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Competence, Performance, and the Locality of Quantifier Raising: Evidence from 4-Year-Old Children

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We revisit the purported locality constraint on Quantifier Raising (QR) by investigating children's and adults' interpretation of antecedent-contained-deletion (ACD) sentences, where the interpretation depends on the landing site targeted by QR out of an embedded clause. When ACD is embedded in a nonfinite clause, 4-year-old children and adults access both the embedded and the matrix interpretations. When ACD is embedded in a finite clause, and the matrix interpretation is generally believed to be ungrammatical, children and even some adults access both readings. These findings allow for the possibility that the source of QR's reputed locality constraint may instead be extragrammatical, and they provide insight into the development of the human sentence parser.

Keywords: quantification, syntax-semantics interface, Logical Form, VP-ellipsis, language processing, child language acquisition

1 Introduction

The locality properties of Quantifier Raising (QR) constitute a long-standing puzzle for the theory of movement (see Beghelli and Stowell 1997, Cecchetto 2004, Farkas 1981). *Wh*-movement, the canonical form of Ā-movement, is not bounded by Tense.

(1) a. John [said that Mary read <u>what</u>].
    b. <u>What</u> did John [say that Mary read <u>t</u>]?

Assuming that QR is an instance of Ā-movement (May 1985), we would expect it to show similar locality properties. However, QR appears to show stricter locality restrictions than other

Ā-movement processes. For example, the quantified NP (QNP) in (2) appears to be able to take scope over the matrix subject when it is contained in a nonfinite clause (2a), but not when it is contained in a finite clause (2b).

(2) a. A different professor expected [Mary to read <u>every book</u>].
     (a > every, every > a)
  b. A different professor expected [that Mary would read <u>every book</u>].
     (a > every, *every > a)

In this article, we present the results from a set of experiments with 4-year-old children and adults in which we use potentially ambiguous sentences containing antecedent-contained deletion (ACD) in an embedded clause, such as (3a) and (3b), to probe the locality conditions on QR.

(3) a. John wanted [to read <u>every book that Mary did</u>].
  b. John said [that Mary read <u>every book that Susie did</u>].

To anticipate our results, the findings suggest a need to revisit the conclusion that the locality constraints on QR are *grammatical* in nature, and raise the possibility that they derive instead from other (*extragrammatical*) factors. This line of reasoning follows from two pieces of evidence. First, while the range of children's interpretations for sentences such as (3a) includes the same interpretations that adults have access to, children appear to allow additional interpretations for sentences such as (3b) that most adults do not. Second, a small subset of adults pattern similarly to the children, systematically allowing a wider range of interpretations for sentences such as (3b) than their peers do. For both groups, it appears that QR may not be strictly clause-bounded, as examples like (2b) would suggest.

These patterns therefore pose an interesting puzzle for learnability. If the clause-boundedness of QR is grammatical in nature, then we need to identify what developmental process leads children to ultimately tighten the locality conditions on this type of Ā-movement process but not others. Relatedly, we need to identify what mechanism explains why some adults consistently access these supposedly ungrammatical interpretations. Given that sentences such as the target ACD sentences are far from common in the input (let alone instances attesting to the variability of allowable interpretations), the extra locality conditions associated with QR are not likely to be extracted from the primary linguistic data to which learners are exposed. Thus, we are forced to look beyond the grammar to explain these experimental findings. The most likely place is the nature of these locality conditions. We are therefore led to revisit the claim that QR is necessarily restricted to a finite clause, and to consider the possibility that pressures outside the grammar are responsible for giving the appearance that it is clause-bounded.

2 Antecedent-Contained Deletion

2.1 Quantifier Raising in Antecedent-Contained-Deletion Resolution

In standard accounts of VP-ellipsis (VPE), an elided VP is interpreted as identical in reference to an antecedent VP in the discourse context (Hankamer and Sag 1976). For example, in (4), the elided VP (signaled by *did*) is interpreted as identical to the underlined VP (tense aside).

(4)   Lola <u>jumped over every frog</u> and Dora *did* too.

   = Lola <u>jumped over every frog</u> and Dora *did*
      <u>jump over every frog</u> too.

ACD is a unique case of VPE (see Bouton 1970), because the elided VP is contained in its antecedent. As can be seen in (5), the elided VP (signaled by *did*) is actually part of the underlined VP.

(5) Lola <u>jumped over every frog that Dora *did*</u>.

This situation thus poses two problems. First, any attempt to resolve the ellipsis by replacing the elided VP with the antecedent VP would result in another elided VP, ad infinitum, since an ellipsis site would always remain in the replacement VP.

(6) Lola <u>jumped over every frog that Dora *did*</u>
    [<u>jump over every frog that Dora *did* . . .</u>]

The problem of infinite regress is typically cited in frameworks assuming copying at LF (Fox 2002, Sag 1976, Williams 1977). Second, as long as the elided VP is contained within its antecedent, the two VPs cannot possibly be identical and so the ellipsis cannot be properly resolved. The problem of VP identity or parallelism is typically cited in frameworks assuming PF deletion (Chomsky and Lasnik 1993, Merchant 2000b, Tancredi 1992).[1] A sentence with ACD therefore remains uninterpretable as long as the QNP remains in situ. An operation of covert displacement such as QR averts both the problem of infinite regress and lack of parallelism (Fiengo and May 1994, Kennedy 1997, Larson and May 1990, May 1977, 1985, Sag 1976; but see Baltin 1987, Hornstein 1994).[2] After the QNP moves out of the VP (see (7b)), the elided VP that is part of the QNP is able to find a suitable antecedent (see (7c)).

(7) a. Lola <u>jumped over [every frog that Dora did]</u>   *followed by QR*
    b. [every frog that Dora did] Lola <u>jumped over t</u>   *followed by VPE resolution*
    c. [every frog that Dora did [<u>jump over t</u>]] Lola [<u>jumped over t</u>]

Now, there is good reason to think that QR (at least, and quite possibly only) targets a position lower than the surface position of the subject. Two pieces of evidence support this claim: Principle C effects and scope interaction between a QNP in object position and negation.

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[1] See Cecchetto and Percus 2006 for discussion concerning differences between PF deletion in VPE and VP anaphora.
[2] 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,b, Steedman 1997). Although we essentially adopt the framework of Heim and Kratzer (1998) in order to address our experimental questions with some formal vocabulary, none of the details of the 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 Fox proposes rightward movement of the QNP, followed by late insertion of the relative clause adjunct. Whether this account 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 moving the QNP covertly.

First, observe the contrasts shown in (8a–c) (Fiengo and May 1994, Fox 1995).

(8) a. You introduced him$_{*i}$ to everyone that John$_i$ wanted to meet.
     b. You introduced him$_i$ to everyone that John$_i$ wanted you to ____.
     c. He$_{*i}$ introduced you to everyone that John$_i$ wanted to ____.

In the absence of ACD (i.e., when the verb is present), as in (8a), there is a Principle C effect:
the direct object pronoun *him* c-commands the referring expression *John* inside the indirect object,
barring coreference between these two NPs. The presence versus absence of the verb in (8a) and
(8b), respectively, illustrates the role of QR. Although in (8b) the pronoun also c-commands into
the indirect object at S-Structure in (8b), coreference between the pronoun and the name in this
example *is* possible, because QR can bleed application of Principle C. Once the QNP is raised,
the R-expression antecedent *John* is no longer in the c-command domain of the pronoun. The
fact that in (8c) we again observe a Principle C effect suggests that QR targets a landing site that
is lower than the surface subject. In other words, the QNP [*everyone that John wanted (you) to*]
raises covertly in both (8b) and (8c) to a position below the subject at LF. With the QNP in this
position, the name is not in the c-command domain of the object pronoun in (8b), though it is
in the c-command domain of the subject pronoun in (8c). Thus, QR bleeds Principle C in (8b)
but not (8c).[3]

Second, consider (9).

(9) John didn't read every book that you did.

This sentence does not mean that John read none of the books that you read, which is the interpreta-
tion that corresponds to the universal quantifier *every* taking scope outside negation. Instead, it
means that John read some, but not all, of the books that you read, an interpretation that corresponds
to the QNP being inside the scope of negation. Since the QNP takes scope inside of negation,
there must be a position under negation (e.g., the edge of vP) that serves as the landing site for
QR (Merchant 2000a).

2.2 Locality Properties of Quantifier Raising

Interestingly, QR in ACD resolution is not restricted to a single landing site. The QNP may cross
nonfinite clause boundaries, as illustrated in (10), generating either an *embedded* (local) reading
(10a) or a *matrix* (long-distance) reading (10b) (see Kennedy 1997).

(10) John wanted to read every book that Mary did.

      John wanted to read every book that Mary . . .
      a. read.
      b. wanted to read.

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[3] See Merchant 2000a for a discussion of cases involving QR and negative polarity items, which must be c-com-
manded by negation, and Merchant 2000b for further discussion of the interaction between ACD and Principle C.

If QR were restricted to the first available landing site (the vP of the embedded clause), generating the matrix interpretation (10b) would be impossible, since the QNP would still be contained within the matrix VP antecedent (*wanted to read . . .*). Targeting a landing site higher than the matrix VP allows the matrix interpretation to be generated.

However, as we discussed in section 1, this movement appears to be bounded by Tense. In sentences such as (11), the matrix VP is apparently unavailable as a landing site for QR, making only the embedded interpretation (11a) permissible.

(11) John said that Mary read every book that Susie did.

John said that Mary read every book that Susie . . .
a. read.
b. ≠ said that Mary read.

