

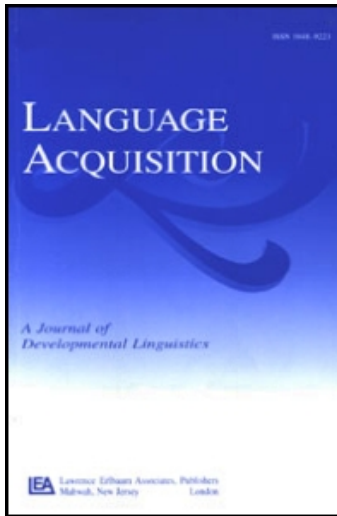
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### QR in Child Grammar: Evidence from Antecedent-Contained Deletion

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ARTICLE

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## QR in Child Grammar: Evidence from Antecedent-Contained Deletion

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We show that 4-year-olds assign the correct interpretation to antecedent-contained deletion (ACD) sentences because they have the correct representation of these structures. This representation involves Quantifier Raising (QR) of a Quantificational Noun Phrase (QNP) that must move out of the site of the verb phrase in which it is contained to resolve a case of verb phrase ellipsis. Furthermore, not only do children provide clear justifications for such sentences with ACD, but they treat ACD sentences differently from sentences with coordinated conjunction, a plausible alternative if they lacked QR. The findings have implications for the interpretation of experimental results in which children appear to lack this grammatical operation, and instead point to extragrammatical factors as the source of this pattern.

### 1. INTRODUCTION

In this article, we investigate children's interpretation of sentences involving antecedent-contained deletion (ACD) structures such as the following:

- (1) Lola jumped over every frog that Dora did.

The meaning assigned to this sentence is that for every frog that Dora jumped over, Lola also jumped over it. We show that children must have knowledge of the abstract representations

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and computational operations required for interpreting such sentences, given a contrast in their interpretation of sentences involving a plausible alternative syntactic configuration that, in the absence of the requisite grammatical knowledge, they might otherwise resort to.

Antecedent-contained deletion (ACD) sentences provide an excellent window into the language acquisition process for two reasons. First, such sentences are far from common in the input. Thus, to the extent that children are able to assign the correct interpretation to these sentences, we are forced to look outside of this domain for the evidence that children would need to encounter in order to acquire (or learn to implement) the relevant constraints. Second, ACD provides what is generally considered the strongest piece of evidence for the existence of the operation of Quantifier Raising (QR) (May 1977; 1985). Other evidence for QR typically comes from ambiguous sentences involving interactions between multiple Quantificational Noun Phrases (QNPs) or from interactions between a QNP and negation. However, experimental results concerning children's ability to deal with such ambiguities are somewhat mixed. Thus, definitive evidence that children's grammars include QR is still lacking.

First, for sentences involving multiple quantificational phrases, such as (2), the issue remains unresolved.

- (2) Every boy is riding an elephant.

In some experiments, children have been shown to differ from adults in ways that suggest that their representations of QNPs might be different from those of adults (Drozd 2001; Drozd & van Loosbroek 1999; Geurts 2003; Inhelder & Piaget 1955/1958, 1959/1964; Philip 1995, 1996). For example, when given a scenario in which there are four elephants, only three of which are being ridden by a boy, children often reject a sentence such as (2), pointing to the elephant that is not being ridden by a boy as supporting evidence for their rejection. If, for example, these responses lead to the conclusion that the universal quantifier *every* quantifies over events rather than properties (Philip 1995), then it suggests that data from these sentences cannot provide evidence for or against the existence of a covert movement operation like QR, which applies only to QNPs.

In other experiments investigating these sentences, experimental manipulations have resulted in children patterning more like adults (Brooks & Braine 1996; Crain et al. 1996; Drozd & van Loosbroek 1999; Freeman, Sinhar, & Stedmon 1982; Freeman & Stedmon 1986). This evidence has been taken by some to indicate that children's errors derive from methodological aspects of the experiments (specifically a failure to control for the effect of pragmatic factors contributing to appropriately restricting the domain of quantification) and not children's grammatical inabilities. Either way, this piece of the literature on children's quantificational abilities does not directly speak to the question of QR.

Second, for sentences involving scope interactions between negation and a QNP, such as (3), the data now clearly indicate that children can compute both readings of the relevantly ambiguous sentences (Gualmini 2003a, 2003b; Lidz & Musolino 2002; Musolino & Lidz 2006; see Musolino 1999a, 1999b for earlier discussion).

