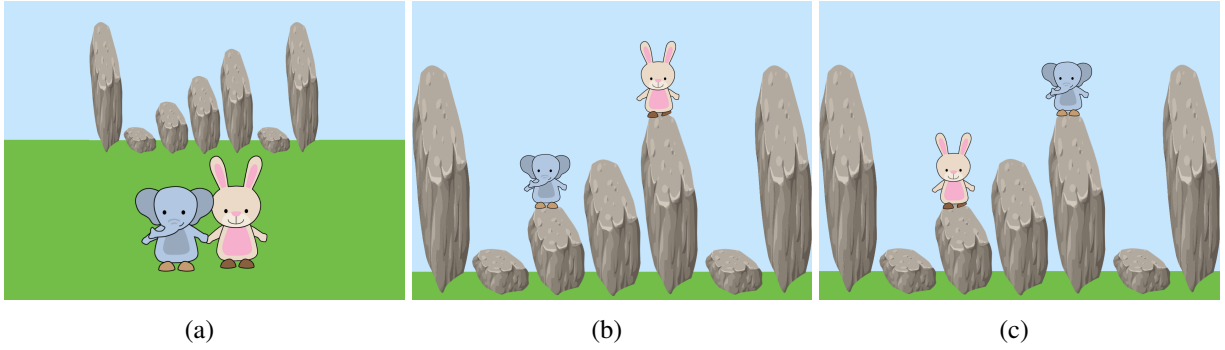
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Figure 5: Comparative control (*Rabbit will climb a bigger rock than Elephant*). (a) Context image. (b) True target image. (c) False target image.
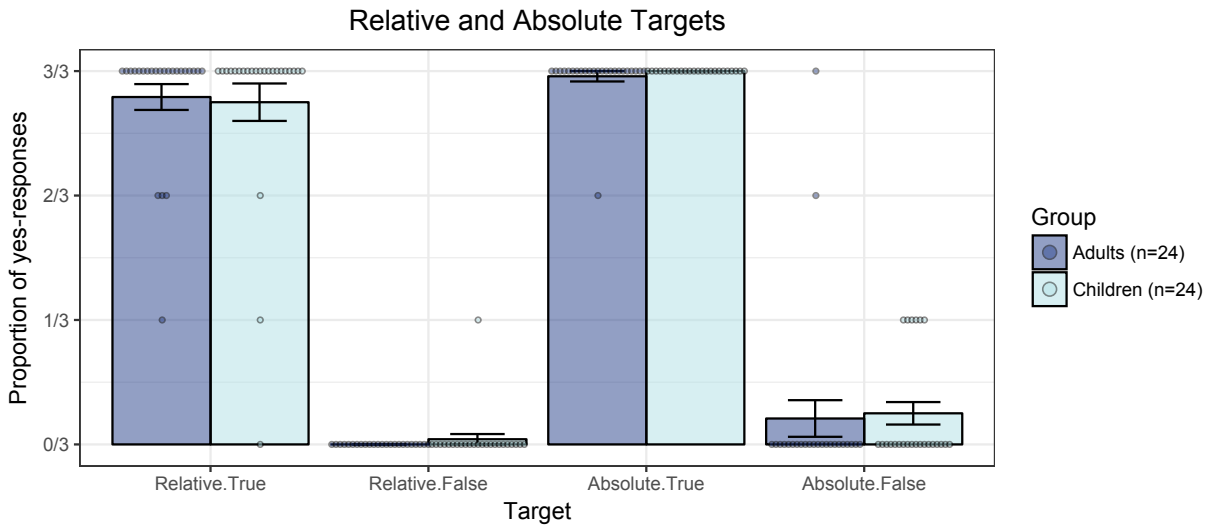

Figure 6: Proportion of *yes*-responses to ABSOLUTE and RELATIVE targets. Dots represent individual participants.