Thus, while the covert QR operation can apply across infinitival clauses, tensed clauses seem to create a barrier to this operation.[4]

This generalization is complicated by data that raise the possibility that QR is not actually clause-bounded as a matter of grammar. Some speakers report that under restricted conditions—for example, when the main-clause subject must be distributed over (as in (12), discussed by Farkas and Giannakidou (1996), and (13), provided by Mark Steedman (pers. comm.); compare with (2b)), or when a *de re* reading requires the phrase to take scope over the matrix verb (as in (14), discussed by Fiengo and May (1994) and Wilder (1997))—a quantificational expression appears to be able to take scope out of a finite clause.

(12) A (different) student made sure that every invited speaker had a ride.
= For every invited speaker, there was a student who made sure that speaker had a ride. (every > a)

(13) A different witness testified that John robbed every bank in town. (every > a)

(14) John thinks that Mary is taller than Bill does.
= The degree to which John thinks Mary is tall exceeds the degree to which Bill thinks Mary is tall.

These data may indicate that quantificational scope is actually not clause-bounded, and hence that the grammar of QR is no different from the grammar of other forms of Ā-movement. Apparent locality restrictions on scope would then need to be derived from factors external to the grammar (perhaps having to do with parsing routines, discourse processes, or a combination of the two), as discussed below.[5]

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[4] See Cecchetto 2004 and Fox 1999 for possible derivations of this clause-boundedness.

[5] An alternative is that QR is indeed a clause-bounded operation, but that these examples receive the interpretations they do by mechanisms other than QR. We leave this option aside until the general discussion in section 5; until then, we entertain the possibility that QR is not clause-bounded as a matter of the grammar in order to remain open in our interpretation of the experimental data.

3 Children's Comprehension of Antecedent-Contained-Deletion Sentences

Previous research (Kiguchi and Thornton 2004, Syrett and Lidz 2010) has established that at 4 years of age, children assign the correct interpretation to ACD sentences such as (15).

(15) Lola jumped over every frog that Dora did.

Moreover, we have demonstrated (Syrett and Lidz 2010) that these interpretations stem from children's ability to deploy QR. This conclusion follows from the fact that children assign a distinctly different interpretation to sentences such as (16), which have coordinated conjunction, an alternative syntactic configuration to which children might resort if their grammars did not include QR.

(16) Lola jumped over every frog, and Dora *did*, too.

Thus, children interpret (15) as 'Lola jumped over every frog *that Dora jumped over*' and (16) as 'Lola jumped over every frog, *and Dora jumped over every frog, too*'.

Additionally, there is evidence that children target the appropriate landing site for this operation. Using the interaction between ACD and binding, discussed in regard to (8), Kiguchi and Thornton (2004) showed that children consistently reject coreference between a pronoun and a name it c-commands on the surface in sentences such as (17).

(17) *Darth Vader found her$_i$ the same kind of treasure that the Mermaid$_i$ did.

What's more, they were able to conclude that this response pattern is due to a Principle B violation at LF (induced by QR) rather than a Principle C violation at S-Structure. When the name is contained within a constituent that undergoes QR at LF and is not c-commanded by a pronoun at that level of representation, children allow coreference (see (18)). In this case, the name is contained in a possessive, which does not c-command the pronoun at LF.

(18) Dora gave him$_i$ the same color paint the Smurf$_i$'s father did.

The difference between these two sentences at LF is illustrated in (19).

(19) a. *Darth Vader [the same kind of treasure that the Mermaid$_i$ found her$_i$ t] found her$_i$ t
    b. Dora [the same color paint the Smurf$_i$'s father [gave him$_i$ t]] gave him$_i$ t

Kiguchi and Thornton further demonstrated that this movement is restricted to a position lower than the subject (e.g., Spec,vP). Evidence for this conclusion comes from the fact that children allow coreference in (18) but reject it in (20), where there is a Principle C violation at LF, because the pronoun in subject position continues to c-command the name in the QNP.

(20) a. *He$_i$ jumped over every fence that Kermit$_i$ tried to.
    b. *he$_i$ [every fence that Kermit$_i$ tried to jump over] jumped over t

Together, these results demonstrate (a) that by 4 years of age, children are able to interpret ACD sentences, because QR is part of their grammar, and (b) that their QR operation targets the

appropriate landing site. However, two questions about children's interpretations remain unresolved. First, when given a choice of landing sites in an ambiguous sentence such as (10) (repeated here), are children able to access both landing sites and hence both interpretations? Second, do children exhibit the same interpretive constraints as adults have been claimed to possess, restricting QR to a clause-internal landing site for sentences such as (11) (repeated here)?

(10) John wanted to read every book that Mary did.

(11) John said that Mary read every book that Susie did.

As we discussed in section 1, answering these questions will provide insight not only into child grammar, but also into theoretical claims concerning the very nature of QR.

In the remainder of this article, we report on the results of three experiments that shed new light on this issue. In Experiment 1, we show that when presented with ambiguous sentences involving VPE *without* QR, children and adults are able to access either of two interpretations, depending on which antecedent VP interpretation is made true in the experimental scenario. Having shown that children and adults are able to access multiple interpretations of ambiguous VPE sentences, we then investigate their interpretation of ACD sentences like (10) and (11), which involve both VPE and QR.

In Experiment 2, we show that when ACD is contained within an embedded nonfinite clause, and the sentences are ambiguous, children and adults are able to access both the embedded and the matrix interpretations, demonstrating for both age groups that QR is not restricted to the first available landing site. Finally, in Experiment 3, we show that children—and even some adults—systematically allow the QNP to raise across a finite clause boundary, contrary to what one would predict if QR were indeed clause-bounded. The combined results lead us to revisit theoretical assumptions regarding the clause-bounded nature of QR, and to ask whether these purportedly *grammatical* locality constraints might instead arise from *extragrammatical* factors (in particular, the dynamics of a retrospective search mechanism in parsing; see McElree, Foraker, and Dyer 2003).

4 Experiments

4.1 Experiment 1

The purpose of Experiment 1 was to determine whether children and adults can access multiple interpretations of sentences that are made ambiguous because a site of VPE is contained in an embedded clause, and further, whether either group exhibits a bias with regard to the antecedent targeted for VP interpretation.

4.1.1 Method The participants in Experiment 1, and the materials and procedure used, were as follows.

4.1.1.1 Participants Twenty-four 4-year-olds (12 M 12 F, *M* 4;6, range 3;8–4;10) and 24 undergraduates participated. The undergraduates in all three experiments were students at Northwestern University who were assigned experimental credit as part of a linguistics course for their participation.

4.1.1.2 Materials   Participants were presented with test sentences such as (21). In this sentence, a VPE site (signaled by *did*) is contained within an adjunct *because*-clause, allowing the elided VP to be interpreted as identical to either the embedded VP (22a) or the matrix VP (22b).

(21) Clifford asked Goofy to read the [big/small] books because Scooby *did*.

(22) Clifford asked Goofy to read the [big/small] books because Scooby . . .
    a. read the [big/small] books.
    b. asked Goofy to read the [big/small] books.

Participants were randomly assigned to one of two conditions (embedded or matrix), based on which of these two interpretations was made true in the experimental context. Each participant was presented with four test sentences and three filler sentences in one of two pseudorandomized orders, counterbalanced across participants. Filler sentences also contained VPE, but were unambiguous. All sentences used in the three experiments are listed in appendix A.[6]

4.1.1.3 Procedure   The procedure used for all three experiments was the truth-value judgment task (TVJT) (Crain and McKee 1985, Crain and Thornton 1998). In this task, one experimenter tells the child a story using toys and props, while a puppet (played by a second experimenter) watches the story alongside the child. The puppet appears to watch very carefully and, at the end of the story, makes a statement about what he thought happened in the story, which features the target construction. The child's job is to assess the validity of the puppet's statement with respect to the events in the story. That is, the child must say if the puppet was right or wrong. In our experiments, if the puppet was right, he was allowed to nibble a cupcake, and if he was wrong, he nibbled a cookie; either way, he received a sweet, but it was made clear to the child that the puppet preferred cupcakes.

    In all three experiments, children were encouraged to tell the puppet why he was right or wrong so that the puppet could learn more. Eliciting 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., the truth value they assigned to the proposition expressed by his utterance). These justifications become especially important when interpreting the results of Experiments 2 and 3. It is important to note that we elicited justifications for both *yes* and *no* responses (as in Lidz and Musolino 2002, Syrett and Lidz 2010, but unlike in Crain and Thornton 1998). Doing so ensured that we did not unintentionally favor one type of response over the other. Similarly, it ensured that we did not give children an indication that they would have to work harder or provide additional information only when they rejected the puppet's statement (which could result in a *yes* bias stemming from children's wanting the puppet to be correct more often than not).

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[6] The choice of the lexical item in the bracketed material depended on the experimental condition. In both conditions, Scooby asks Goofy to read the big books but Scooby himself reads the small books. In the condition favoring the *embedded* VP, Clifford then comes along and asks Goofy to read the small books (the books that Scooby read, but not the ones that Scooby asks Goofy to read). In the condition favoring the *matrix* VP, Clifford comes along and asks Goofy to read the big books (the books that Scooby asked Goofy to read, but not the ones that Scooby read). In this way, it is what Clifford asks Goofy that favors either the embedded or the matrix interpretation in both conditions.

Adults participated in the same task as the children so that we could make a clean comparison between the two age groups without the possibility of an artificial experimental variable presenting a confound. The discourse contexts used in the TVJT were designed to make both possible interpretations of the target sentences equally available for the participants—regardless of their grammaticality. This design feature allows participants to move beyond any default interpretation and assign an interpretation that is both allowed by their grammar and consistent with the context. Instead of responding directly to the puppet, adults were required to fill out a response sheet, on which they circled *yes* or *no* in response to each of the puppet's statements and which gave them space to provide a reason for their response. They were asked to provide a justification for every response and were given enough time to do so.[7]

For Experiment 1, we introduced one slight change in the TVJT procedure in order to make the presence of the *because*-clause felicitous. After the story, and before the puppet delivered his statement, the experimenter asked the puppet a question, as in (23).

