Children Want to Access Every Interpretation Adults Do: Children's Knowledge of Ambiguity in ACD Constructions

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1. Introduction

Syntax presents difficulties for the child acquiring language because it requires the induction of an underlying grammatical system from a corpus of sentences. Certain aspects of this acquisition are especially challenging, because they require the learner to induce representations that have no correlate in the surface structure. Antecedent-contained deletion has such properties: it involves two kinds of invisible syntactic elements, verb phrase ellipsis and covert displacement of a quantifier phrase. This construction therefore presents a unique opportunity to investigate certain questions about children's language acquisition.

An example of antecedent-contained deletion (ACD) is shown in (1). In this sentence, the word *did* indicates a site where a verb phrase (VP) has been elided.

(1) Miss Piggy [$_{\mathbf{VP}}$ drove every car that Kermit **did**].

Typically, the resolution of ellipsis proceeds as follows. Given a sentence like (2), where there is an ellipsis site, we look back to a VP that can serve as the antecedent for the ellipsis. In this case, the VP *drove the car* precedes the ellipsis, and we fill this VP into the ellipsis site (or "reconstruct it"), resulting in an interpretation as in (3).

(2) Miss Piggy [$_{\mathbf{VP}}$ drove a car], and Kermit **did**, too.

(3) Miss Piggy drove a car, and Kermit **did** *drove a car* , too.[1]

* This work was funded in part by an NSF grant to the second author (#BCS-0418309) and an NIH grant (#HD 30410) to Sandra Waxman for the Project on Child Development at Northwestern University. We are grateful to Chris Kennedy for illuminating discussion, and to the Northwestern Acquisition Lab Group for helpful comments.

[1] In this paper, when an example is provided that demonstrates how an interpretation has been assigned to a VP ellipsis site, we will use the following convention: the *do* will remain (tensed), and the

However, the sentence in (1) presents a problem: the site of ellipsis, or *deletion*, is *contained* within its *antecedent*. An attempt to look back at the VP that serves as the antecedent for the ellipsis results in an infinite regress, continually filling in the ellipsis site, as illustrated in (4). Thus, the sentence is uninterpretable as long as the quantified DP remains in its base position.

(4) Miss Piggy drove every car that Kermit **did** [$_{\mathbf{VP}}$ *drove every car that Kermit* ***did*** [$_{\mathbf{VP}}$ *drove every car that Kermit* ***did*** [$_{\mathbf{VP}}$ *drove every car that Kermit* ***did ...***]]]

An additional problem is that if the elided VP were to be interpreted *in situ*, it could not be structurally identical to its antecedent VP, a violation of *parallelism*.[2] If the quantified DP is raised to a position external to the VP, these problems are solved. The ACD construction has been studied and discussed at length in the linguistic literature (Sag 1976, Fiengo and May 1994, Kennedy 1997, Fox 2002, Merchant 2000, and others). However, only recently has it attracted attention in the field of language acquisition.

In this paper, we focus specifically on whether or not children appreciate the ambiguity of ACD sentences that host multiple landing sites for the displaced quantifier phrase, and which are therefore ambiguous between multiple interpretations. These sentences (discussed in Section 2) allow us to determine whether children are limited in their choice of landing site when they perform Quantifier Raising.[3] If we find that children are able to access multiple interpretations by targeting multiple landing sites (we find that they are), we can also ask if the landing site they prefer to target is the same as the one adults prefer to target (we discover it is not). That children appear to have adult knowledge with respect to this construction but behave unlike adults when responding to these sentences leads us to ask about the constraints governing their sentence processing.

In Section 2, we will present the linguistic background of the ACD construction, and discuss the main solutions that have been proposed in response to the puzzle presented by ACD. We will then introduce the central issue to be examined. In Section 3, we discuss the relevant previous research in the field of language acquisition. In Section 4, we present our investigation of four-year-olds' comprehension of ambiguous sentences with ACD constructions. Anticipating the results, we show that at this age, children can successfully access the same interpretations that adults do, and also provide articulate justifications for their responses; however, children and adults diverge with

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material being "reconstructed" in the ellipsis site will follow in . In English, "*do* support" is employed with VP ellipsis. *Do* does not substitute for the elided VP; it appears higher up in the hierarchical syntactic structure.

[2] We present an analysis that is consistent with the copy theory of movement, but remain agnostic as to whether a copy theory of movement or PF deletion is the right approach.