Due to ceiling and floor effects in some conditions, it was not possible to fit a mixed effects logistic regression model to the responses. We thus eliminated the random effect structure and modeled the responses with Group (Child vs. Adult), Condition (ABSOLUTE vs. RELATIVE), Target Truth Value (True vs. False), and their interaction as fixed effects. Model comparisons revealed a significant effect of Target Truth Value ($\chi^2(1) = 619$, $p < .001$), with more *yes*-responses in True conditions than False conditions, as well as a significant effect of Condition ($\chi^2(1) = 22.5$, $p < .001$), but no significant effect of Group or interaction (all $p > .05$).[4]

What is important for us is the finding that children did not differ from adults, with both groups

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[4]The observed effect of Condition, with greater rates of acceptance in the ABSOLUTE conditions compared to the RELATIVE conditions, can likely be explained as follows. While the RELATIVE reading is not relevant in the ABSOLUTE conditions, the ABSOLUTE reading is always a possibility even in the RELATIVE conditions, no matter the context. On the true RELATIVE targets, the RELATIVE reading was made true but the ABSOLUTE reading was falsified. Thus, the small proportion of *no*-responses in the 'Relative-True' condition may have arisen from participants accessing the ABSOLUTE interpretation, despite our best efforts to facilitate a RELATIVE interpretation.
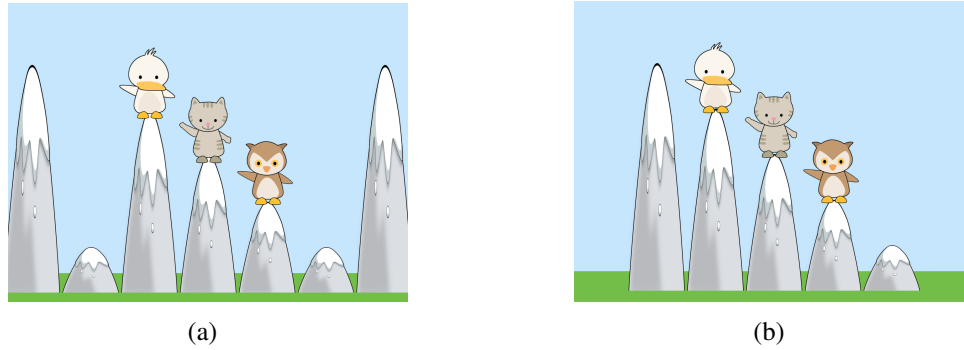
Figure 7: RELATIVE target (*Cat will climb the highest mountain*). (a) Experiment 1 false target image. (b) Experiment 2 false target image.

giving 'yes' and 'no' responses as appropriate if they were accessing both ABSOLUTE and RELATIVE readings.

3.3 Discussion

Experiment 1 provides the first experimental evidence, to our knowledge, that children as young as 3 years of age can access both ABSOLUTE and RELATIVE readings of superlative expressions, once the relevant comparison classes are made salient. Children's success in spite of the absence of evidence for the RELATIVE reading in their input, suggests that the mechanism that generates the RELATIVE reading (cf. Heim 1999) is likely already in place once the ABSOLUTE reading is detectable. The results suggest that the problems obtaining RELATIVE readings in earlier studies likely stemmed from a difficulty constructing the relevant comparison set. Once conditions are set up to facilitate a RELATIVE interpretation (e.g., a clear context and explicit question that highlights the relevant comparison set, no distractions in the visual array), RELATIVE readings do not appear to pose a problem for young children.

Before concluding, there is one objection that should be addressed. Notice that in the RELATIVE targets, the mountains that were not climbed were located to the periphery of the picture, as in Figure 7(a). Imagine that a child took these mountains as simply irrelevant, and contextually restricted the domain to just the three mountains that were climbed. Imagine further that the child could only access the ABSOLUTE reading of the test sentence "Cat will climb the highest mountain". In this case, the child would actually reject the sentence as a description of Figure 7(a)—but not for the right reason. She would be rejecting the sentence because it is false on the ABSOLUTE reading, and not necessarily because it is false on the RELATIVE reading.

To address this issue, we ran a follow-up experiment in which these peripheral objects were removed, as in Figure 7(b). This change in fact made the stimuli more similar to those in Arii (2011). Recall that in Arii's experiment, children had favored an ABSOLUTE interpretation, pointing out the tallest of all of the pictured mountains; clearly they were not simply discounting unclimbed mountains in the pictures. With modified images like Figure 7(b) then, we could be reasonably reassured that children would not simply disregard the objects in the periphery. We kept all other aspects of the methodology the same.

4 Experiment 2

4.1 Participants

A group of 24 English-speaking children (3;04–5;09, $M = 4;05$) who had not previously partic-ipated in the study completed Experiment 2. Another 24 adult native speakers of English were recruited as controls through Amazon Mechanical Turk.