(23) Why did Clifford ask Goofy to read the [big/small] books?

The puppet then answered this question with the test sentence, as in (20).

Let's look at the scenario for the test sentence in (21). This story begins with three dogs, Clifford, Goofy, and Scooby, standing in front of two piles of books—a pile of big books and a pile of small ones. Scooby asks Goofy to read the big books, reasoning that since they are big, they must contain some very impressive words. Goofy agrees to read the books, but before he does, Scooby decides to read the small books, which are appropriate for his reading level. When Scooby is done reading, he tells Goofy he is ready for Goofy to read the big books. At this point, though, Goofy acknowledges that Clifford has been waiting patiently and asks Clifford what he would like. It is at this point that the two experimental conditions diverge, depending on what Clifford requests.

In the *embedded* condition, Clifford asks Goofy to read the *small* books. He explains that if Scooby likes them, they must be good. Thus, Clifford asks Goofy to read the books that Scooby read. In the *matrix* condition, Clifford asks Goofy to read the *big* books. He notes that Scooby always has good ideas, so if Scooby wants Goofy to read these, then Clifford wants Goofy to read these, too. Thus, in this condition, Clifford asks Goofy to read the books that Scooby asked Goofy to read. The truth values for the two experimental conditions are presented in table 1.

4.1.2 Results   For all three experiments, participants' responses were analyzed in terms of the percentage of acceptance of the puppet's statement in each experimental condition, supported by participants' justifications, as captured in appendix B. We predicted that in the embedded condition, the rate at which participants accessed the embedded interpretation would be significantly higher than both the rate at which they accessed the matrix interpretation in this condition and the rate at which they accessed the embedded interpretation in the matrix condition. We predicted

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[7] Children readily provided the puppet with oral justifications for accepting or rejecting his statement, just as adults easily provided written justifications for both *yes* and *no* responses.

Table 1
Truth values for test sentences in Experiment 1

VP interpretation	Embedded condition	Matrix condition
(Clifford asked Goofy to read the [big/small] books because Scooby . . .)		
read the [big/small] books	T	F
asked Goofy to read the [big/small] books	F	T

the reverse pattern for the matrix condition. The percentages for Experiment 1 are presented in figure 1.

Participants performed well on the filler sentences (children: 86%, *SE* .04; adults: 100%). A 2 × 2 ANOVA (age × condition) revealed a main effect of condition ($F(1, 23) = 76.04, p < .001$), no reliable effect of age ($F(1, 23) = 0.58, p = .45$), and a significant interaction between age and condition ($F(1, 23) = 7.26, p < .01$). The interaction was driven by the fact that children were equally likely to accept the test sentences in either condition, while adults were slightly more likely to accept the test sentences in the matrix condition. Representative examples of children's justifications for both acceptances and rejections of the puppet's statement are presented
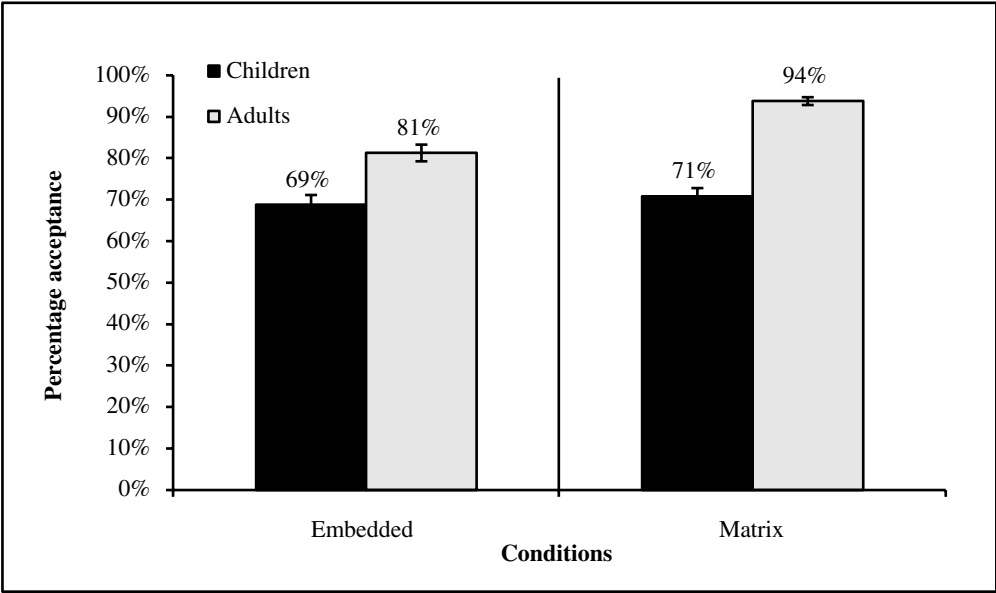

Figure 1
Percentage acceptance in two conditions in Experiment 1

in appendix B. Notice that when accepting the puppet's statement, children appealed to the interpretation that was made true in that particular condition, be it the embedded or the matrix interpretation. When rejecting his statement, though, they appealed to the interpretation that was not true in that condition to justify the falsity of his statement.

4.1.3 Discussion   The motivation for this experiment was to determine whether children and adults are able to access multiple interpretations of ambiguous VPE sentences and whether they have a bias toward targeting one VP antecedent over another. We found that when presented with sentences in which a VPE site appeared in an embedded clause, both children and adults accessed whichever interpretation was made true in the experimental scenario. Moreover, children were able to provide clear justifications for their choices.

4.2 Experiment 2

The sentences in Experiment 1 involved VPE without QR. Experiments 2 and 3 involved ACD test sentences with both VPE and QR, allowing us to evaluate the locality conditions on QR. Recall that when a QNP is contained in an embedded nonfinite clause, QR is generally believed to be able to target the edge of either the embedded or the matrix vP. However, when a QNP is contained in a finite clause, QR is generally believed to be restricted to the embedded clause (i.e., it is clause-bounded).

    The purpose of Experiment 2 was to determine whether children can access multiple interpretations of ambiguous ACD sentences, thereby indicating whether QR in the child grammar has access to the same choice of landing sites as QR in the adult grammar.

4.2.1 Method   The participants in Experiment 2, and the materials and procedure used, were as follows.

4.2.1.1 Participants   Twenty-four 4-year-olds (12 M 12 F, *M* 4;6, range 4;1–4;10) and 30 undergraduates participated.

4.2.1.2 Materials   Participants were presented with sentences such as (24a) and (24b), in which ACD is embedded in a nonfinite clause.

(24) a. Miss Piggy wanted to drive every car that Kermit did.
     b. Clifford asked Goofy to read every book that Scooby did.

Recall from (10) that such sentences are ambiguous, having both an embedded and a matrix interpretation. QR can target either the vP of the embedded clause or the vP of the matrix clause. Crucially, the matrix interpretation is only possible if the QNP raises above the matrix VP and if QR is not restricted to the lower landing site.[8]

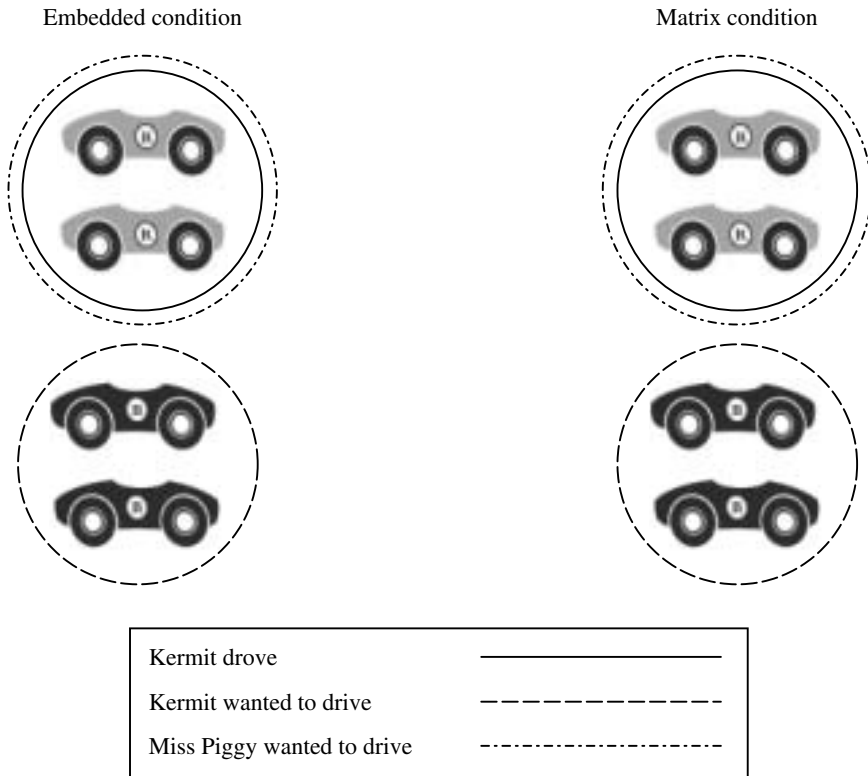[8] Note that if the QR operation targets the higher landing site, participants should be able to access both interpretations: because the QNP is no longer contained in either VP, either VP should be available as an antecedent for the elided VP. Thus, if children access the matrix interpretation, we have clear evidence that they were not restricted to the lower landing site and were able to target the higher landing site.