[3] Throughout this paper, we will make reference to QR and the landing sites targeted by this operation. Since the experimental findings presented in this paper concern which interpretations are being accessed and do not provide support for one framework over another, the data could easily be interpreted under other approaches, such as Categorial Grammar. The reader is referred to Jacobson (1992) for a formal presentation of how to account for ACD under a Categorial Grammar approach.

respect to the processing of these constructions. Finally, in Section 5, we discuss the implications of this experiment for issues of language learnability and further research.

2. Linguistic Background

The main solution that has been proposed to resolve ellipsis in ACD constructions like (1) relies upon the operation of Quantifier Raising (QR). As described above, the problem in this construction is that the elided VP occurs inside the DP object of the main verb. Through QR, the DP headed by the quantifier *every* is covertly displaced (i.e., at Logical Form (May 1985)) to a VP-external position. The output of QR with the reconstructed VP is seen in (5).

(5) Miss Piggy [$_{v\text{P}}$ [$_{\text{DP}}$ every car that Kermit did *drove t*]$_{\text{i}}$ [$_{\text{VP}}$ drove t$_{\text{i}}$]]

We assume, following Fox (1999, 2000) and Merchant (1999, 2000) that QR can target *v*P.[4] In this position, the quantifier that hosts the site of ellipsis takes scope over what is interpreted as the antecedent of ellipsis.[5] The picture becomes slightly more complicated when we embed a sentence, as in (6). The quantified DP is now contained in two, and not just one, VPs.

(6) Miss Piggy [**$_{\text{VP}}$** wanted to [**$_{\text{VP}}$** drive [$_{\text{DP}}$ every car that Kermit did]]]

There should be a correlation between quantifier scope and the interpretations that are available (or the reconstruction that takes place): the greater the distance of LF movement, the wider the scope of the quantifier, and the greater the number of VPs (and hence the amount of material) that can serve as the antecedent of the ellipsis (Fiengo and May 1994). If the quantified DP is removed from and permitted to take scope over the innermost VP, then we expect to generate one reading; if the DP is removed from and permitted to take scope over the outermost VP, we expect to generate another. This is what we find: two interpretations[6] of (6) are, in fact, available. Following Kennedy (1997), we will refer to the first reading in (7) as the *embedded* reading and second as the *matrix* reading.

(7) Miss Piggy wanted to drive every car that Kermit did *drove* / *wanted to drive* .

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[4] The reader is referred to the works cited for reasons why this landing site is also proposed in addition to IP, as originally proposed by May (1977) and Fiengo and May (1994). Here we will only mention that the reasons are based on c-command.

[5] Other frameworks require equally abstract representations and do not change the nature of the learning problem. For example, in a variable-free approach, such as Categorial Grammar, the problem is that *did* requires a certain kind of complement. The question for language development is whether children will be able to identify a constituent of the appropriate type for function composition, and if they will be able to function compose the elements to generate the right kind of interpretation.

[6] The target sentence should actually be more than two ways ambiguous, taking into account both *de re* and *de dicto* readings.

If children are limited in their ability to perform QR, they should be limited in their ability to access multiple interpretations.[7] By presenting children with sentences like (6) in a controlled experimental context, we can assess their grammatical knowledge with respect to this syntactic construction, which will in turn inform us about children's ability to successfully resolve ellipsis and apply syntactic-semantic operations in an adult-like manner. To the extent that they are able to access the multiple grammatical interpretations of these sentences, we have evidence for the adult-like nature of their grammar with respect to quantification, and can begin to ask if they also process these sentences in an adult-like manner. That is, *that* they access these interpretations is adult-like; is *how* they access these interpretations also adult-like?

3. Previous Research

Complex sentence constructions are sentences with an independent/matrix clause and a dependent/subordinate clause. Between ages two and three, the child begins to produce her first complex sentences, and by four years of age (the age of the children in the current study), children are producing complex sentences with infinitival complements and with relative clauses. While early evidence suggested that children had difficulty assigning the correct interpretation to relative clauses, their non-adult-like patterns were later explained by experimental artifacts (e.g., production-oriented tasks and lack of satisfying felicity conditions). Recent evidence from judgment/comprehension tasks shows that children can and do assign an adult-like interpretation to relative clauses, and perhaps most importantly, to ACD constructions (Lidz et al. 2003, Kiguchi and Thornton 2004). Children's ability to correctly interpret sentences with infinitival complements depends on their understanding of how to interpret the missing subject, which must be controlled by a DP standing in a c-command relation in the matrix clause. A body of child language literature provides support for children's understanding of control complement structures, and recent work has also shown that children rely on c-command at LF and not linear surface order. We are therefore in a good position to think that children in our experiment will be able to interpret these target constructions, but the open question is whether or not they will appreciate the ambiguity of the construction.

