Children's understanding of verbal comparatives

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Abstract

English-acquiring children before 4 years of age show a fine-grained understanding of how the meaning of *more* interacts with the lexical semantics of nouns: if the noun expresses a concept of objects, the comparison is based on number; if it expresses a concept of substance, it is based on volume or area. Is the meaning that children have acquired sufficiently general to support parallel semantic sensitivities when *more* combines with verbs? We probe this question with 4-5 year olds. Our expectation, based in semantic theory, is that *more* combined with an 'event' verb like *jump* should be quantified by number, but with a 'process' verb like *walk* it should be more flexible. Our Experiment 1 tests this with adults and Experiment 2 with children. We find children's understanding to be broadly consistent with that of adults, providing initial support for an early-acquired, highly general meaning for *more*.

Keywords: telic/atelic verbs, event/process distinction, individuation, number, adverbial quantification

Introduction

To learn a language, one must figure out the meanings of both contentful (e.g., verbs) and functional vocabulary (e.g., *more*). This may seem straightforward for nouns like *cow* (though cf. Quine, 1960; Gleitman, 1990), perhaps less so for verbs like *run* (Waxman & Lidz, 2006) or event nouns like *nap* (Arunachalam & He, 2018), but in such cases it is at least possible to imagine that children could be exposed to learning contexts that support direct pairings between the words and their target concepts. Acquiring the meaning of a functional item like *more* poses a different sort of challenge. For one thing, its specific meaning contribution in a given sentence or context of use depends on subtle linguistic and extralinguistic factors that may themselves still be developing.

We study children's understanding of comparatives targeting verbs. Of particular interest here is that some adverbial comparative forms explicitly indicate dimension (*faster*, *farther*), while the interpretation of bare *more* depends on the semantics of its target verb: intuitively, (1a) is about a number of happenings, while (1b) is about some distance or duration. The situation with nouns is analogous: (2a) is about a number of things, while (2b) is about some volume.

(1) a. Ann jumped more than Betty did.
 b. Ann walked more than Betty did.

(2) a. Ann bought more toys than Betty did.
 b. Ann bought more stuff than Betty did.

What is it to grasp a meaning for *more* that ensures such patterns of interpretation? Semantic theory attributes to this item a certain kind of context-sensitivity, linking the choice of dimension to particular features specified by the class of concept associated with the noun or verb (Schwarzschild, 2006; Nakanishi, 2007; Solt, 2009; Wellwood, Hacquard, & Pancheva, 2012; Wellwood, 2015). For example, Bale and Barner (2009) link the pattern displayed in (2) to formal differences between pluralities (of objects) versus substances, and Wellwood et al. (2012) link that in (1) to differences between pluralities (of events) versus processes. These formal distinctions characterize the relevant regions of conceptual space (e.g. Rips & Hespos, 2015; Wellwood, Hespos, & Rips, 2018). Achieving an adult-like understanding of *more* requires mastery of this particular sort of context-sensitivity.

What do we know about children's knowledge of *more*? Barner and Snedeker (2005) showed 4-year-olds scenes with, for example, one long string and three short strings, and showed that children evaluated *more string* by combined length but *more strings* by number. This pattern is consistent with adult-like understanding (e.g. Odic, Pietroski, Hunter, Lidz & Halberda, 2013). But what about verbs? When both number and continuous dimensions are available, adults evaluated deverbal nominal comparatives like *more jumping* by number, but *more walking* by distance (Barner, Wagner, & Snedeker, 2008; cf. Wagner & Carey, 2003 for evidence of such 'telicity' understanding in answering "how many times" questions). But the question of children's knowledge of *more* in relation to the semantics of verbs remains open.

Demonstrating adult-like understanding here presupposes at least the ability to parse a scene for multiple dimensions along which entities can be compared, and isolating a dimension of interest based on the compositional meaning of the sentence. Imagine two monkeys moving such that you would recognize that the first jumped more than the second (event verb → number comparison), but that the second moved more than the first (process verb → distance or duration). Issuing such judgments requires tracking multiple comparison relations, and sensitivity to the dimension implied by the question posed. Our studies, then, look for evidence of both the ability to select the appropriate dimension for comparative forms like *higher*, *farther*, and *more times*; and sensitivity to how dimensional interpretation shifts with verb semantics.

