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Which account of *wh-*/quantifier interaction Should everyone adopt? A new take on a classic developmental puzzle

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1. Introduction

Quantifiers are expressions that denote number and quantity (Peters & Westerståhl 2006). When quantifiers interact with each other or with other logical expressions in a sentence, the resulting interpretation may be ambiguous (cf. May 1985, a.o.). In this paper, we focus on young chilren's understanding of the interaction of the universal quantifiers *every* and *each* with *wh*-expressions (*who*, *which*) in questions such as (1).

(1)   <u>Which game</u> did <u>every friend</u> play *t*?
            a. Every friend played Candy land.
            b. Woody played Candy Land, Jessie played Sorry, and Buzz played Monopoly.

In (1), the quantifier phrase *every friend* is in subject position and the underlined *wh*-expression has moved to the front of the sentence. This question allows for at least two types of answers: a single answer (1a) and a pair-list answer (PLA) (1b). Questions such as (2), where the quantifier phrase is in object position, are claimed to only allow a single answer and not a PLA. (Compare (2a) to (2b).)

(2)   <u>Which friend</u> *t* played <u>every game</u>?
            a. Jessie played every game.

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*b. Woody played Candy Land, Jessie played Sorry, and Buzz played Monopoly.

Several analyses have been proposed to account for this subject-object asymmetry. May (1985, 1988) characterized the ambiguity of answers in (1) as a scopal ambiguity. A single answer is derived when the *wh*-phrase takes scope over the quantifier. For a PLA, the quantifier must scope over the *wh*-phrase, reversing the order of these elements in Logical Form. (See Chierchia (1993) and Szabolcsi (1997) for accounts that do not rely on scope.) Beghelli (1997) Chierchia (1993), Agüero-Bautista (2001) have also emphasized the importance of quantifier type (*every*/*each*) and the *wh*-phrase (*who*/*which*) in the availability of a PLA. In light of the complexity of this phenomenon, sentences with *wh*-/quantifier interactions may pose a challenge for preschoolers.

Indeed, Roeper & de Villiers (1991) observed that while children 3 to 5 years of age are capable of producing PLAs for subject-quantifier questions like (1), they appear to overgeneralize PLAs for object quantifier questions like (2). These results suggested that preschoolers have yet to acquire the necessary linguistic operations governing question-quantifier subject-object asymmetries. Yamakoshi (2002) later questioned these findings, citing oversights in experimental design. However, neither of these studies took into account the above lexical distinctions. As a result, the current literature paints an incomplete picture of what children know about the range of possible answers to question-quantifier interactions. In this paper, we restrict our attention to *which*-phrases, which are predicted under all accounts to induce a subject-object asymmetry in interactions with the quantifier *every*, as in (1). By doing so, we demonstrate that children do produce significantly more PLAs in questions with object quantifier *every* than adults. Second, by carefully controlling for quantifier type and *wh*-phrases, we illustrate that the development of this linguistic phenomenon is more complex than originally observed.

In the next section, we review the key previous studies on this topic. In Section 3, we offer a brief theoretical overview of the factors influencing the availability of PLAs. Sections 4 and 5 present our research design and experimental findings. We conclude with a general discussion in Section 6.

2. Production and availability of pair-list answers

Roeper & de Villiers (1991)'s pioneering studies investigated whether children produce PLAs to subject-quantifier questions, but refrain from doing so for object-quantifier questions. Children were shown pictures accompanied by

stories like the one in (3). These were followed by subject or object questions such as (4) or (5). In this example, the picture showed the sister pulling the boy, the Daddy pulling the sister, and the horse pulling the dad.

(3)   A little boy got stuck in the mud. He called his sister for help. She tried pulling him, but was unable to get him out. Then they called Daddy, who could not help either. Finally, a horse came and pulled the Daddy, and look, out came the boy!

(4)   Who did everyone pull?
(5)   Who pulled everyone?

The subject quantifier question in (4) has two possible answers: either that everyone pulled the boy (a single answer), or a list of the puller-pullee pairings (a PLA). The percentage of answers reported by Roeper & de Villiers is presented in Table 1. Children allowed single answers, as expected, but preferred PLAs for both question types – even for questions with object quantifiers like (5), where PLA should be unavailable. This pattern of overgeneralization led Roeper & de Villiers to conclude that children are insensitive to the attested subject-object asymmetry and therefore have an immature grammar.