Over the course of the last decade, quantification in child language has been investigated from a number of different perspectives. Although children often have difficulty mapping the quantificational sentence onto the context, it appears that they possess knowledge of how quantifiers interact with other elements of the sentence at LF. Musolino (1999) observed that English-speaking children display a reliable preference for the quantifier to take narrow scope[8] with respect to negation in sentences such as the following.

(8) The detective didn't find some guys.

[7] The embedded reading could be generated by the quantified DP targeting either the lower or higher landing site. However, if participants are able to generate the matrix reading, they must have targeted the highest landing site and reconstructed the larger of the two VPs.

[8] May (1985): The scope α of is the set of nodes that α c-commands at LF.

Because this scopal relation (NEG > QDP) is isomorphic with the surface word order, it initially appeared like children were limited by the order of presentation of the words. However, using sentences similar to those in Musolino (1999) with both English- and Kannada-speaking children, Lidz and Musolino (2002) demonstrated that children compute the scopal relation between negation and the quantified DP on the basis of surface c-command relations, *not* linear order.[9] Gualmini (2003) used similar sentences to show that children's performance improves when the felicity conditions governing the use of a negated sentence are satisfied. Thus, children can access an inverse scope (QDP > NEG) reading. When negation is not involved, children's performance improves dramatically (Lidz et al. 2003).

However, children do not always assign adult-like interpretations to sentences with quantifiers. Standing in contrast to these findings are those from research on quantifier spreading, a phenomenon first observed by Inhelder and Piaget (1964) and investigated more recently by Philip (1995) and others. Thus, despite children's success in a number of studies of quantification, there are still questions remaining about how and why they sometimes pattern differently from adults. However, children seem to know enough about QR to identify at least one grammatical interpretation for the ACD construction.

The open question is *which* reading children and adults will access. The interpretation participants assign to the target sentence may be motivated by processing constraints. Tunstall (1998) argues that in building LF structure, the processor follows considerations of economy and does not do any more at LF than is required by the grammar (unless the extra structure 'work' is motivated in some way). That is, when movement is required, the shortest possible movement satisfying grammatical requirements will be used, since a shorter movement requires less structure building. If the resolution of ACD is about movement to one *v*P or another that is higher, adults might employ the shortest possible movement that results in a grammatical interpretation and prefer the embedded reading. Participants might also access the embedded reading because it means reconstructing less material into the site of ellipsis. If children's parsers are not as economical as adults', children may be split between both readings.

We may however find that the embedded reading is appealing to children for reasons other than processing economy. It may be that when given a choice of landing site, children only have access to the closest available landing site. In previous experiments involving scopally ambiguous sentences and negation, children repeatedly preferred a scopal relation in which negation had wide scope over a quantifier in object position. Perhaps in these experiments, children were performing Quantifier Raising to *v*P, but since this site is lower than the NEG head in the syntactic structure[10], negation still took wide scope. Children might also be more biased to access the embedded reading because of the verb and the salience of the action involved. Verbs that take

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[9] English is an SVO language, and negation precedes the quantifier on the surface. Kannada is an SOV language, and the quantifier precedes negation on the surface. Both sets of children displayed a preference for the quantifier to take narrow scope with respect to negation.

[10] It is assumed that Negation, as the head of a functional projection, does not move. The quantifier would therefore need to covertly raise higher than this projection to achieve wide scope in relation to it. When a quantifier is in subject position, children allow it to take wide scope over negation.

infinitival complements generally express somewhat more abstract concepts than their complements, as is the case with the sentences used in this experiment. As children watch the stories being presented to them, they may be influenced by the more salient actions and led to consider the lower verb more when resolving the ellipsis. For example, *wanting* is more abstract than *driving*, and the child watches cars being driven in the story. However, there is reason to think that children might more easily access the *matrix* reading instead. Tom Roeper (p.c.) has suggested that targeting a lower, more deeply embedded site in the syntactic structure might be more challenging for children. This type of pattern would not be unexpected, given children's preference for high adjunct attachment elsewhere. A processing constraint might also favor this reading, if children 'hold on' to the first verb while processing the sentence.