As in Experiment 1, participants were presented with four test sentences and three filler sentences in one of two pseudorandomized orders counterbalanced across participants. Two of the test sentences involved subject control, where the unpronounced embedded-clause subject was interpreted as bound by the matrix subject (see (24a)), and two involved object control, where the embedded-clause subject was interpreted as bound by the matrix object (see (24b)). We varied subject and object control in order to determine whether the choice of landing site varied with either structure.[9] Participants were randomly assigned to one of two conditions, based on which of the two possible interpretations (matrix or embedded) was made true in the experimental context. The filler sentences were the same VPE sentences used in Experiment 1. The full set of sentences is given in appendix A.

4.2.1.3 Procedure   As in Experiment 1, the procedure used was the TVJT. Let's review one of the experimental scenarios, featuring two main characters: Kermit and Miss Piggy. Kermit has two sets of cars, a red set and a black set. Miss Piggy is very interested in his cars and wants to hear about them. Kermit explains that he has had the red cars for a long time and has driven them so many times that he is now tired of driving them. The black ones, however, are new; he just received them for his birthday. He is not allowed to drive them yet, but he is eager to get the chance to drive them later, since he thinks they must go very fast. Miss Piggy is very excited about Kermit's cars and asks to see him drive some. Kermit agrees to do so (albeit reluctantly, since this means he is stuck driving the red ones). After Kermit drives each of the red cars, Miss Piggy is so excited that Kermit decides to let her drive some of his cars and as a bonus allows her to choose which she will drive. It is at this point that the two experimental conditions diverge, depending on what Miss Piggy decides.

In the *embedded* condition, Miss Piggy says that despite what Kermit thinks about the red cars, she really liked them when he drove them, and she wants to drive those. Thus, Miss Piggy wants to drive the cars that Kermit drove (but did not want to drive). In the *matrix* condition, Miss Piggy says she agrees with Kermit that the red cars aren't so great; on the other hand, she can see why he is excited about the black cars, so she wants to drive those. Thus, in this condition, Miss Piggy wants to drive the cars that Kermit wanted to drive (but did not drive). The difference between the two conditions is captured in figure 2. Note that in each condition, once Miss Piggy chooses which cars she wants to drive, the story ends, and she never actually drives any cars. By ending the story here, we avert the possibility that children could be biased to respond on the basis of what *actually* happened as opposed to what the characters *wanted* to happen. This design allows the truth value of the test sentence to vary in the two contexts, based on the interpretation of the elided VP, as is captured in table 2.

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[9] Because the two subject control verbs that we used (*want* and *need*) have been claimed to be able to unify the domains of the matrix and the embedded verbs for various word order phenomena in various languages (e.g., Aissen and Perlmutter 1983, Rizzi 1978, Wurmbrand 2000) and affect the range of interpretations available for sentences such as those in question (e.g., Bruening 2001, Larson and May 1990), one might expect these contexts to force QR to target a higher landing site.

Embedded condition   Matrix condition

Kermit drove   ────────────

Kermit wanted to drive   ── ── ── ── ──

Miss Piggy wanted to drive   ─·─·─·─·─·─·─

Figure 2
Experimental conditions for test sentences in Experiment 2. Red cars are in grey.

4.2.2 Results   As for Experiment 1, we analyzed the results in terms of the percentage of accep-
tance of the puppet's statement in each condition. These percentages are presented in figure 3.
As before, participants were at ceiling with the filler sentences (children: 96%, *SE* .02; adults:
100%).

A 2 × 2 ANOVA (age × condition) revealed a main effect of age ($F(1, 23) = 4.66$, $p <$
.04), no main effect of condition ($F(1, 23) = 0.11$, $p = .74$), and a significant interaction of age

Table 2
Truth values for test sentences in Experiment 2

VP interpretation	Embedded condition	Matrix condition
(Miss Piggy wanted to drive every car that Kermit . . .)		
drove	T	F
wanted to drive	F	T
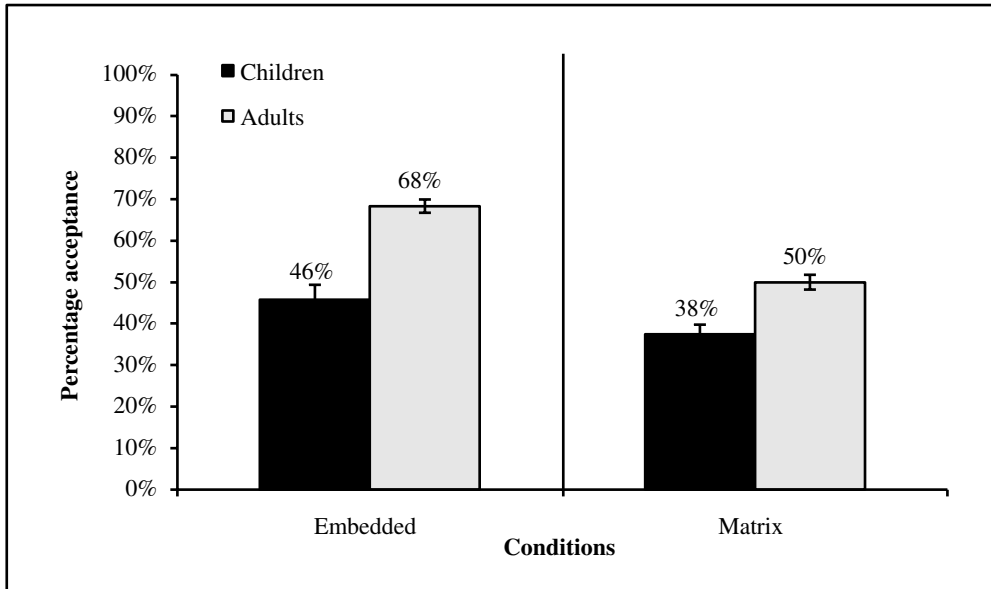
Figure 3

Percentage acceptance in two conditions in Experiment 2

and condition ($F(1, 23) = 4.44, p = .04$). The age effect is due to the fact that the adults were more likely to accept the test sentences in the embedded condition than the matrix condition (one-tailed t-test: $t(14) = -1.798, p < .05$). This, combined with the adults' relatively high acceptance rate of this interpretation in the matrix condition, may reflect an overall bias for the embedded interpretation, which may arise because the embedded vP presents the first available landing site for QR (perhaps a consequence of an efficient processing strategy for these sentences, as we will discuss below). We found no pattern attributable to the difference between subject and object control structures (i.e., *want/need* vs. *ask/invite*) or to lexical frequency (*want* and *need* are more frequent than both *ask* and *invite*): *p* values for comparisons of these items within the two experimental conditions in each age group ranged from .08 to .36.[10]

What is perhaps unexpected from the point of view of the TVJT is that children were more likely to reject the interpretation made true in the experimental context than to accept it, independently of condition. This is surprising because a widespread assumption among researchers using the TVJT is that children will obey the Principle of Charity (Quine 1960) and answer in a way that makes the puppet's statement true, if such an interpretation is generated by their grammars (Crain and Thornton 1998). Crain and Thornton (1998:211) claim that the Principle of Charity

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[10] The frequencies listed in Kučera and Francis 1967 are *want* 329, *need* 260, *ask* 128, and *invite* 11 (per million words).

makes the TVJT a good task because it can override a child's preference for one interpretation of an ambiguous sentence over another, ''especially if the preference for interpretation A over interpretation B is slight.'' But Crain and Thornton (1998:211) also correctly note that preferences for one reading of an ambiguous sentence over another may derive from a wide number of factors, including processing considerations, frequency, parsing strategies, situational preferences, and the syntactic or semantic complexity of the relevant readings (see also Boland and Cutler 1996, Frazier and Clifton 1996 for adult psycholinguistic data and Conroy et al. 2009 for discussion in the context of children). Thus, to the extent that children do not perform as the Principle of Charity predicts, it is likely because some of these other factors contribute to the response pattern.

In the case of adults, who seemed to show a baseline preference for the embedded interpretation, which was amplified in the condition that made that reading true, we can see that the preference for one interpretation over another is not so slight, and so the Principle of Charity serves to modulate that preference but not to override it altogether. In the case of children, the correct diagnosis for their tendency to answer in accord with the interpretation made false in the context is less obvious. One possibility concerns the matrix verbs in this experiment (*want*, *need*, *ask*, *invite*). These verbs embed propositions about events that never took place in the stories (e.g., Miss Piggy never drove any cars, Piglet never tasted any treats), and the real-world correlates of a propositional attitude verb such as *want* or *need* (Frege 1892) are not observable. These semantic properties may have resulted in an increased cognitive load, which could interact with the Principle of Charity. Indeed, Okanda and Itakura (2010) have found that 4-year-olds' general tendency to answer *yes* to a yes/no question depends on the type of predicate in the question being asked. It is quite likely that with our test questions, all things are not equal, and there is no reason to expect that children will exhibit a *yes* bias.

It is important to point out, though, that although the responses were not categorical in either age group, two results point toward participants' ability to represent the ambiguity of these sentences. First, a significant deviation from 0% acceptance suggests that an interpretation is available to the participants. Since this deviation from 0% held across conditions, we can infer that participants were able to access both readings. Second, the fact that different discourse contexts yield different patterns of behavior indicates that multiple interpretations are available to participants and that the contexts we provided included information that would enable them to switch the likelihood of selecting one interpretation or the other.