Table 1. Production of pair-list answers in Roeper & de Villiers (1991)

Question	Single answer	Pair-list answer
Who did everyone pull *t*? (subject)	11%	**73%**
Who pulled everyone? (object)	26%	**69%**

Yamakoshi (2002) later attempted to replicate these results, but included a twist by asking children whether they thought the horse also pulled the boy. 73.8% of the children replied 'no', presumably indicating that they did not recognize that the horse indirectly pulled everyone, even though it only directly pulled the father. Yamakoshi reasoned that they were therefore unable to access the single answer and only had the PLA as an option. Yamakoshi's experiment avoided this pitfall, and rate of PLAs were lower in object-quantifier than in subject-quantifier questions. See Table 2. Yamakoshi concluded that although children age four and five may prefer PLAs when given the option, they do not overgeneralize PLAs.

Table 2. Production of pair-list answers in Yamakoshi (2002) and revised count in parentheses

Question	Single answer	Pair-list answer
What did everyone take? (subject)	0%	**62% (94%)**
Who took every vegetable? (object)	69%	**8% (26%)**

The picture, however, is not so black and white. First, Yamakoshi (2002) employed a conservative method of tallying PLAs. A partial answer or one that only listed one member of a pair was not counted as a PLA, and was instead classified as 'other'. In our experiments, we found that children often provided such partial answers in response. For example, when asked *Which game did every friend play?* children would answer, *Candy Land, Sorry, and Monopoly*. Moreover, some children did not respond verbally, instead pointing to items on the screen. If we return to Yamakoshi's study and count such answers as PLAs (since they are clearly not single answers, and indicate a character-object mapping as in a PLA), we obtain a much higher rate of PLAs, as indicated in the percentages in parentheses in Table 2.

In the next section, we briefly present theoretical accounts stating that PLAs are typically barred in such object-quantifier questions. However, we also review arguments that the choice of *wh*-phrase and universal quantifier influence the presence of the subject-object asymmetry. Neither of the previous studies systematically controlled for either type of lexical item—a factor that appears to be of no small consequence.

3. The availability of pair-list answers with object quantifier questions

In this section we briefly review the major theoretical accounts of the subject-object asymmetry in *wh*-/quantifier interaction. According to May (1985, 1988), a PLA is possible with a subject-quantifier question, but it is blocked for object-quantifier questions, because the movement path of the *wh*-phrase to its surface position in the Specifier of CP and of the quantifier phrase undergoing Quantifier Raising (QR) would have to cross. Alternative accounts of the subject-object asymmetry have appealed to a Weak Crossover constraint (Chierchia 1993) or restrictions on reconstruction of the *wh*-phrase to its base position (Beghelli 1997, Agüero-Bautista 2001, 2007). PLAs require the *wh*-phrase to reconstruct below the quantifier. Both Chierchia (1993) and Agüero-Bautista (2001), albeit for different reasons, note that questions with *who-*

phrases can sometimes give rise to PLA, even when the quantifier is in object position. However, Agüero-Bautista (2001) argued that presuppositional *wh-*phrases, such as *which-*phrases, cannot reconstruct into the position from which they originated. Thus, the object quantifier is prevented from taking scope over the *wh-*phrase. For subject-quantifier questions, a position is available for reconstruction below the quantifier but outside of the VP where the *wh-*phrase originated, allowing PLAs. By using questions with *who*, Roeper & de Villiers (1991) introduced a possible confound: the rather high production rate for PLAs in response to object-quantifier questions could have been due in part to the choice of lexical item.

Likewise, the choice of quantifier matters. Beghelli (1997) pointed out that not all universal quantifiers display the same behavior in questions. While questions with *every* in object position appear not to allow PLAs, questions with *each* in object position do. See (6).

(6)   Q: Which friend played <u>each</u> game?
        A: Woody played Candy Land, Jessie played Sorry, and Buzz played Monopoly.

According to Beghelli, in the process of Quantifier Raising, *each* takes a position higher in the syntactic tree than *every*, landing in the Specifier of a Distributive Phrase (a projection he proposes is situated above the IP node). As a result, *each* can take scope over the subject *wh-*phrase at LF, and a PLA becomes available. The quantifier *every* stays within IP (Beghelli 1997, Beghelli & Stowell 1997, Szabocsi 1997), a position too low to take scope over the reconstructed *wh-*term. This difference in syntactic behavior is related to a semantic difference in the distributivity requirements of these two quantifiers, in that *each* has a stronger event distributivity requirement than *every* (Tunstall,1998).