4. Experiment

4.1. Method

4.1.1. Participants

24 four-year olds from Evanston area preschools participated. There were two experimental conditions based on the interpretation of the test sentence being favored (LO: *embedded*, HI: *matrix*): LO (6 boys, 6 girls; age range 4;1;0 - 4;10;5; M = 4;5;1), HI (6 boys, 6 girls; age range 4;3;5 - 4;10;3; M = 4;7;3). The overall age range was 4;1;0 - 4;10;3, with an overall mean of 4;6;1. 30 adults participated, all of which were Northwestern University undergraduates fulfilling an experimental requirement for an introductory Linguistics class: LO (4 M, 11 F), HI (4 M, 11 F).

4.1.2. Stimuli

Participants were presented with four test stories and three filler stories in one of two pseudo-randomized orders. Participants were also randomly assigned to one of the two experimental conditions (LO, HI). Each test sentence involved ACD with a quantified DP headed by *every*. Two test sentences involved subject control ((9), (10))[11], and two involved object control ((11),(12)).[12]

(9) Miss Piggy$_i$ wanted to PRO$_i$ drive every car that Kermit did.

[11] The two subject control constructions involved restructuring/intentional verbs, which have been claimed to unify the domains of the matrix and embedded verb in such a way that has implications for clitic climbing in languages like Spanish and *de dicto* readings for sentences such as those in question (Sag 1976, Rizzi 1978, Aissen and Perlmutter 1983, Larson and May 1990, Hornstein 1994, Bruening 2001). The results of this experiment show that for children and adults, the two verbs are not treated as an inseparable complex.

[12] A potential confound is that the subject control verbs are more "psychological" or abstract than the more "eventive" or concrete object control verbs. Thus, if any split were seen between the two control structures, a follow-up study would be necessary. This difference did not appear to be a factor, as the results demonstrate.

(10) The Cowgirl$_j$ needed to PRO$_j$ jump over every frog that the Old Cowboy did.

(11) Clifford asked Goofy$_k$ to PRO$_k$ read every book that Scooby did.

(12) Winnie the Pooh invited Piglet$_l$ to PRO$_l$ taste every treat that Tigger did.

The three filler sentences each involved VP ellipsis. Two involved ellipsis in a subordinate structure (*before*/*after*, comparative *further than*), and one in a coordinated conjunction structure. A short warm-up preceded the test session, allowing participants to become accustomed to the task at hand.

4.1.3. Procedure

The methodology used in this experiment was the Truth Value Judgment Task (TVJT) (Crain and McKee 1985). 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 watches very carefully, and at the end of the story, the puppet says what he thinks happened in the story. His statement is the potentially-ambiguous target construction. The child's job is to assess the validity of this statement with respect to the events in the story. If the puppet is wrong, he gets a cookie; if he is right, he gets a cupcake (the sweet he prefers). The child is encouraged to tell the puppet why he was right or wrong so that the puppet can learn.

When ambiguous sentences are investigated in a TVJT, the context is manipulated to favor one interpretation over the other. We assume that the combination of the child's desire for the puppet to be right and the salience of the context will boost one of the readings and override any preference for another reading. Therefore, in the LO condition, the puppet's statement is *true* with respect to the *embedded* reading and *false* with respect to the *matrix* reading; in the HI condition, the statement is *true* with respect to the *matrix* reading and *false* with respect to the *embedded* reading.

Let us turn now to a prototypical test scenario. This story involved Kermit and Miss Piggy. Kermit has four cars, two of which are old, and two of which are new. Miss Piggy asks Kermit about his cars. Kermit says he has driven his old cars a lot and is tired of driving them. The ones he really wants to drive are his new ones he just received for his birthday; however, he's not allowed to drive them yet, so he hasn't. Miss Piggy would like to see Kermit drive his cars, and asks him to do so. Kermit concedes (reluctantly), but he balks because this means he is stuck driving the old cars once again. He drives both cars, one after another, and when he is done, he offers Miss Piggy a chance to drive some of his cars. He lets her choose which set she will drive. Note that at this point, Miss Piggy could say that she wants to drive *either* set of cars—the ones Kermit drove, or the ones he wanted to drive, thus satisfying the *condition of plausible dissent*. In the LO condition, Miss Piggy says that she wants to drive the old cars, and in the HI condition, she says that she wants to drive the new cars. (See Figure 1.) At the end of the story, the toys and props are situated in a way that gives the child a *record of events*. The puppet then delivers the target sentence.