As in Experiment 1, we obtained percentages from the acceptance or rejection of the puppet's statement in each condition, and we gained additional support from participants' justifications for their responses, as reflected in appendix B. Reference to participants' justifications above and beyond their simple *yes* or *no* in response to the puppet provides firmer grounds for determining which interpretation(s) the child accessed and—since the possible interpretations of the test sentences covary with the possible landing sites for QR—which landing sites QR was able to target. One child who was assigned to the embedded condition, for example, accepted the puppet's statement, explaining that Kermit drove the red cars and that *these* were the cars that Miss Piggy wanted to drive (thereby indicating unambiguously that the embedded interpretation was accessed, which in this condition was true). By contrast, a child who was assigned to the matrix condition

rejected the puppet's statement, explaining that Miss Piggy wanted to drive the cars that Kermit did *not* drive (again unambiguously indicating that the embedded interpretation was accessed, which in this condition was false).

Likewise, two children who heard the test sentence in (25), but each in a different experimental condition, assigned it the same interpretation (the matrix interpretation) and therefore displayed different acceptance patterns.

(25) The cowgirl needed to jump over every frog that the old cowboy did.

In both conditions, the cowboy needed to jump over the *big* frogs, but actually jumped over the *small* ones (just as Kermit wanted to drive the black cars, but actually drove the red ones). In the matrix condition the cowgirl needed to jump over the big frogs, too, but in the embedded condition she needed to jump over the small frogs. One child who was assigned to the matrix condition accepted this statement, explaining that the cowboy and the cowgirl both needed to jump over the big frogs, a response that has the force of the matrix interpretation 'The cowgirl needed to jump over every frog that the old cowboy needed to jump over'. However, a child who was assigned to the embedded condition rejected the statement, explaining that the contestants needed to jump over different frogs. This response indicates that this child was also accessing the matrix interpretation rather than the embedded interpretation 'The cowgirl needed to jump over every frog that the old cowboy jumped over', which had been made true in that condition.

We took advantage of the large number of participants' justifications to perform an additional analysis of their responses. For each opportunity a participant had to respond to a test sentence (four times in an experimental session for each of the 24 children and 30 adults), we recorded whether a response was *given*, whether the response was *relevant* to the story,[11] and whether the response was *reliable* (i.e., whether one of the two grammatical readings could be inferred from it). The distribution of responses is presented in table 3. These percentages show not only that children consistently provided justifications for accepting or rejecting the puppet's statement, but also that the vast majority of these responses (close to 99%) were directly relevant to the plot of the story and most (68%) allowed one of the two readings to be clearly inferred.

An analysis of all of the reliable responses reveals a pattern that closely resembles the pattern of acceptances presented in figure 3: children accepted the target sentence 39% of the time (9/23) in the embedded condition and 35% of the time (10/29) in the matrix condition, while adults accepted the target sentence 77% of the time (39/51) in the embedded condition and 56% of the time (25/45) in the matrix condition. On average, 54% (28/52) of children's reliable responses and 62% (59/96) of adults' reliable responses corresponded to an embedded interpretation ($n = 16$ children and 28 adults). In addition, of these participants, 7 children and 12 adults provided justifications for *both* embedded and matrix interpretations *within* an experimental session.

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[11] Only five responses were irrelevant: one from a child and four from adults.

Table 3
Distribution of all responses in Experiment 2

Response type	Children		Adults	
Given/Total	79.2%	(76/96)	100.0%	(120/120)
Relevant/Given	98.7%	(75/76)	96.7%	(116/120)
Reliable/Given	68.4%	(52/76)	80.0%	(96/120)

4.2.3 Discussion   Recall that the motivation for this experiment was to determine whether children can access multiple interpretations of ambiguous ACD sentences, thereby determining whether QR in the child grammar is able to target multiple landing sites. As children were able to access both interpretations in both conditions, the results answer in the affirmative and therefore shed new light on the nature of QR in child grammar. If QR in child grammar were restricted to the lower landing site, children would only be able to access the embedded interpretation of our test sentences. Instead, children patterned with adults, accessing both the embedded and the matrix interpretations—at times within a single session. This pattern is possible only if QR in their grammar is able to escape the embedded clause.

4.3 Experiment 3

Whereas Experiment 2 was conducted to test whether there are limits to children's interpretations of sentences in which an ACD structure is embedded in a *nonfinite* clause, Experiment 3 was conducted to test whether there are limits to children's and adults' interpretations of sentences in which an ACD structure is embedded in a *finite* clause. Recall from section 1 that a finite embedded clause is generally believed to create a barrier to QR. In contrast to the results of Experiment 2, where we found that QR in child grammar is not *over*constrained, in this experiment we sought to determine whether QR in child grammar is *under*constrained. To our knowledge, while the grammaticality of the matrix interpretation has occasionally been questioned in the theoretical literature (e.g., Cecchetto 2004, Fiengo and May 1994, Wilder 1997), no study has systematically investigated participants' ability—either children's or adults'—to access the matrix interpretation of sentences in which ACD is embedded in a finite clause. The results of this experiment therefore present an opportunity to experimentally test intuitions and syntactic hypotheses presented in the theoretical literature.

4.3.1 Method   The participants in Experiment 3, and the materials and procedures used, were as follows.

4.3.1.1 Participants   Twenty-four 4-year-olds (11 M 13 F, *M* 4;8, range 4;1–4;11) and 24 undergraduates participated.

4.3.1.2 Materials   Participants were presented with sentences such as (26).

(26) Clifford said that Goofy read every book that Scooby did.

Recall from our earlier discussions that such sentences are reported to be unambiguous. This is coded into the theory with the restriction that the QNP cannot be moved by QR out of a finite embedded clause, giving the result that the matrix interpretation is barred and only the embedded interpretation is accessible. Thus, (26) should only mean 'Clifford said that Goofy read every book that Scooby read', and not 'Clifford said that Goofy read every book that Scooby said that Goofy read'.

As in Experiment 1, participants were presented with four test sentences and three filler sentences in one of two pseudorandomized orders counterbalanced across participants. Participants were randomly assigned to one of two conditions, based on which of the two interpretations was made true in the context. The filler sentences were unambiguous VPE sentences, presented following a plot similar in design to the test scenarios. The full set of sentences is given in appendix A.

4.3.1.3 Procedure   As in Experiments 1 and 2, the procedure used was the TVJT, and the stories were similar in design. In this experiment, for reasons that will become clear below, the stories were videotaped with a Sony Handycam video camera, and scenes were then edited and spliced together using Final Cut Pro software.

Let's review one of the experimental scenarios. In this story, three dogs, Clifford, Goofy, and Scooby, begin by standing in front of two piles of books, a pile of big ones and a pile of small ones. Scooby tells the others how much he likes to read, and he decides to read each of the small books. After he has finished reading the small books, Goofy proposes a game. Clifford and Scooby will leave the room. While they are gone, Goofy will read some books. When Clifford and Scooby return, they will guess which books Goofy read. Scooby and Clifford are delighted by this idea and leave. Now, because we did not want participants to be influenced by seeing which books Goofy read, we made sure that they never actually saw Goofy read any books. At the point in the story where Scooby and Clifford leave the room, the scene closes with Goofy considering both sets of books. Then the scene fades to black, transitioning to the next scene, in which Goofy tells Scooby and Clifford that they can return and make their guesses.

Upon their return, Scooby guesses first and says that he thinks Goofy read the big books (the ones Scooby did not read). The two experimental conditions diverge when it is Clifford's turn to guess. In the *embedded* condition, Clifford disagrees with Scooby and says that he thinks Goofy read the small books (the ones Scooby read, but not the books that Scooby said that Goofy read). In the *matrix* condition, Clifford agrees with Scooby and says Goofy read the big books (the ones Scooby said that Goofy read, but not the books that Scooby read). This design is illustrated in figure 4. As in Experiment 2, this design allows the truth value of each interpretation to vary across the two conditions, as shown in table 4.

The filler stories were similar in format to the test stories. In each, two characters are engaged in an activity when a third character enters and proposes a game. The two characters continue to participate in their activity while the third leaves the room. When the third character returns, he guesses what the two other characters did.

4.3.2 Results   Our predictions are as follows. If previous theoretical claims are correct that a finite clause creates a boundary for QR, then the test sentences in this experiment should be
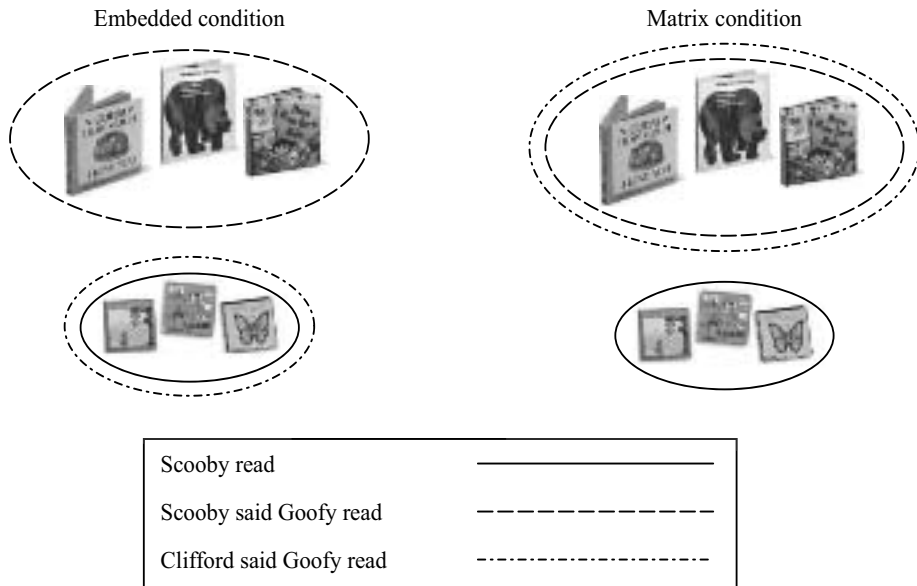
Figure 4
Experimental conditions for test sentences in Experiment 3

unambiguous and have only the embedded interpretation. Adults should, then, uniformly reject the matrix interpretation in both conditions. If children exhibit the same locality conditions on QR as adults are predicted to have, then they too should allow only the embedded interpretation and disallow the matrix interpretation. If, however, QR in child grammar is not clause-bounded, then the test sentences in this experiment should be ambiguous, as the test sentences were in Experiment 2, and we should observe comparable patterns of acceptance.