Concerns with previous experimental methodology and the role of lexical items led us to revisit children's comprehension of *wh-/*quantifier questions and the question of whether they actually do overgeneralize PLAs. We were also interested in obtaining an adult baseline related to the above theoretical claims. Specifically, we sought to determine (a) the rate of PLAs for both age groups in response to subject- and object-quantifier questions involving *which* (to ascertain the presence of a subject-object asymmetry) and (b) whether this pattern is sensitive to quantifier type (*each* vs. *every*).

4. Methods

Participants. 32 children (16 four-year-olds, mean: 4.6, range: 4.0-4.9 and 16 five-years-old, mean: 5.2; range: 5.0-5.4 y.o.) and a control group of Rutgers undergraduates (n = 28) participated. Three children who did not successfully complete the practice trials were excluded from the analysis.

Design and procedure.

We employed a 2x2 design: syntactic position of the quantifier (subject vs. object) was manipulated within subjects, while quantifier type (*each* vs. *every*) was between subjects. The *wh*-word was always *which*. The experiment began with a 2-item practice session, which was followed by an experimental session consisting of 12 items (6 critical and 6 control trials). Control trials aimed at testing whether children understand questions without quantifiers, are able to produce PLA and single answers in general, as well as whether children treat *every* and *each* as universal quantifiers.

Participants were tested individually. They were presented with a story animated on a computer monitor and narrated by the experimenter. For adults, the narration and question were pre-recorded; for children, these were presented live by a female native speaker of English. The story was followed by a *wh*-/quantifier question. Each story had the same template. There were three characters and three objects. All of the characters first interacted with one of the objects. Then two of the characters interacted with another object. The narrative and question from a sample story is presented in (7), accompanied by the on-screen display in Figure 1.

(7)   Buzz, Jesse, and Woody decided to play board games. They played Candy Land first. But then Buzz wanted to play another game, so he played Monopoly. Jesse also wanted to play another game, and so she played Sorry. **Which game did <u>every</u> friend play?**

Figure 1. Subject-quantifier story

The single answer, in which the *wh*-phrase takes scope over the quantifier, should be *Candy Land*. The PLA, derived from the quantifier taking scope over the *wh*-phrase, should be *Woody played Candy Land, Jesse played Sorry, and Buzz played Monopoly*. For each story, we used verbal cues and visual aids, such as footprints in this example, to make both readings salient.

The example in (8) and the scene in Figure 2 accompanied an object-quantifier question. Here, only the single answer should be available.

(8)   Princess Belle, Princess Jasmine, and Princess Cinderella are going to have some snacks. Jasmine gets three goodie bags. Inside she finds a Crunch Bar, a Snickers and a Kit Kat bar. She gave a Crunch Bar to Jasmine, and a Kit Kat bar to Belle. **Which princess got <u>every</u> candy bar?**

Figure 2. Object-quantifier story

We predicted that participants who are aware of the constraints associated with the type and position of the quantifier should provide the single answer *Jasmine*. If, however, child participants overgeneralize PLAs (and if adults allow the quantifier to take scope over the *wh*-phrase), they should provide an answer such as *Belle got a Crunch bar, Jasmine got a Snickers, and Cinderella got a Kit Kat bar*.

5. Results

We begin with the results for the quantifier *every*, which was predicted to exhibit a subject-object asymmetry. Adults showed a strong preference for single answers over PLAs, even in situations where both answers are allowed. Adults produced PLAs only 4% of the time for subject-quantifier questions, and never produced them for object-quantifier questions. See Figure 3.

Children, by contrast, produced PLAs to subject-quantifier questions approximately half of the time and significantly more than adults ($p < 0.01$). The crucial test of their grammatical competence came with the object-quantifier questions, where PLAs are not allowed. Here, children produced PLAs 33% of the time, again significantly more than adults ($p < 0.01$). Thus children do overgeneralize PLAs in response to object-quantifier questions with *every*. Children do, however, produce fewer PLAs to object-quantifier questions than to subject-quantifier questions, a point we retun to below.
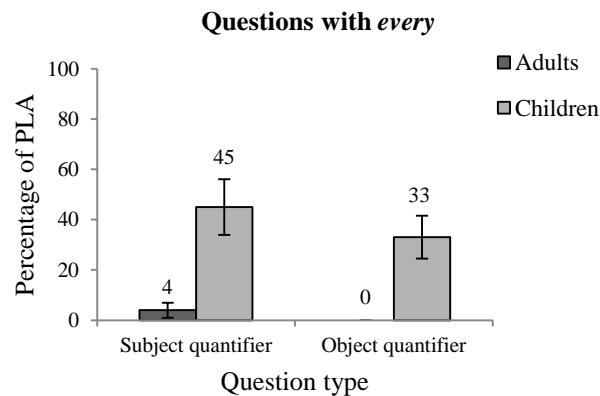