- (3) a. Every horse didn't jump over the fence.  
 b. The Smurf didn't buy an orange.

For a sentence such as (3a) where the universal quantifier *every* is in subject position, the interpretation corresponding to the surface scope (*every* > *not*) is that no horse jumped over the fence. Inverse scope (*not* > *every*) allows for some number of horses less than the total to have jumped over the fence. While preschoolers are able to compute both interpretations of these sentences, it is less obvious that doing so requires QR at all. First, for (3a), it is more likely that the inverse scope interpretation derives from interpreting the QNP *every horse* in its base position inside the VP (McCloskey 1996) and thus bears more on the question of children's knowledge of reconstruction than on their knowledge of QR (cf. Leddon 2006; Leddon & Lidz 2006). And second, for (3b), the specific reading of the indefinite might not be derived by raising the quantificational phrase covertly but instead by treating this phrase as though it were referential (Fodor & Sag 1982; Kratzer 1998) or quantificational through existential closure (Abusch 1994; Reinhart 1997; Winter 1997). Thus, although a sizable amount of literature has developed focusing on how children deal with QNPs, very little of this literature directly addresses the question of whether children's grammar actually contains the operation of QR.<sup>1</sup>

One structure that would provide clear evidence for QR in children is ACD. To our knowledge, only one other published study (Kiguchi & Thornton 2004) has examined ACD in children directly, and thus is the only study to directly address the question of children's QR.<sup>2</sup> The authors argued that children do indeed interpret sentences containing ACD in an adult-like fashion; however, although this study is highly suggestive, it leaves open a number of important questions, and as we will see, does not provide conclusive evidence that children resolve ACD in the same way as adults. Before continuing in a discussion of these questions, let us first take a digression into the grammar of ACD.

## 2. THE GRAMMAR OF ACD

Antecedent-contained deletion, first discussed by Bouton (1970), is a special case of verb phrase ellipsis (VPE) and is now generally held to provide one of the strongest pieces of evidence for the covert displacement operation of QR (Fiengo & May 1994; Kennedy 1997; Larson & May 1990; May 1985; Sag 1976; but also see Baltin 1987; Hornstein 1994). It is now part of the standard analysis of elided VPs that they are interpreted as identical in reference to another VP in the discourse context (Hankamer & Sag 1976). For example, in (4), the elided VP (signaled by *did*) is interpreted as identical to the underlined VP (tense aside).

- (4) Lola jumped over every frog and Dora *did* too.  
= Lola jumped over every frog and Dora *did* jump over every frog too.

<sup>1</sup>Note that for these same reasons, even children's interpretation of much simpler sentences with a quantified NP in the object position such as (i) cannot be offered as proof of the existence of QR in child grammar, since it is possible that for children, there is no type mismatch between the QNP and the transitive verb, or because the quantifier is not treated as a universal quantifier and is interpreted in its base position.

(i) Mary met every student

<sup>2</sup>See also Guasti & Chierchia (1999/2000), for discussion of reconstruction effects in child language, which also points to the existence of the QR operation in child grammar.

What makes ACD unique, though, is that the elided VP is contained in its antecedent. As is illustrated in (5), the elided VP is part of the underlined VP.

- (5) Lola jumped over every frog that Dora did.

Thus, if we were to replace the elided VP with the matrix VP, the ellipsis site would remain in the replacement VP:

- (5') Lola jumped over every frog that Dora did [jump over every frog that Dora did ...]

Any attempt to resolve the ellipsis with this antecedent VP results in another elided VP *ad infinitum*. And as long as the elided VP is contained in its antecedent, the two VPs cannot possibly be identical and so the ellipsis cannot be properly resolved.<sup>3</sup> The sentence therefore remains uninterpretable as long as the QNP remains *in situ*. An operation of covert displacement, however, averts both the infinite regress and a lack of parallelism (May 1977). After movement of the QNP, the elided VP can now find a suitable antecedent, as illustrated in (6).