We first established adult-like understanding using dynamic displays that made available multiple dimensions for comparison (cf. Wellwood & Farkas, 2020) in a child-friendly task. Thus, Exp.1 measured adults' judgments in response to *jump* versus *walk* both with explicit dimensional terms (e.g., *jump higher*) and implicit (e.g., *jump more*). The results of this study extend Barner et al.'s finding that adults evaluated bare *more* dependent on the semantics of closely-related deverbal nominals. Our study goes beyond theirs in testing verbal targets directly, and in the use of dynamic scenes rather than textual descriptions.

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Next, we measured preschoolers' understanding. Exp.2 reports results from children aged 4;00 to 5;08 (mean 4;10) on the same task. Odic, Pietroski, Hunter, Lidz, and Halberda (2013) found that children as young as 3;04 demonstrate adult-like competence with nominal *more*. We tested a higher age group for this probe since verbs can take longer to acquire than nouns (Waxman & Lidz, 2006). If children have the verbs, can parse the available comparative relations in our displays, and if they have a general meaning of *more*, their pattern of responses should look like that of adults' in Exp.1. To preview, we find evidence for some of these elements: children's performance reflected ease with *higher/longer* but not with *more times*, and their responses to *jump more* and *walk more* showed the same overall sensitivities as adults. This suggests an overall developmental continuity, and bears on whether the acquisition of a fully general *more* is incremental or all-at-once (see esp. Odic 2014, ch.6).

Background

Semantic theory suggests a single, cross-categorial meaning for *more* (Wellwood, 2019). We consider what is so far known about children's acquisition of nominal *more* and abilities with event quantification in order to bootstrap predictions for how they might understand verbal *more*.

Evidence that a child has acquired an adult-like meaning requires demonstration that they understand how *more* is sensitive to ontology and grammar across at least its nominal and verbal occurrences. Tests of this understanding will, of course, presume the development of a number of important conceptual and linguistic precursors. In relation to nominal *more*, many of these questions have been addressed: children can distinguish objects and substances very early on (Soja, Carey, & Spelke, 1991; Imai & Gentner, 1997); they quantify entities from these domains differently and, by 3 years of age, know how grammatical context can shift default quantificational preferences (cf. *more rock/s*). Yet few of the relevant parallel results have been found in the dynamic domain.

The success of such a study will depend on the child's ability to categorize their experience in similar ways as adults. Children show early success in this for both objects and events. Hespos, Saylor, and Grossman (2009) showed that six-month-old infants can isolate familiar events from within a sequence of continuous actions. Infants presented with target actions in isolation, and then with continuous action sequences that either did or did not contain instances of the actions from habituation, looked reliably longer at the novel action sequences (i.e., those not containing the target action from habituation). This result held even when the order of actions from habituation and test were switched, suggesting that infants possess an early ability to individuate events.

There is evidence that the ability to quantify events by number is in place by infancy as well. Six-month-olds can discriminate between sequences of four and eight jumps, even when number is uncorrelated with duration, height, etc (Wood & Spelke, 2005). In both the object and event domains, children's early success is supported by the use of their Approximate Number System (Dehaene, 1997; Feigenson, Dehaene, & Spelke, 2004), proficiency with which is observed long before children are able to explicitly count and assign exact number words. And at least by 3 and a half years of age they are able to consistently count pluralities of events (e.g., jumps of a puppet; Wynn, 1990).

With respect to distinguishing events and processes, research suggests that verb lexical semantics impacts how children quantify dynamic entities. Wagner and Carey (2003) showed children as young as 3 years videos of an agent engaged in a goal-oriented task (e.g., building a house), divided into temporally distinct segments (e.g., the house-building process was paused after the first half was built). When asked how many times the agent "built the house" (event), children said "one", but they said "two" when asked how many times the agent "worked" (process). To see process cognition as distinct from that of event cognition, though, one would want to see that differences in continuous extent are more important for processes than are differences in number.