Questions with *every*

Figure 3. Production of pair-list answers for questions with *every*

We now turn to the results for the quantifier *each*. Recall that because *each* lands in a position high in the syntactic tree, and can take scope over the subject

wh-phrase at LF, PLAs are permitted with both subject- and object-quantifier questions. Interestingly, adults – who resisted PLAs with *every* – are drawn to them with *each*. See Figure 4. In addition, as predicted by Beghelli (1997), adults produced significantly more PLAs to object-quantifier questions *each*, than to object-quantifier questions *every* (p < 0.01).

One might suspect, given the results with *every* and the distributivity properties of *each*, that children would increase their rate of PLAs with this quantifier. However, their rate of PLAs remains comparable with subject-quantifier questions and *decreases* with object-quantifier questions (although this difference was not significant p = 0.129, n.s.). In other words, compared to adults, who in fact did produce PLA in questions with both subject- and object-quantifier questions, children under-produced PLAs to question with *each*. Thus, children did not show a strong sensitivity to the choice of the quantifier.
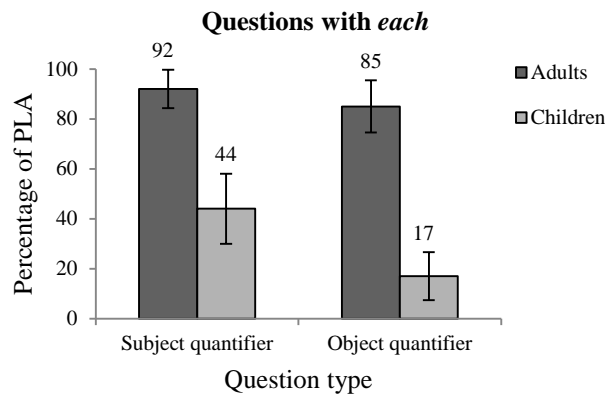

Figure 4. Production of pair-list answers for questions with *each*

In order to detect any developmental trends in PLA production, we analyzed the two child age groups. While the data are preliminary, the trends are already quite clear. For questions with *every*, production of PLAs decreases with age. See Figure 5. For *each* the pattern is reversed: children exhibit a lower rate of PLAs than adults, and consistently so across child age groups. See Figure 6.
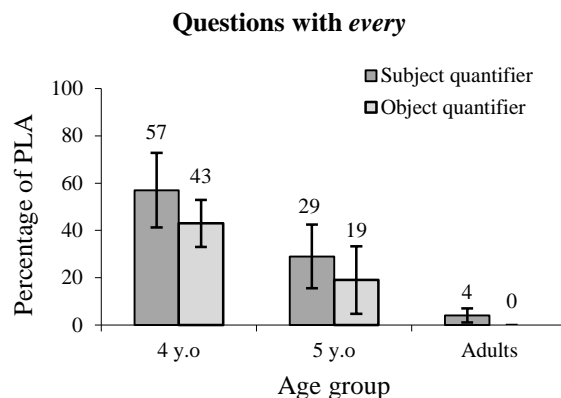
Questions with *every*

Figure 5. Production of pair-list answers by age group (*every*)
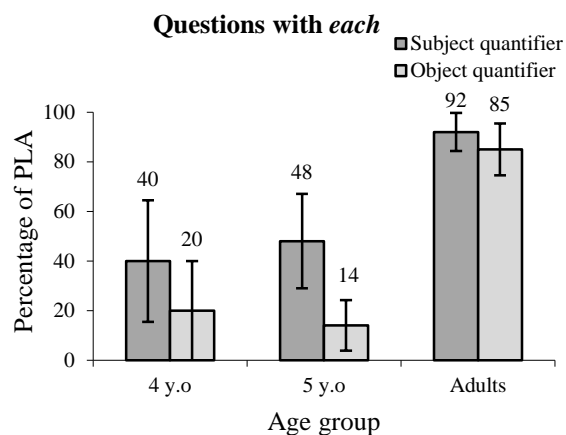
Questions with *each*