- (6) a. Lola jumped over [every frog that Dora did] *next step: QR*  
 b. [every frog that Dora did] Lola jumped over *t* *next step: VPE resolution*  
 c. [every frog that Dora did [jump over *t*]] Lola [jumped over *t*]

These examples illustrate that QR must apply in ACD environments, because if it did not, there would be no way to assign a meaning to the elided VP.<sup>4</sup> Thus to the extent that children interpret ACD sentences like adults, we are able to conclude that QR is part of child grammar. If, however, we find that children differ from adults in the interpretations of ACD sentences—and moreover, assign similar interpretations to sentences that do not require QR—then we are forced to conclude that children do not have access to the QR operation. The work presented here provides support for the claim that QR is indeed part of child grammar.

<sup>3</sup>Typically, in a framework assuming PF deletion (Chomsky & Lasnik 1993; Merchant 2000; Tancredi 1992), VP identity or parallelism is the problem; in a framework assuming LF copying (Fox 2002; Sag 1976; Williams 1977), infinite regress is the problem. Either way, QR has been proposed as the solution. Here, however, we present a barebones LF copying approach for concreteness, making no theoretical commitments as to the exact nature of ellipsis resolution. See Cecchetto & Percus (2006) for a discussion of the differences between PF-deletion in VPE and VP anaphora.

<sup>4</sup>The problem of antecedent containment is independent of the particular semantic framework adopted and requires special considerations in any theory, even, for example, in approaches whose key feature is direct compositionality (e.g., Jacobson 1992a, 1992b; Steedman 1997). We use essentially the framework of Heim & Kratzer (1998) so that we can address the acquisition questions that we are interested in with some formal vocabulary. None of the details of the experimental data or the learning problems associated with ACD depend on this framework. Germane to this discussion, we note that Fox's (2002) account of ACD resolution, which assumes similar semantics, also involves movement of the QNP, although he proposes rightward movement of the QNP, followed by late insertion of the relative clause adjunct. Whether this or the account we assume here is correct, what is important to note is that to the extent that children are able to assign a correct interpretation to ACD sentences, their grammars must have a mechanism for covertly moving the QNP.

## 3. THE ACQUISITION OF ACD

We noted in the introduction that very little work on the acquisition of quantification directly addresses the question of whether children can apply QR (or its equivalent in another framework) appropriately. Most work on the acquisition of quantification examines children's abilities in the areas of domain restriction or in the scope of a QNP relative to negation, but neither line of research directly addresses the question of whether children can apply QR. To our knowledge, the only other study that directly addresses this question is Kiguchi & Thornton (2004).

Kiguchi & Thornton (2004) used the interaction between ACD and the binding principles (Chomsky 1981; Reinhart 1976) to determine not only whether children correctly apply QR but also whether they target the appropriate landing site for this operation. The authors showed that children, like adults, consistently reject coreference in sentences such as (7):

- (7) a. \*Darth Vader found her<sub>i</sub> the same kind of treasure that the Mermaid<sub>i</sub> did.  
 b. \*[the same kind of treasure that the Mermaid<sub>i</sub> did find her<sub>i</sub> t] Darth Vader found her<sub>i</sub> t

To identify whether the source of this response pattern was due to a Principle C violation at S-structure (because the name is c-commanded by the pronoun) or to a Principle B violation at LF (because the pronoun is c-commanded by the name), the authors showed that 4-year-olds, who typically obey Principle C (Crain & McKee 1985; Crain & Thornton 1998; Kazanina & Phillips 2001; Leddon & Lidz 2006), allow coreference between a VP-internal pronoun and a name that it c-commands on the surface, as in (8):

- (8) Dora gave him<sub>i</sub> the same color paint the Smurf<sub>i</sub>'s father did

Here, the only way to avert the violation of Principle C that would obtain at S-Structure is to QR the QNP *the same color paint the Smurf's father did* so that at LF (after QR), the NP *the Smurf* is no longer in the c-command domain of the pronoun *him*. Unlike in (7), the name (here, in the possessor position) does not c-command the pronoun at LF. This derivation is illustrated in (9):

- (9) a. Dora gave him<sub>i</sub> [the same color paint the Smurf<sub>i</sub>'s father did]  
 b. [the same color paint the Smurf<sub>i</sub>'s father did] Dora gave him<sub>i</sub> t  
 c. [the same color paint the Smurf<sub>i</sub>'s father did [give him<sub>i</sub> t]] Dora [gave him<sub>i</sub> t]

The authors argued that the lack of Principle C effects in such cases provides support for children's ability to apply QR. Children's responses to sentences like (7) must therefore derive from an LF Principle B violation and not from an S-structure Principle C violation, which entails that children are able to apply QR in order to resolve ACD (cf. Fox 1999). They further argued that while children's grammar allows QR to target a VP-external landing site, this movement is restricted to a position that is lower than the subject. Support for this claim comes from the fact that children allow coreference in (9a) but reject it in (10a), where there is a Principle C violation at LF.