Even presuming the ability to discriminate event from process, children need to know how the specific verb semantics interacts with the semantics of *more*. This appears to be in place by age 3;04 for object and substance nouns (Odic et al., 2013). Odic et al. asked children to evaluate questions involving *more dots* (object) or *more goo* (substance) against displays with a scattering of blue and yellow filled-in circles (objects) or a single bi-colored blob (substance). Children preferred to answer the question about dots based on number, and that about goo based on area. Other studies have shown scenes which support quantification by number and area and paired these with novel nouns, finding that 3 year olds preferred to quantify by area given *more fem* but preferred to quantify by number given plural *more fems* (Barner & Snedeker, 2004). So far, it is unknown whether children would quantify differently using verbal *more* depending on the semantics of the verb. Our study aims to fill this gap.

The present study

Do preschoolers understand the meaning of verbal comparatives like adults do? A semantic theory on which *more* is univocal expects, all else equal, that fine-grained knowledge of its meaning in the nominal domain would go along with knowledge of its meaning in the verbal domain. We asked adults (Exp.1) and children (Exp.2) to compare the distance and number of two sets of movements, probing their knowledge of comparatives with explicit dimensional terms (*higher/farther*, *more times*) and bare *more*.

Experiment 1 (Adults)

Participants

We recruited 144 adults on Amazon's MTurk platform following our university's IRB-approved protocol. Turkers were offered $1 for 5 minutes of their time. Participation was restricted to accounts located in the U.S., with an overall approval rating $\geq$ 99%, and HIT completions $\geq$1000.

Predictions

We predicted that adults would evaluate *higher/farther* by distance and *more times* by number, but judgments with bare *more* would depend on the verb: *jump more* (event) should be evaluated by number, but *walk more* (process) should be more flexible. The latter can indicate continuous extent or number, though we may observe a preference for the former (cf. results for *more walking*, Barner et al., 2008).

Design

Our 2 x 3 design manipulated the factors VERB (*jump*, *walk*) and COMPARATIVE (*higher/farther*, *more times*, and *more*), between subjects. Crossing these determined 6 sentences comprising our linguistic stimuli; see the schematics in (3).

(3) Did A [VERB] [COMPARATIVE] than B?

a. Did A jump HIGHER than B?
b. Did A jump MORE TIMES than B?
c. Did A jump MORE than B?
d. Did A walk FARTHER than B?
e. Did A walk MORE TIMES than B?
f. Did A walk MORE than B?

Displays

We created the visual stimuli in Matlab version 8.6 using the PsychoPhysics toolbox (Brainard, 1997; Pelli, 1997; Kleiner, Brainard, & Pelli, 2007). We took screen recordings of the animations using Quicktime for use online. Each animation involved two monkeys moving back and forth on the screen vertically (*jump* conditions) or two cheetahs moving back and forth horizontally (*walk* conditions). Each complete activity by A or B instantiated different numbers of back-and-forths to different distances, and took place sequentially. Trials were counterbalanced such that duration correlated half of the time with each of the other two dimensions. See Figure 1.

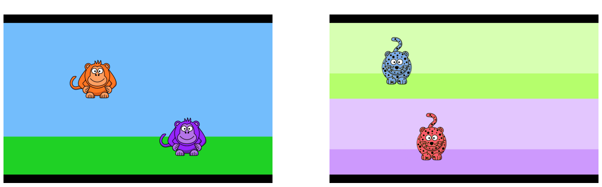

Figure 1: Screenshots of *jump* (L) and *walk* (R) conditions.

We defined the movements in the following way. First, we defined 'parameter sets' involving, for each of A and B, the choice of one of 3 possible values along each relevant dimension: number (2, 3, or 4 back and forth movements), distance (400, 600, or 800 pixels), and duration (4, 6, or 8 seconds). Distance values equal the number of pixels an object traverses in a single 'crossing'. Duration values equal the total time for

Number			Distance (px)			Duration (s)		
A	B	win	A	B	win	A	B	win
4	2	A	800	400	A	8	4	A
2	3	B	400	600	B	4	6	B
3	2	A	400	800	B	8	6	A
4	3	A	400	800	B	6	4	A
4	2	A	400	600	B	6	8	B
4	2	A	600	800	B	4	6	B
2	4	B	600	400	A	8	6	A
2	4	B	800	600	A	6	4	A
2	3	B	800	400	A	6	8	B
3	4	B	800	400	A	4	6	B

Table 1: Parameter sets defining movements of two entities on one trial. The first two rows indicate practice trials.

an object to complete its movements. A set of 30 potential trials, then, could be defined by the assignment of nonidentical parameter sets to A and B.