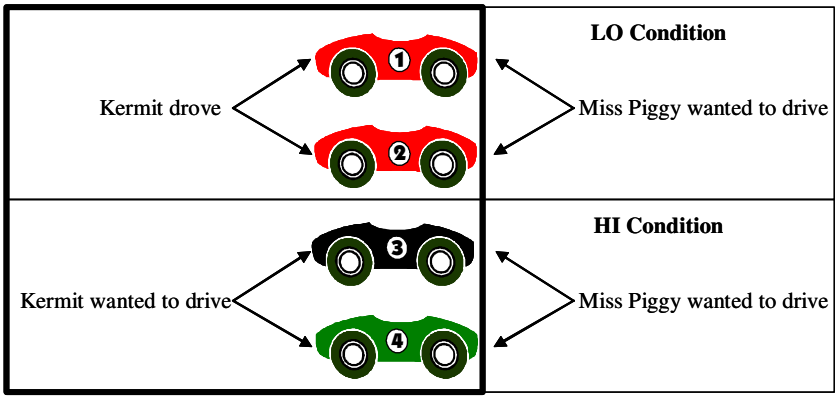

Figure 1. Setup of the two experimental conditions for one test story

Let us pause here to recall our predictions. Adults should be able to access both the embedded and matrix reading, and children should be able to access at least the *embedded* reading. However, an open question is whether children will be able to access the *matrix* reading. If they are limited in their interpretation of the ellipsis, then we predict that they will have difficulty accessing this matrix reading. However, if children can resolve this ellipsis in an adult-like manner, they should be able to access the matrix reading.

4.2. Results

Because accessing the matrix reading is the crucial indicator of children's adult-like grammar with respect to the target construction, the percentages reported correspond to the percentage of answers in each of the two conditions that correspond to the *matrix* reading. There should be a small percentage of matrix responses in the LO condition and a larger percentage in the HI condition (because participants should accept the puppet's statement, justifying their response by referencing the favored reading. The percentages of matrix readings obtained were as follows: LO (Adults 32%, Children 54%), HI (Adults 50%, Children 38%). A 2 x 2 factorial ANOVA was run, comparing Age (child, adult) and Condition (LO, HI). There were no Main Effects of Age ($p = .920$, $F = .010$) or Condition ($p = .550$, $F = .362$). The Age*Condition Interaction approached statistical significance ($p = .115$, $F = 2.576$). Out of the entire set of answers, there were only three incorrect responses to the filler sentences, from three separate children.

To ensure that participants were not patterning at chance, we conducted a thorough analysis of the responses. The justifications that each participant provided when accepting or rejecting the puppet's statement were reviewed. For each opportunity for the subject to respond (that is, for each presentation of a test story), we recorded whether a response was *given*, whether that response was *relevant* to the story[13], and (if the response was relevant) whether the response was *reliable* (i.e., one of the two grammatical interpretations could be inferred from it). This distribution is presented in Table 1.

[13] Only five responses fell into the *given, but not relevant* category (1 child, 4 from adults).

Table 1: Distribution of responses across the three coding categories

	Children	Adults
Given	79.2%	100.0%
	76/96	120/120
Relevant	98.7%	96.7%
	75/76	116/120
Reliable	68.4%	80.0%
	52/76	96/120

We can observe from these percentages that children not only provided justifications for accepting or rejecting the puppet's statement the majority of the time, but also that the vast majority of these responses were directly relevant to the plot of the story.

An analysis of the reliable responses demonstrates that children accessed both readings. Approximately 54% of children's responses (28 of 52 reliable responses, 16 children) and 62% of adults' responses (59 of 96, 28 adults) reflected an embedded reading. 46% of children's responses (24 of 52, 13 children) and 39% of adults' responses (37 of 96, 23 adults) reflected a matrix reading. While adults appear to display a preference for the embedded reading, this is not the case with children. The matrix reading is being accessed in nearly half of the reliable cases and by about half of the children, regardless of the condition they were assigned to in the experiment. Interestingly, seven children provided justifications corresponding to both the embedded and matrix readings within the experimental session.

Children's justifications for both the embedded and matrix readings in both the LO and HI conditions were clear and adult-like. In both conditions, participants used the corresponding reading to justify the truth of the puppet's statement (e.g., (13) and (14)) and the other reading to justify the falsity of the puppet's statement (e.g., (15) and (16)).