- (10) a. \*He<sub>i</sub> jumped over every fence that Kermit<sub>i</sub> tried to.  
 b. \*He<sub>i</sub> [every fence that Kermit<sub>i</sub> tried to jump over] [jumped over t]

Now, while the findings reported by Kiguchi & Thornton (2004) are highly suggestive that children employ QR as adults do, they do not provide unambiguous evidence that this is the case. While children in their experiments interpreted these sentences in a way that matches the interpretation adults would assign, it is possible that this result obtained for reasons other than their correctly applying QR. Consider the possibility that children lack QR. When faced with a sentence such as (8), children would need to find a way to resolve VPE which did not involve QR, since by hypothesis, this operation would be unavailable to them. What could they do instead?

One possibility is that children would treat the relative clause as though it were a coordinate clause. Errors of this kind have been reported, for example, when children have been asked to interpret a relative clause in a context that does not meet the felicity conditions on the use of a relative clause (Hamburger & Crain 1982, Tavakolian 1981).<sup>5</sup> If the problems associated with antecedent containment were not resolvable by QR, children faced with ACD would still need to find some way to resolve VPE. It is possible that with these sentences, they might also turn to coordination as an alternative structure. Thus, the child might represent (14a) with a structure along the lines of (11):

(11) [<sub>IP</sub> Dora gave him the same color paint] and [<sub>IP</sub> the Smurf's father did]

If children adopted this strategy, then the pronoun would not c-command the name with which it is coreferential, and no Principle C violation would result. Thus, a child lacking QR could assign the adult-like interpretation to this sentence without having the adult-like representation.<sup>6</sup>

Now let's consider children's interpretations of sentences like (10). Here, children disallowed coreference between the pronoun and the name. This result was argued to derive from children correctly applying QR to resolve the antecedent containment and targeting only a position below the subject as the landing site for QR. But suppose again that children treated relative clauses in ACD constructions as coordinate clauses. This strategy would yield the representation in (12).

(12) [He jumped over every fence] and [Kermit tried to]

While there is no Principle C violation in this configuration, the coreference interpretation in which *he* refers to Kermit is highly dispreferred, if not impossible (cf. Evans 1980; Lakoff 1968; Langacker 1969). Moreover, in the particular contexts presented to children by Kiguchi & Thornton (2004), the children could have rejected the sentence only on the basis of the first clause, provided that they assigned *he* a referent other than Kermit. In this story, only Kermit

<sup>5</sup>For example, a relative clause helps to distinguish between multiple members of a contextually relevant set of objects. If there is only one entity in question, the use of a relative clause violates the Gricean Maxim of Quantity (Grice 1989) and may not seem warranted.

<sup>6</sup>This same line of reasoning would yield the asymmetry between (7) and (8) that Kiguchi & Thornton (2004) observed. If children interpreted (7) as a coordinate structure, as in (i), then upon resolving the VPE, as in (ii), a Principle B violation would be incurred:

- (i) [Darth Vader found her<sub>i</sub> the same kind of treasure] and [the Mermaid<sub>i</sub> did]
- (ii) [Darth Vader found her the same kind of treasure] and [the Mermaid did find her ...]

jumped over each of the three fences, while Cookie Monster, his competitor, stopped after two. Thus, it remains a live possibility that children succeeded on this task for the wrong reasons. Because the ACD sentences were not compared with corresponding coordinate structures, we cannot be sure that children were not assigning the coordinate structure interpretation to these sentences. We therefore consider it an open question whether preschoolers' interpretations of sentences exhibiting ACD are adult-like because they have adult-like representations.

In the remainder of this article, we report on an experiment designed to directly contrast children's interpretation of ACD sentences with sentences with coordinated conjunction (CC). We show that children have adult-like interpretations of sentences exhibiting ACD, and that these interpretations are a consequence of children's adult-like representations of ACD. We therefore conclude, in agreement with Kiguchi & Thornton (2004), that children resolve ACD appropriately because they correctly apply the covert QR operation.