We restricted this set by eliminating those parameter sets in which (i) one of A or B won along one dimension but tied on the other, and (ii) those where the same object won by both dimensions. The final set included 8 unique trials (See Table 1), half featuring A 'winning' by number and B winning by distance, and the other half featuring A winning by distance and B winning by number. Which entity 'won' by duration was counter-balanced across these subsets. 2 practice trials featured one of A winning or one of A losing on both dimensions. These were used to explicate the structure of the task without inadvertently biasing our participants towards a specific dimension or 'winner'.

Procedure

After consenting to and accepting the task on Mturk, participants were taken to a new browser window displaying an instructions screen. Here, participants were told they would be viewing simple animations and answering a question about them. This screen included pictures of the two entities along with their labels (e.g., "the orange monkey"). Participants pressed spacebar to proceed to the practice trials, the first of which was described as showing "A VERBed more than B" and the second as showing "It is not the case that A VERBed more than B". Next, participants proceeded to the test trials (see Figure 2). First, a fixation cross appeared, followed by an animation in which A then B moved. Next, a response screen requested an answer to the target question, along with two boxes marked 'yes' and 'no' indicating the response options. Participants clicked the box to indicate their answer. This advanced the experiment to a screen with a 'counter' consisting of either bananas (*jump* conditions) or stars (*walk* condition) that tracked progress through the trials.

Data coding

Each question featuring an explicit dimensional term provided a baseline accuracy measure for distance and number evaluation. We expected no better than equivalent accuracy in participants' responses along a given dimension when asked any question with bare *more*. Thus, we coded each

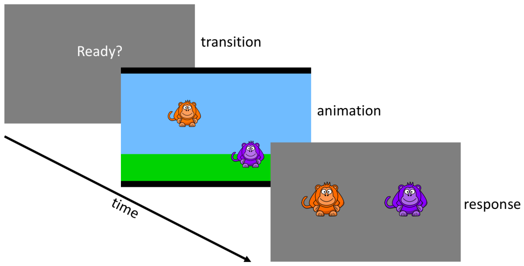

Figure 2: Trial structure for Exp.1

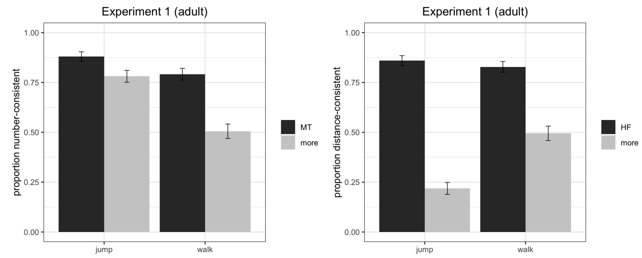

Figure 3: Results from Exp.1. Left: proportion of responses consistent with number for *more times* (control) and *more* by verb. Right: proportion of responses consistent with distance for *higher/farther* (controls) and *more* by verb.

"yes"/"no" response with a separate indication of its consistency with a 'win' or 'loss' according to number or distance. We use 'correct by number' to compare *more* and *more times*, and 'correct by distance' for *more* and *higher/farther*. Since every 'win' by number represents a 'loss' by distance in our design, a response profile e.g. 100% consistent with number was 0% consistent with distance, etc.

Statistical analyses

We report the results of generalized linear mixed effects model comparisons with maximal random effects structure, including random slopes and intercepts by subject (Barr, Levy, Scheepers, & Tily, 2013). First, we created a maximal model for each consistency measure (Number, Distance) against a different subset of the data, i.e. the subset combining responses to the relevant explicit dimensional term, and those in response to the *more* question. Consistency with number was checked by comparing *more* responses to *more times* responses, and consistency with distance compared *more* and *higher/farther* responses. We report model comparisons with contrast-coded parameters for VERB and COMPARATIVE, and the significance levels that we report for a given factor f were derived by comparing the relevant maximal model m to a model just like m but which excludes f. All analyses were conducted using R's *lme4* package (Bates, Maechler, Bolker, & Walker, 2014).

Results

We indeed found that adults were sensitive to verb semantics in evaluating comparatives with *more*, broadly consistent with the semantic theory and replicating Wellwood & Farkas, 2020 in a simplified task: *jump more* was preferentially evaluated by number while *walk more* was more variable.