Figure 6. Production of pair-list answers by age group (*each*)

6. Discussion

We began this paper by observing that quantifiers and *wh*-expressions exhibit complex interactions in questions that give rise to structural ambiguities. These interactions – and specifically, the availability of PLAs with *which*-questions – are constrained by the position of the quantifier and *wh*-word with respect to each other, and lexical factors such as the type of quantifier and the type of *wh*-word. With the quantifier *every*, PLAs are predicted to be possible only for subject-quantifier and not for object-quantifier questions, resulting in a

subject-object asymmetry. With *each*, PLAs are predicted to be possible with both subject- and object-quantifier questions. Our results do not simply replicate previous studies. Nor do they simply reflect theoretical claims.

In line with previous results from Roeper & de Villiers (1991), we showed that children do indeed overgeneralize PLAs relative to adults, producing them with *every* questions, regardless of quantifier position. The fact that they did so with our *which* object-quantifier questions (claimed to unequivocally bar PLAs) reinforces this observation. That the rate of PLAs in our studies is not as high as in previous acquisition studies may be a reflection of the use of *who* in those studies and *which* in ours. Adults did not display the anticipated subject-object asymmetry (allowing PLAs with subject-quantifier questions, but not allowed them with object-quantifier questions), because they seemed to strongly prefer single answers to *every* questions across the board.

The picture was different with *each*. Here, the strongly distributive quantifier was expected to give rise to PLAs more easily (Beghelli 1997, Szabolcsi 1997). This prediction was confirmed by the adults, who – in contrast to their performance with *every* – strongly preferred PLAs with *each*. Children were strikingly different. They not only produced fewer PLAs than adults, but displayed performance similar to questions with *every*. Thus, children do not seem to have drawn a sharp distinction between the two universal quantifiers.

This observation is not entirely surprising, given the results from recent child language studies, which show that children have a different interpretation of *each* than do adults. For example, Roeper, Pearson & Grace (2011) found that when faced with a choice such as the one shown in Figure 7, and asked to judge two separate sentences (*Every flower is in a vase* and *Each flower is in a vase*), children chose picture C as the best match for the target sentence with *every*, and were evenly distributed across A, B, and C in their choice for the best match for the *each* sentence. By contrast, while adults sometimes found C acceptable for the *each* sentence, they never picked C as the best match.
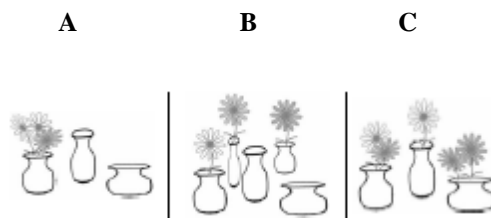
<div align="center">

A   **B**   **C**

</div>

Figure 7. Stimuli for *every* and *each* from Roeper, Pearson & Grace (2011)

Roeper, Pearson & Grace argue that for children, exhaustivity of the quantifier is its defining property (and so children want all vases to be filled), and distributivity is not yet projected as a lexical feature.

Syrett & Musolino (*in press*) also observed that children differed from adults in their interpretation of *each*. When asked to judge sentences such as *Two girls each completed a puzzle* in a scenario in which both girls had worked together to complete one puzzle (a 'collective' context), children accepted the sentence, indicating that each of the girls had participated in the puzzle event. Thus, they did not predicate the property 'complete a puzzle' of each girl, but rather allowed each girl to have participated in a 'puzzle completion' event.

Why would children exhibit non-adult-like behavior with *each* in these experiments and the current one reported here? One explanation might be that they are still learning what *each* means, and that they interpret it as a quantifier that bears properties of both *every* and *each*, allowing for both weakly and strongly distributive patterns. Possibly, in the child grammar, *every* can raise higher in the tree, just like *each* in the adult grammar. Children could therefore access a PLAs for questions with object *every*. That would explain why the production rates for PLAs are similar for *every* and *each* for children but different for adults. A question remains as to why children do not always produce PLAs to questions with *each*. It is possible that in child language *each* has properties similar to those of *every*, namely it does not always act as a strongly distributive quantifier, failing to take scope over the *wh*-term. In sum, our results favor a lexical rather than a structural explanation to the children's previously observed overgeneralization of PLA in questions with *every*. While our data do not reveal when the adult interpretation of *every* and *each* emerge, it should manifest itself when children have fully acquired the distributive properties of each quantifier and can therefore target the right landing site in the syntactic structure.

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