## 4. EXPERIMENT

The purpose of this experiment was to determine whether children not only assign the correct interpretation to sentences containing ACD, but also whether they assign the correct representation to such structures.

### 4.1. Method

#### 4.1.1. Participants

Forty four-year-olds (23 M 17 F, *M* 4;6, range 4;0–4;11) and 40 undergraduate students at Northwestern University participated.

#### 4.1.2. Materials

Participants were randomly assigned to one of two experimental conditions and were presented either with sentences such as (13a) (ACD) or (13b) (CC).

- (13) a. Miss Red jumped over every frog that Miss Black did.  
 b. Miss Red jumped over every frog and Miss Black did, too.

Note that while both sentence types have an instance of VPE (signaled by *did*), the syntactic structure differs between the two types of sentences. While the elided VP in (13a) is contained within a relative clause, in (13b) the elided VP is inside a conjoined clause. Filler sentences for the ACD test sentences contained a relative clause without VPE, as in (14a). Fillers for the CC test sentences contained conjunctions without VPE, as in (14b).

- (14) a. The rhino [made/didn't make] friends with the hippo that kicked the rock into the water.  
 b. The rhino picked up the rock and [fell in the water/jumped over the hippos].

The variations in the brackets allowed us to elicit variable responses based on the participant's response to the test sentences, so that a bias towards *yes* or *no* responses was avoided. Each



participant was presented with four such test sentences and three such filler sentences in one of two pseudo-randomized orders, counterbalanced across subjects. The full set of test and filler sentences is included in Appendix A.

#### 4.1.3. Procedure

The procedure used in this experiment was the Truth Value Judgment Task (TVJT) (Crain & McKee 1985; Crain & Thornton 1998). One experimenter told the child a story using toys and props, while a puppet (played by a second experimenter) watched the story alongside the child. The puppet appeared to watch very carefully, and at the end of the story he made a statement about what he thought happened in the story, including the target construction. The child's job was to assess the validity of the puppet's statement with respect to the events in the story. That is, the child had to say if the puppet was right or wrong. If the puppet was right, he got a cupcake, and if he was wrong, he got a cookie; either way, he received a sweet, but the child was told that the puppet preferred cupcakes. Children were always encouraged to tell the puppet why he was right or wrong so that the puppet could learn more. Elicitation of such justifications provided us with a window into children's interpretations of these sentences beyond their mere acceptance or rejection of the puppet's statement (i.e., what propositional meaning they assigned to the utterance as well as the truth value assigned to that proposition).

Recall from our previous discussion that if children do not have the QR operation in their grammar, a plausible alternative interpretation for an ACD sentence might be a sentence with CC. For this reason, we compared children's interpretations of sentences such as (13a) and (13b) in contexts in which one, but not the other, was true. This comparison was accomplished by manipulating the number of target sets of objects. This design is illustrated in Figure 1.

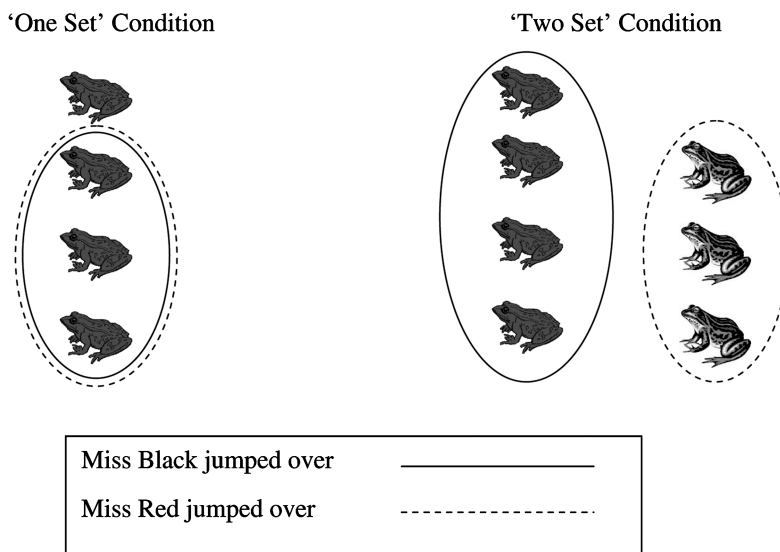


FIGURE 1 Experimental conditions.