4.2 Procedure and Materials

Experiment 2 used the same prediction mode truth value judgment task as in Experiment 1, with 16 test trials in total. The only modification involved the images in the RELATIVE conditions, where the number of objects was reduced from seven to five, and the objects were aligned in ascending or descending height, as illustrated in Figure 7(b).

4.3 Results

All 24 children and 24 adults displayed 100% accuracy on the adjectival and comparative con-trols and were included in the analysis. As seen in Figure 8, both groups generally performed as expected on the ABSOLUTE and RELATIVE targets, consistent with the results from Experiment 1.
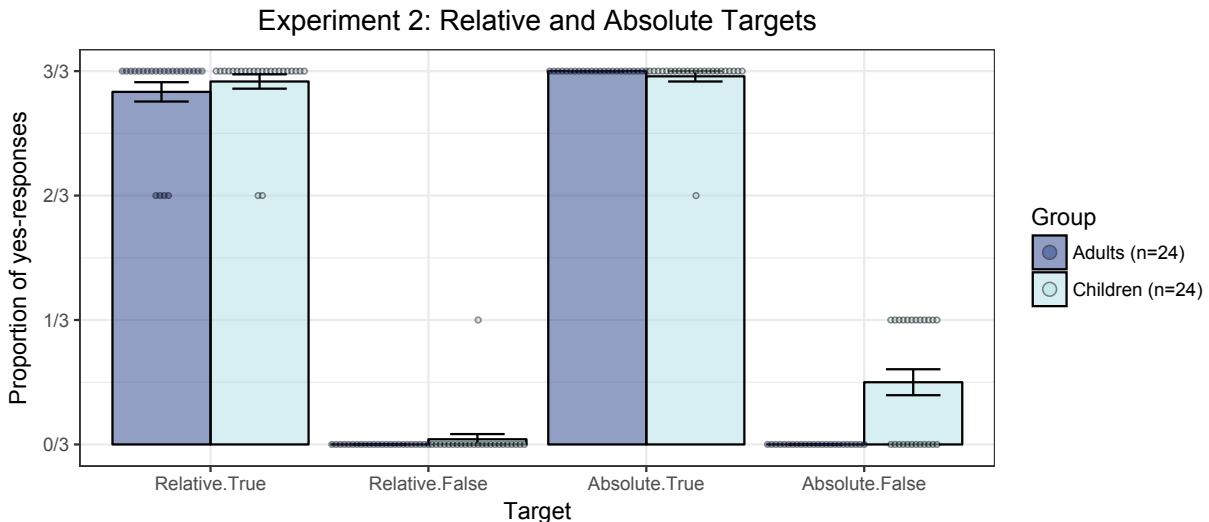

Figure 8: Proportion of *yes*-responses to ABSOLUTE and RELATIVE targets. Dots represent individual participants.

We were interested in the comparison between the RELATIVE targets from Experiments 1 and 2. We fitted a mixed effects logistic regression model to responses to the RELATIVE targets in the two experiments with Target Truth Value (True vs. False), Group (Child vs. Adult), Experiment (Experiment 1 vs. Experiment 2), and their interactions as fixed effects, and random intercepts for participant. Model comparisons with and without the factors of interest revealed a significant effect of Target Truth Value ($\chi^2(1) = 669, p < .001$), no effect of Group, no effect of Experiment, and

no significant interactions between any of the factors. Children's behavior on the RELATIVE targets in Experiment 2, with the removal of the peripheral objects, was consistent with their performance on the RELATIVE targets in Experiment 1. It is thus unlikely that their adult-like performance in Experiment 1 was due to an accidental ABSOLUTE reading.

5   Discussion

The two experiments presented in this paper provide evidence that children as young as 3 years of age can access both ABSOLUTE and RELATIVE interpretations of superlatives – when the right contexts are provided for these readings. In particular, we presented explicit questions that could guide participants to the relevant comparison sets, we gave children the opportunity to generate an interpretation for the superlative before providing any potentially distracting visual displays, and we highlighted the relevant comparison sets visually in the stimuli. Given previous results in the literature, our goal was to facilitate the two interpretations as much as possible, and determine whether children could access them at all. Future work could investigate in more detail the relative importance of different contextual and pragmatic manipulations in facilitating children's access to ABSOLUTE and RELATIVE interpretations.