Here too we analyzed the responses in terms of the percentage of acceptance in each experimental condition. These percentages are presented in figure 5. As in Experiments 1 and 2, participants performed at or near ceiling with the filler sentences (children: 85%, *SE* .04; adults: 100%).

Table 4
Truth values for test sentences in Experiment 3

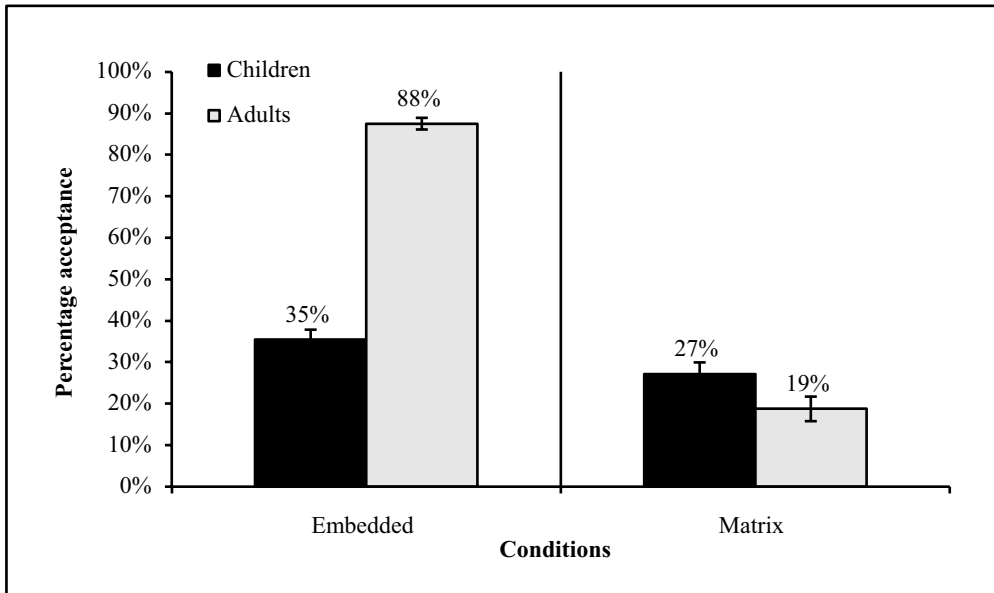| VP interpretation	Embedded condition	Matrix condition
(Clifford said that Goofy read every book that Scooby . . .)		
read	T	F
said that Goofy read	F	T

Figure 5

Percentage acceptance in two conditions in Experiment 3

A 2 × 2 ANOVA (age × condition) revealed a main effect of age ($F(1, 23) = 12.28$, $p = .001$), a marginally significant effect of condition ($F(1, 23) = 3.24, p = .08$), and a significant interaction between age and condition ($F(1, 23) = 6.41, p < .02$). Two patterns stand out from a comparison with the data from Experiment 2. First, as predicted, adults generally strongly dispreferred the matrix interpretation of the test sentences in this experiment. Not only is their willingness to access the matrix interpretation in the embedded condition noticeably diminished from Experiment 2 (32% vs. 12%, the inverse of the percentage of acceptance of the embedded interpretation in that condition), in the condition in which the matrix interpretation is made true, adults accessed it only 19% of the time (compared with 50% in Experiment 2). Moreover, in Experiment 2 adults allowed the matrix interpretation to hold on average 40% of the time overall, accessing it more often in the condition that made it true, while in Experiment 3 they allowed it only 16% of the time across both conditions.

Second, in both Experiment 2 and Experiment 3, children allowed the matrix interpretation to hold on average 46% of the time, and they were more likely to access it in the embedded condition. Surprisingly, in Experiment 3, where the matrix interpretation is claimed to be ungrammatical, children actually accessed it 65% of the time in the embedded condition—the condition in which it was made false—and close to 30% of the time in the matrix condition. A 2 × 2 (experiment × condition) ANOVA comparing children's performance in Experiments 2 and 3 revealed no main effect of experiment ($F(1, 47) = 0, p = 1.0$) and no interaction ($F(1, 47) = 1.14, p = .29$), but a significant effect of condition ($F(1, 47) = 7.7, p < .01$), since in both

Table 5
Distribution of all responses in Experiment 3

Response type	Children		Adults	
Given/Total	82.3%	(79/96)	100.0%	(96/96)
Relevant/Given	97.5%	(77/79)	100.0%	(96/96)
Reliable/Given	33.7%	(26/77)	92.7%	(89/96)

experiments, children were slightly more likely to accept the puppet's statement in the embedded condition.

As in Experiment 2, we analyzed participants' responses further (see table 5). Here, too, the percentages demonstrate that children consistently provided justifications when they accepted or rejected the puppet's statement and that the vast majority of these responses were directly relevant to the plot of the story. What's more, 16 of the 24 children offered an explicit verbal justification for at least one of the test stories that unambiguously pointed toward one of the two interpretations (i.e., reliable responses). The number of reliable responses in Experiment 3 was much lower for the child participants than in Experiment 2, because while children referred to plot content in the justifications supporting their responses, the target sentences in this experiment were more complicated, so children were often unable to articulate a response that allowed an interpretation to be unambiguously inferred from it.

As before, the pattern observed for the reliable responses is similar to the pattern observed for the acceptances for the entire experiment. The children represented among these responses accepted the target sentence 25% of the time (3/12) in the embedded condition and 36% of the time (5/14) in the matrix condition, while adults ($n = 24$) accepted the target sentence 85% of the time (35/41) in the embedded condition but only 19% of the time (9/48) in the matrix condition. On average, 83% (74/89) of adults' reliable responses but only 46% (12/26) of children's reliable responses corresponded to an embedded interpretation. Acceptance of the matrix interpretation was evenly distributed for both sets of participants such that no one item accounted for significantly more or less of the percentage of acceptance of matrix readings.

Representative examples of children's justifications for their responses are presented in appendix B. We provide these to illustrate that it is not only children's ability to *accept* the puppet's statement in the matrix condition and provide a justification for doing so, but also children's ability to *reject* the puppet's statement in the embedded condition and appeal to the competing matrix interpretation in their justification, that demonstrates that children can routinely access the matrix interpretation of these purportedly unambiguous sentences. For example, one child who was assigned to the embedded condition and heard the puppet utter (26), repeated here, rejected the puppet's statement. The child explained to the experimenter that Clifford chose the small ones, and Scooby chose the big ones, remarking that Clifford and Scooby made different guesses about which books Goofy read.

(26) Clifford said that Goofy read every book that Scooby did.

This statement provides clear evidence that the child accessed the matrix interpretation 'Clifford said that Goofy read every book that Scooby said that Goofy read'.

In contrast to the children, adults generally resisted the matrix interpretation. However, fully one-third (8/24) of the adults accessed the matrix interpretation at least once during the experimental session, and 4 of these did so at least half of the time. As with the children, these adults either rejected the puppet's statement in the embedded condition and appealed to the matrix interpretation as a justification, or accepted his statement in the matrix condition and always provided coherent justifications when doing so. For example, an adult in the matrix condition who accessed the matrix interpretation three out of four times provided responses such as that in (27) when accepting the puppet's statement, referencing the parity of statements by the characters.

(27) a. She [Miss Piggy] said she agreed with Kermit that Fozzie would drive the new cars.
   b. He [the genie] said that he agreed with the cowboy that the cowgirl jumped over the bigger frogs for a challenge.

Another adult, assigned to the embedded condition, offered the justification in (28) when rejecting the puppet's statement, clearly accessing the matrix interpretation 'Miss Piggy said that Fozzie drove every car that Kermit said that Fozzie drove'.

(28) She [Miss Piggy] stood next to the two red cars and specifically said Kermit was wrong in choosing the others.

As mentioned above, no one item accounted for this pattern of responses. Thus, if the matrix interpretation is actually ruled out as a matter of the grammar, we are left having not only to account for the robust pattern exhibited by the children, but also to explain away responses such as these from a subset of adult speakers.

4.3.3 Discussion   The purpose of Experiment 3 was to determine whether children and adults treat an embedded finite clause as a barrier to QR. The consequence of this constraint would be that in the case of sentences in which ACD is embedded in a finite clause, only the embedded interpretation (where the QNP is not raised out of the embedded clause) would be grammatical, and the matrix interpretation would be barred. We found that while this pattern held for most adults, children routinely allowed both the embedded and the matrix interpretations, regardless of which interpretation was made true in the experimental context.[12]

What's more, a third of the adults accessed the supposedly ungrammatical matrix interpretation at least once, and 4 adults accessed this interpretation at least half of the time, providing explicit justifications for doing so that referenced the matrix interpretation. In light of these

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[12] It is perhaps worth noting that in other child language experiments investigating the effects of clause boundaries in sentence interpretation (see Chien and Wexler 1990, Jakubowicz 1984, McDaniel, Smith Cairns, and Hsu 1990, Solan 1978), 4-year-olds are well aware that the presence of a clause imposes constraints on the availability of certain interpretations. For example, given sentences such as (ia–b), 4-year-olds know that the reflexive must be locally bound by the subject of the embedded clause and cannot be bound by the matrix subject.