There were therefore three between-subject factors, each with two levels: age (children vs. adults)  $\times$  sentence type (CC vs. ACD)  $\times$  context ('one set' (RC sentences true, CC sentences false) vs. 'two sets' (RC sentences false, CC sentences true)).

A description of a typical experimental scenario will make this design clear. In this story, Miss Red and Miss Black are contestants in a frog jumping contest. They are introduced to the frogs they must jump over in order to win a prize.

*One set condition.* In this condition, each contestant must jump over all four frogs in order to win a prize. Miss Black is assigned to jump first. She jumps over the first frog without any difficulty, and jumps over the second easily, but soon begins to get tired. She pauses to wonder whether she will be able to jump over the third frog. She gives it a try and manages to jump over it. She considers jumping over the fourth frog and thinks she might be able to manage it, as she did with the third frog, but reconsiders when she realizes just how tired she is. When it is Miss Red's turn, Miss Red also jumps over the first three frogs, with increasing difficulty each time. After the third frog, she comes to the same conclusion that jumping over the fourth frog would be too much, and that three frogs is good enough. Neither girl wins, because neither contestant jumps over the fourth frog.

Note that if Miss Red had jumped over all four frogs, the ACD sentence would still be true, but children might focus on the fourth frog, which Miss Black didn't jump over. They might then reject the ACD sentence, not because it was semantically false, but because it was pragmatically felicitous, not fully capturing Miss Red's actions. If instead Miss Red had still only jumped over the first three frogs and Miss Black had jumped over all four frogs, both the ACD sentence and CC sentence would be false (since there was a frog that Miss Black jumped over that Miss Red did not jump over, and since it would not have been the case that both contestants jumped over every frog), so there would be no way to distinguish the two interpretations in children's rejection of the target sentence.

*Two set condition.* In this condition, each contestant is assigned a separate set of frogs, so the rules are slightly different. Each contestant must jump over all of her respective frogs in order to win a prize. Miss Black is an experienced frog-jumper, and is therefore assigned four frogs; Miss Red is less experienced, and is therefore only assigned three. Miss Black is assigned to jump first, and very easily jumps over each of her four frogs in succession. Miss Red follows, jumping over all three of her frogs. In the end, each contestant receives a prize.

There are two important features of this condition. First, Miss Black was assigned more frogs in order to avoid functional readings of the quantifier in the ACD context. That is, if both contestants jumped over each of the three frogs in their set, then it would be appropriate to say "Miss Red jumped over every frog that Miss Black did" on the interpretation that the two participants both jumped over frogs 1, 2, and 3. By contrast, if both contestants jumped over each of their respective frogs, but their sets were of different sizes (as they were in this condition), then this would make the functional reading infelicitous and would restrict the children to focusing on the actual frogs, rather than their serial order. Second, because the rules required each contestant to jump over her own set of frogs, it should have been clear from the context that the interpretation of the QNP *every frog* was restricted to the set assigned to each contestant and did not apply to all of the frogs in the discourse context. As a result,

TABLE 1  
Truth Conditions for ACD and CC Sentences in Two Experimental Conditions

<i>Syntactic Structure</i>	<i>'One Set' Condition</i>	<i>'Two Set' Condition</i>
Antecedent-contained deletion	T	F
Coordinated conjunction	F	T

rejections of the CC sentences on the basis that neither jumped over all seven frogs should have been minimized.

Recall that experiment participants were assigned to one of these two conditions and at the end of each story heard the puppet use either ACD or CC sentences to describe the events in the story. The truth values assigned to the proposition expressed by the puppet's utterance thus depended on the condition to which they were assigned and the target sentence they heard. Since in the 'one set' condition, the two contestants jumped over the same frogs, but did not jump over the fourth frog, the ACD sentence (13a) is true and the CC sentence (13b) false. Since in the 'two set' condition, both contestants jumped over all of their respective frogs, but did not jump over the same frogs, the opposite truth conditions hold. This pattern is illustrated in Table 1.

#### 4.2. Results

Recall our predictions. Participants who hear the ACD test sentences should accept them in the 'one set' condition and reject them in the 'two set' condition. By contrast, participants who hear the CC test sentences should reject them in the 'one set' condition and accept them in the 'two set' condition. Thus if children assign the correct representation to the ACD test sentences, their responses to these sentences should be in inverse relation to the CC test sentences.