These patterns were revealed in the Number analyses as a main effect of COMPARATIVE (*more times*: 0.84, *more*: 0.64; $\beta = -1.41, SE = .41, \chi^2(1) = 12.2, p < 0.001$), and a main effect of VERB (*jump*: 0.83, *walk*: 0.65; $\beta = 1.57, SE = .41, \chi^2(1) = 15.5, p < .001$). Though this overall pattern is consistent with our expectations, we observed no interaction effect between these two parameters ($\chi^2(1) < 1, p = 0.37$).

Similarly in the Distance analyses, we found a main effect of VERB (*jump*: 0.54, *walk*: 0.66; $\beta = -0.77, SE = 0.38, \chi^2(1) = 4.05, p = 0.04$), with *walk* being more distance-consistent than *jump*. And we observed a main effect of COMPARATIVE (*higher/farther*: 0.84, *more*: 0.36; $\beta = -3.31, SE = 0.42, \chi^2(1) = 65.7, p < 0.001$), with *higher/farther* more distance-consistent than *more*. Here, the interaction between these factors was significant ($\beta = -2.23, SE = 0.77, \chi^2(1) = 8.6, p = 0.003$), due to *walk more* being more distance-consistent than *jump more*.

Discussion

Adults tracked the named dimensions with explicit dimensional terms, and strongly preferred number given *jump more* but were more flexible with *walk more*. This is the overall pattern expected by the semantic theory, based on the lexical semantics of *jump* (event verb) vs *walk* (process verb).

Our results with *walk more* (verbal) contrast with those reported by Barner et al. (2008) for *more walking* (deverbal nominal). They observed a strong preference for distance (e.g., 85%), while we saw equivalent distance- and number-consistency. We suspect that differences in methodology explain this. Participants in Barner et al.'s study saw the deverbal nominal form only once, amongst many others; our participants saw 8 of the verbal forms. Additionally, the difference between our dynamic displays and their textual presentation may have affected preference through differences in salience.

Experiment 2 (children)

Participants

We used MIT's Lookit platform (Scott & Schulz, 2017) for participant management and data collection, recruiting 211 children in line with our approved IRB protocol. Participating families were given a $10 Tango gift card for no more than 10 minutes of their time. Families were eligible to participate if their child fell within our target age range and were exposed to English 80% of the time at home.

We aimed to test 24 children per condition. 67 initially-recruited families were excluded, based on review of study session videos and data as follows (see Table 2): (i) the child didn't pay sufficient attention (*inattention*); (ii) someone guided or questioned the child's responses (*interference*); (iii) the parent posed the wrong question or left the child alone

	verb: *jump*		
	higher	more times	more
recruited	**29**	**42**	**37**
prop. excluded	0.17	0.43	0.35
included n	**24**	**24**	**24**
mean age (mos.)	56.0	59.3	56.8
age range (mos.)	49-65	49-66	48-67
excluded n	**5**	**18**	**13**
mean age (mos.)	55.4	56.0	59.2
age range (mos.)	49-61	48-66	49-65
interference	3	12	7
inattention	-	3	6
procedure	1	1	-
bias	1	2	-
	verb: *walk*		
	farther	more times	more
recruited	**30**	**38**	**35**
prop. excluded	0.20	0.37	0.31
included n	**24**	**24**	**24**
mean age (mos.)	59.0	57.5	59.6
age range (mos.)	50-67	49-68	50-68
excluded n	**6**	**14**	**11**
mean age (mos.)	54.5	57.9	58.7
age range (mos.)	49-59	43-67	51-66
interference	2	5	5
inattention	1	1	4
procedure	-	2	-
bias	3	6	2

Table 2: Recruited, excluded, and reasons; Exp.2.

(*procedure*); and (iv) the child selected the same response option every time (*bias*). Our final sample included 144 children aged between 4;00 and 5;08 (mean: 4;10).

Predictions

Children have a sophisticated understanding of nominal *more* earlier than the age range we tested, and so a simultaneous acquisition trajectory would predict, all else equal, that they should show the basics of adult-like understanding by this age. If so, children should evaluate based on the named dimension when evaluating comparatives with explicit dimensional terms (e.g., *more times, higher, farther*), but dimensional choices should be based on the verbs' lexical semantics with bare *more*: *jump more* (event verb) should be preferentially evaluated by number, while *walk more* (process verb) should exhibit greater dimensional flexibility.