(i) a. Grover wants Cookie Monster to pat himself.
   b. Grover says that Cookie Monster is patting himself.

findings, we are led to consider the possibility that the grammar actually does generate the structure from which the matrix interpretation is derived and that adults' disinclination to access this interpretation stems from an extragrammatical factor contributing to its unavailability. Thus, it may be that a finite clause does not actually serve as a barrier to QR from the perspective of the grammar.

We'd like to digress briefly here to address a hypothesis concerning children's interpretation of (potentially) ambiguous sentences. This hypothesis, offered by Grodzinsky and Reinhart (1993) and Reinhart (2004), states that holding multiple derivations in working memory for the purpose of comparing them is beyond children's memory capacity. Thus, when faced with grammatical constructions requiring that multiple items be compared, the child's memory system is overloaded and so the child is unable to find an interpretation. In Reinhart's (2004:122) words, ''The processing poses too big a load on their working memory, . . . [which] is not developed enough to hold the materials needed to complete the execution of this task—namely constructing an alternative derivation while holding the previous one and then comparing the two derivations. Failing the execution, they resort to some strategy.'' This strategy would involve guessing, resulting in chance-like performance due to either a flip of the coin across experimental trials or a default preference for an interpretation evidenced by a bimodal distribution of the experimental participants. In either case, the overall group performance should hover around 50%. On the assumption that computing the meaning of ambiguous ACD sentences involves comparing multiple derivations (Fox 1995, 1999), one might expect this hypothesis to be applicable in Experiments 2 and 3.

While space prevents us from offering a detailed analysis, we briefly observe here that the data are not easily explained by saying that children's memories were overloaded and that they resorted to guessing. Children were consistently able to offer coherent reasons for their responses, which referenced the details of the narrative and the content of the statement made by the puppet. Moreover, even the responses from adults in Experiment 2 hovered around the midrange of the scale, a pattern that certainly cannot be attributed to their poor working memory and their inability to compare multiple derivations. In sum, if children experienced any processing difficulties with these sentences, it does not appear to have derived from an inability to compare competing derivations.

5 General Discussion

We began this article by pointing out that the locality properties of QR are unexpected as compared with those of other forms of Ā-movement, since only QR appears to be bounded by Tense. Having reviewed examples that call this assumption into question (see (12)–(14)), we asked whether the observed locality constraints on QR arise from the grammar or instead derive from other factors, such as parsing dynamics. The results presented here encourage us to take the latter option seriously.

Experiment 1 provided a baseline for participants' interpretation of ambiguous VPE sentences against which we could evaluate the range and limits of QR. In Experiment 2, when the site of ACD was contained within a nonfinite embedded clause, children and adults showed no difficulty in accessing either the embedded or the matrix interpretation, indicating the availability of multiple

landing sites for QR. However, in Experiment 3, when the site of ACD was contained within a finite embedded clause, children robustly accessed both the matrix and the embedded interpretations, contrary to predictions generated by linguistic theory and the performance of the majority of adults. At the same time, we must also explain why a small cohort of adults systematically (and some other adults on occasion) accessed a purportedly ungrammatical interpretation, providing coherent justifications in the process.

The pattern we observe in children's acceptance of the matrix interpretation (and most adults' rejection of it) is reminiscent of the subset problem discussed by Berwick (1985), Bowerman (1974), Gold (1967), Manzini and Wexler (1987), and Pinker (1989), among others. If interpretations allowed by adults are a proper subset of the interpretations allowed by children, then whatever experience children have with the relevant sentences will be consistent with the set of interpretations that they allow. Consequently, it is unclear what developmental process would enable children to add constraints to the possible meanings of sentences or how children could subtract an available meaning from their repertoire. The response to this problem from linguists has been to stipulate that solutions to subset problems are built into the learner such that they should never arise in practice (Berwick 1985, Crain, Ni, and Conway 1994). Thus, whenever a subset problem might arise, the learner should default to the smaller grammar. Clearly, however, no such stipulation is applicable here since the children patently generate a broader set of interpretations than adults (see Goro 2007 for similar overgeneralization data in semantic acquisition).

This overall pattern of results leads us to revisit the constraints on QR itself and to question whether QR is truly clause-bounded by the nature of the grammar or whether these restrictions arise through other, extragrammatical constraints. That is, it is possible that QR is not bounded by Tense from the perspective of the grammar and that the grammar actually does allow QR to move items freely out of tensed clauses just like other forms of Ā-movement. Thus, QR only *appears* to be bounded by Tense because of pressures from the parser: certain factors outside of the grammar make this structure exceedingly difficult to access. Children, not yet being efficient parsers, do not yield to this pressure. Consequently, their behavior reveals the true nature of QR, namely, that it is free to cross tensed clause boundaries. The fact that adults displayed a preference for the embedded interpretation in Experiment 2, when in fact both the embedded and the matrix interpretations are licensed, may be taken as support for a processing account.

It is important to emphasize that the fact that most adults consistently judged the sentences with ACD embedded in a tensed clause as lacking the matrix interpretation is not necessarily evidence that QR is bounded by the grammar. Rather, it is simply evidence that in the contexts we provided, participants failed to access a particular interpretation. QR out of a tensed clause might then be analogous to the case of center-embedded relative clauses, which are generally uninterpretable despite being generable by the grammar (Miller and Chomsky 1963). Thus, QR across a tensed clause boundary might not actually be ungrammatical, but is so difficult to parse under normal circumstances that it might just as well be.

What might an account based on parsing dynamics entail? We would like to briefly sketch one possible account. To begin, let us outline what parsing steps are involved in resolving ACD sentences and how the efficient implementation of these steps could lead to the appearance that

a structure generated by the grammar is not possible. By hypothesis, ACD sentences involve two grammatical operations that target the left edge of VP: QR and anaphora resolution of the elided VP. Assume that the interpretation of the sentence in (29a) requires moving the QNP into a position at the left edge of VP, as seen in the corresponding LF representation in (29b) (Heim and Kratzer 1998). Assume also that part of this interpretation involves creating an S-Structure representation like that in (29c).

(29) a. John saw every boy.
    b. $[_{IP}$ John $[_{VP}$ every boy$_i$ $[_{VP}$ saw t$_i]]]$ =   LF
    c. $[_{IP}$ John $[_{VP}$ saw every boy$]]$ =   S-Structure

Given that the parser cannot know that QR is required for a given quantificational expression until that expression is encountered (here, upon reaching the QNP in object position), it follows that the relevant portions of the S-Structure representation are constructed *prior* to the completion of an LF representation containing the moved quantificational expression. Thus, when the parser encounters a QNP in object position, it must retrospectively search the already constructed S-Structure representation to identify a VP to serve as a landing site, and then allow the QNP to be raised there.[13] Similarly, when the parser encounters evidence that a VP is missing from a structure, as in the case of VPE (30a), it must retrospectively search the already constructed representation (in this case (30b)) in order to identify an antecedent VP to fill in as the content of the elided VP (see (30c)).

(30) a. Lola jumped over the frog and Dora *did* too.
    b. $[_{IP}$ Lola $[_{VP}$ jumped over the frog$]]$ and $[_{IP}$ Dora $[_{I'}$ did $[_{VP}$ ____$]$ too$]]$
    c. $[_{IP}$ Lola $[_{VP}$ jumped over the frog$]]$ and $[_{IP}$ Dora $[_{I'}$ did $[_{VP}$ jump over the frog too$]]$

Putting these two ideas together brings us to the conclusion that in parsing a sentence containing ACD, the parser must implement two searches for VPs, one to resolve QR and one to fill in the ellipsis. We emphasize that these are two distinct processes, which therefore allows for the strong possibility that they are sequential. Because the quantifier is encountered first in the incremental processing of the sentence, it follows that the search for the QR landing site might well take place before the search for the VP to resolve the ellipsis. We would hypothesize that this is the case for adults, who are experienced sentence processors. Children, on the other hand, might instead wait to launch the searches until they have processed the full DP, in which case they might instead display the reverse order.

Adults' contrasting response patterns between Experiment 1 (in which there was VPE and no QR) and Experiment 2 (where VPE and QR interacted) indicate that from the perspective of the parser, QR and VPE resolution have different locality properties with respect to the targeting of multiple VPs. In Experiment 2, where both the matrix and the embedded landing sites are

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[13] See Lewis and Vasishth 2005, McElree, Foraker, and Dyer 2003, and Wagers 2008 for perspectives on searches of representations in memory in sentence parsing; and for specific attention to VPE interpretation, see Martin and McElree 2008.

made possible by the grammar, adults displayed a slight, but reliable, preference for targeting the embedded VP as a landing site for QR. This pattern makes it straightforward to suppose that this preference is amplified in Experiment 3, in which most adults showed a nearly categorical preference for the embedded interpretation when interpreting sentences with ACD inside a finite embedded clause (perhaps because of the extra processing load introduced by the interpretation of Tense and a new discourse referent in the subject of the embedded clause).

Indeed, Jason Merchant (pers. comm.) has observed that making the embedded subject a bound pronoun also seems to weaken the boundary introduced by Tense, allowing for sloppy identity in (31).[14]

(31) Clifford said that <u>he</u> read every book that Scooby did.
     Clifford said that <u>he</u> read every book that Scooby . . .
     a.   read.
     b.   ?said that he read.

Likewise, Fox (1999) and Moltmann and Szabolcsi (1994) show that examples such as (32a) allow both scope relations, even though there is a boundary to movement of the QNP. This observation calls into question the claim that QR is clause-bounded by nature.