The percentage of participants' acceptance of each of the two types of test sentences in the two different conditions is shown in Figure 2 (ACD sentences) and Figure 3 (CC sentences). What is striking is that the adult and child responses are in the same direction in both figures. Participants performed as predicted, accepting the ACD test sentences in the 'one set' condition and rejecting them in the 'two set' condition, while rejecting the CC test sentences in the 'one set' condition and accepting them in the 'two set' condition. (Because both sets of participants were at ceiling with the filler sentences, as predicted, we leave those sentences aside in our analysis and focus only on the test sentences.) Representative examples of children's justifications for their responses are presented in Appendix B.

A  $2 \times 2 \times 2$  ANOVA (age  $\times$  sentence type  $\times$  context) for independent samples was conducted. There was a main effect for all three factors: sentence type ( $F(1, 72) = 8.83, p = .004$ ), context ( $F(1, 72) = 4.17, p = .045$ ), and age ( $F(1, 72) = 5.17, p = .026$ ). There was a highly significant sentence type  $\times$  context interaction ( $F(1, 72) = 193.83, p < .0001$ ), as well as a significant age  $\times$  context interaction ( $F(1, 72) = 5.17, p = .026$ ), but no significant age  $\times$  sentence type interaction ( $F(1, 72) = 1.83, p = .180$ ) and no overall interaction ( $F(1, 72) = 0.17, p = 0.681$ ).

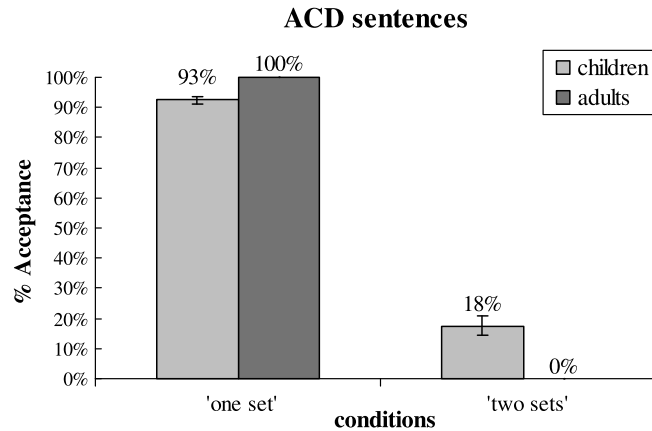


FIGURE 2 Percentage acceptance for the ACD test sentences.

Probing these effects further, we conducted  $2 \times 2$  ANOVAs (age  $\times$  context) for each sentence type. As predicted, there was a main effect of context for each sentence type (ACD:  $F(1, 19) = 273.03$ ,  $p < .001$ ; CC:  $F(1, 19) = 49.17$ ,  $p < .001$ ) resulting from the fact that in the 'one set' condition, participants accepted the ACD sentences, but rejected the CC sentences, while in the 'two-set' condition, they rejected the ACD sentences, and accepted the CC sentences. While age was not a significant factor for the ACD sentences ( $F(1, 19) = 1.07$ ,  $p = .307$ ), there was a significant interaction between age and context ( $F(1, 19) = 5.57$ ,  $p = .024$ ), deriving from the fact that adults performed perfectly on this task, giving completely uniform responses in each condition. Consequently, while child and adult answers are qualitatively similar, the small amount of variability in the child data makes the children and adults statistically distinct.

There was also a main effect of age for the CC sentences ( $F(1, 19) = 4.66$ ,  $p = .037$ ), driven by adults' relatively low percentage of acceptance in the 'two set' condition (52.5%).

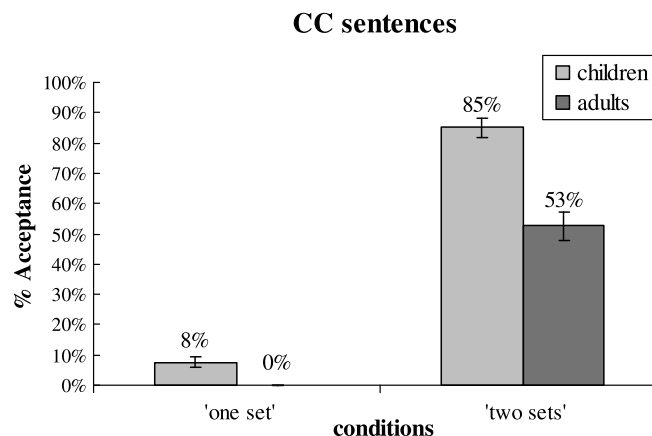


FIGURE 3 Percentage acceptance for the CC test sentences.