(13) 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. (LO Condition)

(14) The old cowboy and the little cowgirl needed to jump over the big frogs. (HI Condition)

(15) Pooh invited Piglet to taste the cookies, and that's what Tigger was nibbling on. Tigger wanted Piglet to eat the other treats. (LO Condition)

(16) Miss Piggy wanted to drive the new cars... Kermit drived the old cars. (HI Condition)

The fact that children are doing this for both conditions demonstrates clearly that they are indeed able to access both readings, and were not restricted to one or the other landing site *a priori*.

Let us now examine the percentage of matrix readings in each condition with our subset of reliable responses: LO (Adults 23%, Children 64%), HI (Adults 56%, Children 31%). Interestingly, while adults' responses are in the general direction we would expect if they were being cooperative in the experiment, but also showing an overall preference for the embedded reading, children's responses are in the opposite direction. It is as if children want to correct the puppet, not give him the benefit of the doubt. Given that children accessed adult-like interpretations of the ACD constructions and gave informative justifications for their responses, they appear to exhibit adult-like grammar with respect to quantification. However, the fact that the pattern of their responses diverges from adults' should lead us to look at extra-grammatical (i.e., pragmatic and processing factors) that influence the response patterns of adults and children. While the direction of adults' responses is as expected, there are still less than 60% responses corresponding to the matrix reading in the HI condition. It therefore appears that adults have a bias towards the embedded reading. This bias is consistent with the hypothesis that adults are guided by processing economy. Given these unexpected percentages, one might wonder if the stories and the verbs used could be a factor. The percentage of matrix readings for the four verbs/stories in the two conditions are presented in Table 2.

Table 2: Percentage of matrix readings for verbs/stories

	LO		HI	
	Adults	Children	Adults	Children
want	36%	62%	36%	14%
need	33%	80%	90%	67%
ask	0%	60%	83%	18%
invite	30%	50%	11%	40%

The asymmetries between verbs observed here do not correspond to control structures (*want*/*need* versus *ask*/*invite*) or to order of production in child language or verb frequency (*want*/*need* v. *ask* v. *invite*). Overall, children are more likely than adults to provide a justification corresponding to a matrix reading in the LO condition, regardless of the verb/story type. For the *need* and *ask* verbs/stories in this condition, adults pattern as expected, but this is in sharp contrast to *want* and *invite*. It seems reasonable to argue that the lower overall percentage of matrix readings for adults across the two conditions (with the exception of the two verbs/stories in the HI condition) is reflective of economical parsing strategies. It is not clear why *want* and *invite* resist a matrix reading. They do not pattern together with respect to frequency; *want* is clearly a more frequent verb than *invite*. The answer might lie in the type and variety of complementation allowed by each verb, a possibility that, at least for now, we leave to future research.

5. General Discussion

In this experiment, we have shown that four-year-old children access multiple interpretations for ambiguous ACD sentences, patterning with adults. However the divergent response patterns suggest that adults and children may differ in their sentence

comprehension strategies. The findings presented here are promising, and lead to a number of questions in the field of language acquisition that should be addressed in future empirical studies. Are children guided by the same language processing principles as adults? If children do not start out processing sentences as adults do, what triggers adult-like processing, and when does this occur? What is the path of development in the interpretation of (VP) ellipsis? How do children learn how to interpret these constructions?

One possible avenue for future research on this last question might lie in the acquisition of *wh*-movement. Given that *wh*-movement and Quantifier Raising both involve A-bar movement (May 1985), it is possible that acquisition of the overt variant (i.e., *wh*-movement) provides a bootstrap for children to learn about the covert variant (i.e., QR). However, these parallels are as dangerous for the learner as they are helpful, since there are key syntactic differences – in terms of both landing site and locality properties – between the two types of movement. We leave the question of whether there is a relation between the acquisition of overt and covert A-bar movement for future research.

In this paper, we have shown that children are able to access multiple interpretations of ambiguous sentences with ACD in an embedded structure. Like adults, they know that the quantified DP must undergo covert movement so that it is no longer contained in the VP. Children are not restricted with respect to which VP is targeted as the antecedent. Under an account that appeals to Quantifier Raising for resolution of ellipsis in ACD constructions, this means that children are not restricted to the closest QR landing site, and have choices about what material is allowed to be reconstructed in the site of ellipsis. Thus, we have further support for the view that children have full grammatical competence with respect to quantification. Finally, the findings of this experiment have implications for future investigations of children's resolution of VP ellipsis, which in turn may help answer larger questions about the relationship between syntax and semantics in child language, and children's sentence processing strategies.

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