Design & Displays

Identical to that of Exp.1.

Method

Families ran the study online in their homes, with parents posing the target question and registering the child's responses.[1] Parents first reviewed the consent information, checked their microphone and camera set-up, and recorded their consent to participate. Next, a series of pages guided them on the procedure; then the study began and was recorded using their webcam. Practice trials, test trials, and response pages were just as in Exp.1, except that here the target question was read aloud by the parent to the participating child. Parents completed a short demographic survey at the end.

[1] Study session videos were later independently coded by two research assistants to check children's intended responses based on verbal cues, eye gaze, or pointing. We calculated the degree of alignment between these independent assessments and the responses input by parents. RAs were blind to the correct response on any given trial, and reported no difficulty guessing children's intentions. The agreement rate between RAs and the data was 97.8%.

Data coding & statistical analyses

Identical to Exp.1, except for an added age parameter.

Results

We again present our analyses in two parts. We first compare responses to *more* and *more times* in terms of number-consistency, and then responses to *more* and *higher/farther* in terms of distance-consistency.

With respect to the Number analyses, we found a main effect of COMPARATIVE in the same direction as adults: *more times* received higher number-consistent responses overall than *more* (*more times*: 0.53, *more*: 0.39; $\beta = -0.70, SE = 0.22, \chi^2 = 10.25, p = 0.001$). And we found a main effect of VERB, in the same direction as adults: *jump* received higher number-consistent responses than *walk* (*jump*: 0.52, *walk*: 0.41; $\beta = 0.49, SE = 0.22, \chi^2 = 5.13, p = 0.023$). There was no interaction effect between these two parameters ($\chi^2(1) < 1, p = 0.87$), and no main effect of AGE ($\chi^2(1) = 0.7, p = 0.41$). An interaction effect between COMPARATIVE and AGE revealed that, overall, children decreased in number-based responses for *more* with age, while the opposite was true for *more times* ($\beta = 1.68, SE = 0.56, \chi^2(1) = 8.7, p = 0.003$). There were no other effects of AGE (all χ^2s < 1 and *p*s $< .69$).

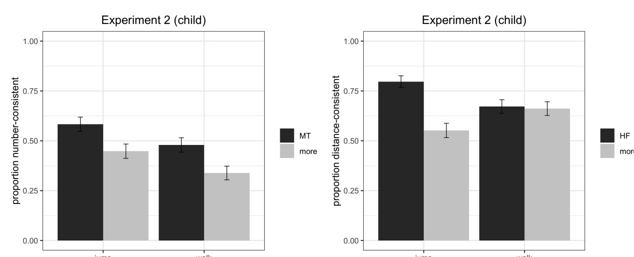

Figure 4: Results from Exp.2. Left: proportion of responses consistent with number for *more times* (control) and *more* by verb. Right: proportion of responses consistent with distance for *higher/farther* (control) and *more* by verb.

With respect to the Distance analyses, results revealed a main effect of COMPARATIVE in the same direction as adults: *higher/farther* received higher distance-consistent responses than did *more* (*higher/farther*: 0.73, *more*: 0.61; $\beta = -0.65, SE = 0.23, \chi^2(1) = 8.1, p = 0.005$). We found no main effect of VERB: here, *walk* and *jump* received equally distance-consistent responses (*jump*: 0.67, *walk*: 0.67; $\beta = 0.14, SE = 0.23, \chi^2(1) = .4, p = 0.53$). This differs from the pattern with adults, where *walk* was overall more distance-consistent. Like adults, however, we found an interaction effect between these two parameters ($\beta = -1.20, SE = 0.46, \chi^2(1) = 6.9, p < 0.01$): *jump* was more distance-consistent with *higher* than *walk* was with *farther* (*jump higher*: 0.80, *walk farther*: 0.67), but *walk* showed more distance-consistent responses with *more* (*jump more*: 0.55, *walk more*: 0.66). There were no effects of AGE here (all $\chi^2(1)$s ≤ 1 and ps $> .31$).