Here, it seems that our attempt to restrict the domain of quantification uniquely for each contestant was successful for children, but was less so for adults. Adults occasionally interpreted *every frog* as referring to every frog in the entire context, not every contextually appropriate frog. This is likely due to some adults overthinking the task. The interaction was not significant ( $F(1, 19) = 1.82, p = .186$ ).

## 5. GENERAL DISCUSSION

The findings of this experiment add to the mounting evidence that the QR operation is part of the grammar of 4-year-olds (cf. Guasti & Chierchia 1999/2000; Kiguchi & Thornton 2004; Lidz et al. 2004). Children not only assigned the correct meaning to ACD sentences, which require this covert operation for interpretation in order to remove the ellipsis site from its antecedent and resolve the VPE, but they also treated such sentences differently from sentences with CC, a structure that children might appeal to, were QR not part of their grammatical repertoire. Thus we have evidence that 4-year-olds are able to assign the correct interpretation to ACD sentences because they have the correct representations for these structures.

Now, given that sentences with QNPs are rare enough in the input to children, let alone those sentences in which a QNP is contained in an ellipsis site in the object position, it seems unlikely that children could have learned to appropriately assign meanings to such sentences based on experiences with those structures in the input. The most parsimonious explanation is the one in which QR is a part of the child's grammar and gives children the tools to assign interpretations even to sentences never before encountered. A direct consequence of this conclusion is that then when we are confronted with situations in which children appear to experience difficulty interpreting sentences in which the QR operation is invoked (e.g., in scopally ambiguous sentences), the source of the difficulty must reside in extragrammatical demands, rather than a lack of the relevant operation in the child's grammar.

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## APPENDIX A

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### Test Sentences

#### ACD

- (1) Miss Red jumped over every frog that Miss Black did.
- (2) Miss Red fed every snake that Miss Black did.
- (3) Lady Bug drove every race car that Mister Bug did.
- (4) The black dinosaur landed on every dinosaur that the green dinosaur did.

#### Coordinated Conjunction

- (5) Miss Red jumped over every frog, and Miss Black did, too.
- (6) Miss Red fed every snake, and Miss Black did, too.
- (7) Lady Bug drove every race car, and Mister Bug did, too.
- (8) The black dinosaur landed on every dinosaur, and the green dinosaur did, too.

### Filler Sentences

#### ACD

- (9) The rhino [made/didn't make] friends with the hippo that kicked the rock into the water.
- (10) The cow [played/didn't play] with the horses that jumped over the barn.
- (11) [The lizards that ate the lobsters/the lizard that didn't eat the lobster] got sick.

#### Coordinated Conjunction

- (12) The rhino picked up the rock and [fell in the water/jumped over the hippos].
  - (13) The [cow/black horse] jumped over the [log/barn] and kicked the [black horse/cow].
  - (14) Some lizards ate lobsters and [got/didn't get] sick.
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## APPENDIX B

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### Justifications of the truth of the puppet's statement

#### ACD—'one set' condition

- (15) Both didn't jump over all of them. (test sentence (1))
- (16) Those two fed these three snakes. (test sentence (2))

#### CC—'two set' condition

- (17) They jumped over all their frogs. (test sentence (5))
- (18) Miss Black jumped over *her* frogs, and Miss Red did, too. (test sentence (5))
- (19) Ladybug went on *her* cars. Mr. Bug went on *his* cars. (test sentence (7))

### Justifications of the falsity of the puppet's statement

#### ACD—'two set' condition

- (20) The red one fed *these* snakes, and the black one fed *these* snakes. (test sentence (2))
- (21) The big bug drove all *these* cars, and the little bug drove all *these* cars. (test sentence (3))
- (22) The black butterfly landed on *his* dinosaur friends, and the green butterfly landed on *his* dinosaur friends. (test sentence (4))

#### CC—'one set' condition

- (23) They jumped that one and that one and that one but *not* that one. (test sentence (5))
  - (24) They fed all the snakes except the last one. (test sentence (6))
-