(32) a. One girl knows <u>what</u> every boy bought for Mary.
        (one > every, every > one)
     b. One girl knows <u>that</u> every boy bought a present for Mary.
        (one > every, *every > one)

Recall that examples such as (12)–(14), repeated here, further support the possibility that the grammar does generate structures requiring QR out of an embedded clause.

(12) A (different) student made sure that every invited speaker had a ride.
     = For every invited speaker, there was a student who made sure that speaker had a ride.

(13) A different witness testified that John robbed every bank in town.

(14) John thinks that Mary is taller than Bill does.

It is possible that for children, activating the matrix VP for the purpose of ellipsis resolution somehow makes it easier to activate that VP for the purpose of targeting a landing site for QR. That is, it is possible that children are less able than adults to keep the two VP searches—one

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[14] If indeed this is the case, then we might predict that although children rejected sentences such as Kiguchi and Thornton's (2004) example in (20a), repeated here as (i), presumably because in this sentence QR targets a position lower than the subject and incurs a Principle C violation, they might accept a matrix interpretation of (iia) with a range of possible coindexing, as indicated in (iib).

   (i) *He$_i$ jumped over every fence that Kermit$_i$ tried to.

   (ii) a. Clifford said that he read [every book that Scooby's brother did].
        b. Clifford$_i$ [every book that Scooby$_j$'s brother$_k$ did ⟨say that he$_{i/j/k}$ read⟩] said that he$_{i/j/k}$ read t

for a QR landing site and the other for an ellipsis antecedent—separate and that they exhibit a kind of facilitation effect on the matrix VP, making that VP more available as a QR landing site than it would be otherwise. This kind of similarity-based interference in memory retrieval has been repeatedly found in psycholinguistics (Anderson 1995, Lewis, Vasishth, and Van Dyke 2007, Wickelgren and Corbett 1977). If the grammar places no restrictions on the matrix VP as a landing site for QR, it should be a viable option.[15]

The transition to adulthood, then, would involve becoming more efficient at keeping the search for a VP as a QR landing site separate from the search for a VP as an antecedent for ellipsis. As this ability develops, presumably as a consequence of increased efficiency in performing such searches during online sentence comprehension, children's behavior should eventually become more like that of adults, without requiring any changes to their grammar per se. If this account is on the right track, then we might predict that children would be less likely to raise the QNP out of a finite embedded clause in the absence of VPE. We leave testing this prediction for further research.

The experimental findings and the account offered here suggest that it is promising to pursue an extragrammatical account of why the matrix interpretation of the target ACD sentences is barred. At the same time, we do not want to be too hasty and discard the grammatical account. It may be possible to account for the pattern observed in our data while still maintaining that QR has locality constraints that arise from the grammar.

Under this account, QR should be prohibited from crossing a tensed clause boundary. Thus, when the parser conducts a search for VPs to serve as landing sites for QR, it finds only one: the embedded VP. However, the search for potential antecedents for VPE still yields two VPs (the embedded and matrix VPs). It may be that the search for a suitable VP antecedent leads the parser to erroneously consider the matrix VP as a potential landing site for QR. As a result, the parser would temporarily consider as acceptable an interpretation that is not actually licensed by the grammar. This type of situation (where an interpretation, though ungrammatical, might still be considered acceptable) has recently gained considerable attention in the literature on adult sentence processing (e.g., Arregui et al. 2006, Gordon, Hendrick, and Johnson 2001, Lewis and Vasishth 2005, McElree, Foraker, and Dyer 2003, Van Dyke and Lewis 2003, Van Dyke and McElree 2006). (See Conroy et al. 2009 for related discussion in the domain of Principle B effects.) While adults would generally be able to recover from this interference, children—as novice and less efficient sentence processors—would be more susceptible to it. On this view, children may have acquired the correct locality conditions for QR, but parsing factors make it appear that they have not. Development, according to this view, would involve children's parsers improving the ability to overcome interference effects during online sentence processing. Examining the resolution of ACD in real time in adults might help to determine the viability of this hypothesis, though we leave this work for the future.

[15] Although we have tried to account for *why* the matrix interpretation is possible, we have not addressed the question of *when* it is accessible. While we are not entirely sure, this phenomenon should be similar to other examples of ambiguity in natural language and visual perception, in which ambiguity can be resolved by a given syntactic frame, by a salient context, or by having one's attention directed to a particular element of the scene.

In this article, we have shown that experimental data from both child and adult participants concerning their interpretation of ACD sentences may be informative about theoretical assumptions concerning the very nature of the locality constraints on one form of covert movement, QR. Indeed, these data raise the possibility that the pattern of interpretations found in children reveals more about the nature of the grammar than the corresponding pattern in adults, illustrating the utility of developmental data in building a theory of grammar. Moreover, these data speak to the importance of integrating parsing models with grammatical theory in identifying the appropriate mapping between acceptability judgments and grammaticality. Future research in this area should help to tease apart the grammatical and extragrammatical accounts outlined above and shed light on the locality conditions on QR, and consequently be informative about what development of both grammar and parsing entails.

Appendix A: Test and Filler Sentences Used in the Experiments

Experiment 1
Test sentences

1. Miss Piggy wanted to drive the [red/black] cars because Kermit did.

2. The cowgirl needed to jump over the [small/big] frogs because the old cowboy did.

3. Clifford asked Goofy to read the [big/small] books because Scooby did.

4. Winnie the Pooh invited Piglet to taste the [cookies/cupcakes] because Tigger did.

Filler sentences

5. The [monkey/elephant] pushed the rock further than the [elephant/monkey] did.

6. The [shark/lizard] ate a lobster before the [lizard/shark] did.

7. The rhino rode the motorcycle, [and the hippo did, too/but the hippo didn't].

Experiment 2
Test sentences

8. Miss Piggy wanted to drive every car that Kermit did.

9. The cowgirl needed to jump over every frog that the old cowboy did.

10. Clifford asked Goofy to read every book that Scooby did.

11. Winnie the Pooh invited Piglet to taste every treat that Tigger did.

Filler sentences

The filler sentences were the same as in Experiment 1.

Experiment 3
Test sentences

12. Miss Piggy said that Fozzie drove every car that Kermit did.

13. The genie said that the cowgirl jumped over every frog that the old cowboy did.

14. Clifford said that Goofy read every book that Scooby did.

15. Winnie the Pooh said that Piglet tasted every treat that Tigger did.

Filler sentences

16. The lion said that the [monkey/elephant] pushed the rock further than the [elephant/ monkey] did.

17. The dinosaur said that the [shark/lizard] ate a lobster before the [lizard/shark] did.

18. Ernie said that the rhino rode the motorcycle, [and the hippo did, too/but he said that the hippo didn't].

Appendix B: Justifications Offered by Children in the Experiments

Experiment 1

Justification of the *truth* of the puppet's statement (acceptance of statement)

19. Because Kermit drove the red cars and Piggy thinks . . . and she wanted to drive them. (test sentence 1, embedded condition)

20. Because the cowboy teaches the little girl to jump over the frogs (pointing to small frogs). (test sentence 2, embedded condition)

21. Clifford asked Goofy to read the big books 'cause Scooby didn't know how to read the big books. (test sentence 3, matrix condition)

22. 'Cause Miss Piggy and Mr. Froggy wanted to drive the black cars, but he not allowed to. (test sentence 1, matrix condition)

Justification of the *falsity* of the puppet's statement (rejection of statement)

23. The girl had to jump over the little frogs, and the cowboy had to jump over the big frogs. (test sentence 2, embedded condition)

24. Kermit did the red, but Miss Piggy wanted to do the black. (test sentence 1, matrix condition)

Experiment 2

Justification of the *truth* of the puppet's statement (acceptance of statement)

25. Kermit drove the red ones. Miss Piggy wanted to drive the red ones. (test sentence 8, embedded condition)

26. The cowboy showed the cowgirl with the little frogs, and the cowgirl needed to jump over the small ones, and the cowboy needed to jump over the big ones. (test sentence 9, embedded condition)

27. The old cowboy and the little cowgirl needed to jump over the big frogs. (test sentence 9, matrix condition)

Justification of the *falsity* of the puppet's statement (rejection of statement)

28. They needed to jump over different frogs. (test sentence 9, embedded condition)

29. Pooh invited Piglet to taste the cookies, and that's what Tigger was nibbling on. Tigger wanted Piglet to eat the other treats. (test sentence 11, embedded condition)

30. Miss Piggy wanted to drive the new cars. Kermit drived the old cars. (test sentence 8, matrix condition)

31. Miss Piggy wanted to drive the cars Kermit didn't drive. (test sentence 8, matrix condition)

32. Clifford wanted Goofy to read *these* books, but Scooby read *those*. (test sentence 10, matrix condition)

Experiment 3

Justification of the *truth* of the puppet's statement (acceptance of statement)

33. Genie said what the . . . the same . . . so he went on the cowboy's side. (test sentence 13, matrix condition)

34. Experimenter: What did Miss Piggy say?
    Child: She go with Kermit. (test sentence 12, matrix condition)

Justification of the *falsity* of the puppet's statement (rejection of statement)

35. Winnie the Pooh said Piglet tasted the cookies and Tigger—he said Piglet tasted the icing. (test sentence 15, embedded condition)

36. Clifford chose the small ones. Scooby chose the big ones. (test sentence 14, embedded condition)

37. The genie said the little frogs. The old cowboy said she jumped over the big frogs. (test sentence 13, embedded condition)

38. First Scooby read the little ones, then they [Clifford and Scooby] hid, and then he [Goofy] read a book. They guessed the big ones. (test sentence 14, matrix condition)

39. Winnie the Pooh agreed with Tigger. (test sentence 15, matrix condition)

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