The present data add to the empirical landscape of children's acquisition of superlatives; while corpus data and previous experimental data would only seem to support the availability of the ABSOLUTE interpretation in young children, our experiments reveal that both interpretations are in fact available to children as young as 3 to 4 years of age. This raises the question of *how* children learn that sentences containing superlatives are ambiguous. One natural hypothesis is that children hear sentences with superlatives being uttered both in scenarios where the ABSOLUTE reading is true, and in scenarios where the RELATIVE reading is made true. Yet Tieu & Shen (2015) report that not only are superlatives infrequent in parental speech (occurring in roughly .02–.07% of utterances), the samples they looked at contained evidence only for the ABSOLUTE reading of superlatives (e.g., "that's the biggest round one", Brown corpus, Brown 1973). The findings thus suggest that children are able to acquire both ABSOLUTE and RELATIVE interpretations of superlatives on the basis of exposure only to the ABSOLUTE reading; they do not seem to need much (or any) exposure to examples of the RELATIVE reading in their input to become sensitive to the availability of this reading.

What role then might superlatives in the input play in guiding children's development of superlative meanings? Perhaps the superlatives that children hear in the input aren't directly informative about the relative availability of the two readings; rather, instances of the ABSOLUTE reading allow children to eventually map the *–est* morpheme to the target superlative meaning. The syntax or pragmatics (depending on whether one assumes a syntactic or pragmatic account of the RELATIVE interpretation) then allows the child to access the two readings. Further research could attempt to tease apart the contributions of the syntax and the pragmatics to children's development of superlative meanings, and the developmental relationship between the two readings, if any.

Finally, our study leaves open the question of *when* the two readings are acquired relative to each other. While children's spontaneous production data show evidence only of the ABSOLUTE interpretation, the experimental data presented in this paper suggest both readings are in place by as young as 3 years of age. But these two data sources do not tell us whether the ABSOLUTE reading is acquired earlier, or whether the two readings are acquired concurrently. Discovering the answer to this could shed light on the nature of the two interpretations, and further inform theories of

superlatives. This is worth further investigation, perhaps through devising experimental paradigms that can investigate the understanding of superlatives in even younger children.

Appendix: Test sentences

Practice items

(5)   *Question:* Who will climb the hill?
        Answer: Rabbit will climb the hill.   (True target)

(6)   *Question:* Who will climb the tree?
        Answer: Elephant will climb the tree.   (False target)

ABSOLUTE targets

(7)   *Question:* Which tree will Donkey climb?
        Answer: Donkey will climb the tallest tree.   (True target)

(8)   *Question:* Which mountain will Raccoon climb?
        Answer: Raccoon will climb the highest mountain.   (True target)

(9)   *Question:* Which rock will Owl climb?
        Answer: Owl will climb the biggest rock.   (True target)

(10)   *Question:* Which tree will Bear climb?
        Answer: Bear will climb the tallest tree.   (False target)

(11)   *Question:* Which mountain will Kangaroo climb?
        Answer: Kangaroo will climb the highest mountain.   (False target)

(12)   *Question:* Which rock will Monkey climb?
        Answer: Monkey will climb the biggest rock.   (False target)

RELATIVE targets

(13)   *Question:* Who will climb the tallest tree?
        Answer: Tiger will climb the tallest tree.   (True target)

(14)   *Question:* Who will climb the highest mountain?
        Answer: Cat will climb the highest mountain.   (True target)

(15)   *Question:* Who will climb the biggest rock?
        Answer: Lion will climb the biggest rock.   (True target)

(16)   *Question:* Who will climb the tallest tree?
        Answer: Koala will climb the tallest tree.   (False target)

(17)   *Question:* Who will climb the highest mountain?
        Answer: Mouse will climb the highest mountain.   (False target)

(18)   *Question:* Who will climb the biggest rock?
        Answer: Hippo will climb the biggest rock.   (False target)

Comparative controls

(19)   *Question:* Who will climb a bigger rock?
       Answer: Rabbit will climb a bigger rock than Elephant.   (True control)

(20)   *Question:* Who will climb a taller tree?
       Answer: Panda will climb a taller tree than Chicken.   (False control)

Adjectival controls

(21)   *Question:* Which tree will Frog climb?
       Answer: Frog will climb the tall tree.   (True control)

(22)   *Question* Which rock will Fox climb?
       Answer: Fox will climb the big rock.   (False control)

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