Discussion

The results of Exp.2 with children differed from those of Exp.1 with adults, though the overall direction of children's responses across conditions was the same as adults'. Most striking was children's early decreased number performance using *more times*, which could suggest a general difficulty in extracting the number comparisons, or a delayed acquisition for this unusual composite expression (cf. Rothstein, 1995). Indeed, the interaction effect we observed for number-consistency in Exp.2 supports this: children's performance on control *more times* increased with age. Additionally, children's preference for distance evaluation was greater with process *walk more*, equivalently so to *walk farther*, whereas adults showed greater variability in the former case.

Another unexpected finding was that children showed higher distance-consistency with *jump higher* than with *walk farther*, whereas adults did not differentiate these. Here, children may not have been tracking distance as we coded it, i.e. in terms of the distance of individual screen crossings. Instead, they may occasionally have tracked 'total' distance, i.e. a measure equivalent to number of crossings x individual distance. Some evidence that this was so can be gleaned from looking at trials in which total distance and individual distance would support different answers: in such cases, adults' responses in Exp.1 were 28% consistent with total distance for *walk more* but 17% for *jump more*, while children's in Exp.2 were 47% for *walk more* but 26% for *jump more*.

General Discussion

Consistent with prior research (Wellwood & Farkas, 2020), our adult participants in Exp.1 evaluated verbal comparatives with explicit and implicit dimensional terms as predicted by the semantic theory: dimensionality was resolved directly with adverbial comparatives like *higher*, *farther*, and *more times*, while it was resolved based on verb semantics with bare *more*. Specifically: eventive *jump* was preferentially compared by number, while process *walk* was flexibly evaluated by distance or number. These results provide a baseline measure of such evaluations in a simplified, child-friendly experimental setting using dynamic displays that make multiple competing dimensions available.

Our results with children show that the same overall sensitivities to comparative form are in place by about 4 and a half years of age. Our 4-5 year olds were generally able to evaluate comparatives with explicit dimensional terms along the named dimension, but their choices were not strongly categorically different for *jump more* versus *walk more*. This pattern might be explicable if children understood *jump* as a process verb at root. In fact, at least one view posits 'process' as a denotational default for all verbs, deriving any 'individuated' understanding syntactically (i.e., *jump* would, on some level, support the same syntax-semantics mappings as *walk*).[2] Thus, children's non-adult-like behavior could reflect a difference in derivation, rather than lexicon.

Follow-up studies should investigate children's default encodings of scenes like ours, and the impact of such encodings on how they quantify with bare *more*. To remove any possibility that children have simply misunderstood the syntax-semantics of verb phrases headed by an item like *jump*, for example, one could introduce animations like ours using a novel verb (cf. Carey, 1978, among others), and compare the resulting quantificational preferences against the patterns we observed in Exp.2. If children's evaluation of, e.g. *blick more*, is qualitatively like that we observed for *jump more*, this could support the idea that children's parse of the relevant sentences depends on the interpretations best supported by their encoding of the scene, rather than difficulty understanding which parses are available to the sentences we happened to test.

If so, perhaps our dynamic scenes could be manipulated to render different encodings more salient, with concomitant effects on how preschoolers quantify. In particular, scenes can be designed to better support event- rather than process-based categorization, and measuring how those manipulations impact adults' and children's responses to questions whose responses demand, rather than merely permit, event-based categorization (e.g., like "how many times?"). Scenes supporting 'better event-based categorization' should be determinable via independent tests that manipulate different features of the display—e.g., overall speed, changes in velocity, etc (cf. Zacks, 2004; Wellwood, He & Farkas, 2019). The expectation based in semantics is that scenes better supportive of event-based categorization should lead to greater number-based evaluation/accuracy.

So far, our results support the suggestion that children's understanding of verbal occurrences of *more* is not substantially different from their understanding of its nominal occurrences. On the contrary: given differences in lexical category (noun versus verb), the available grammatical cues to dimensionality (overt nominal versus covert verbal plural), and the types of entities measured (dynamic versus static), the fact that children's performance approximated that of adults is a testament to the sophistication of their understanding. Certainly, our results can be explained without positing any deep discontinuity between child and adult understanding of cross-categorial *more*, though further research is needed.

On balance, then, our results are continuous with semantic approaches to such functional items that assign them a uniform interpretation. In turn, such analyses invite very interesting questions about just what sorts of meanings these cross-categorial items have, and how they interact with available rules and representations in non-linguistic cognition.

[2]See Rothstein 2017 and references therein for discussion and elaboration of such a view.

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