Reconstruction Effects in Child Language

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A central question in the study of language acquisition is how children develop a grammar consisting of abstract syntactic representations and computations. Especially problematic are grammatical operations not apparent in the surface form of children's input, like *reconstruction*, the mechanism by which a syntactically moved constituent is interpreted in its pre-movement position. Reconstruction effects vary across syntactic environments, creating a complex system for language-learners to acquire. Nevertheless, the current study reveals that four-year-old children have adult-like knowledge of reconstruction, despite lacking direct evidence for it. Moreover, in cases where children appear to differ from adults, their differences are best attributed to their distinct parsing mechanisms, and not disparities in competence.

An example will help illustrate reconstruction effects. As noted above, reconstruction is available in structures where a constituent has undergone syntactic movement, as in wh-questions. For example, in (1), the wh-phrase *which book* is associated with two structural positions: its surface position at the beginning of the sentence, and a reconstructed position as the object of the verb:

(1) <u>Which book</u> did John read ___ ?

Evidence for interpretation in this reconstructed position may be found in structures where movement interacts with binding theory (Chomsky, 1981, 1986). Binding theory is a set of constraints on when two noun phrases can be coreferential. As its formulation relies on structural position, it is useful for revealing where moved items are interpreted.

(2) a. Principle A: An anaphor must be locally bound[1].
     b. Principle B: A pronoun must be locally free.
     c. Principle C: A referring expression must be free.

1. For present purposes, it is assumed the local domain is the clause. "Binding" is defined by the c-command relation: *a* binds *b* if and only if *a* c-commands *b* and *a* and *b* are coindexed.

For example, the sentence in (3a) contains an anaphor, the reflexive pronoun *herself*, which must be bound by a local antecedent in order to satisfy Principle A. Because the noun phrase *every girl* c-commands the anaphor, Principle A is satisfied, and a bound interpretation is licensed:

(3) a. Every girl$_1$ has seen a baby picture of herself$_1$.
     b. Which picture of herself$_1$ did every girl$_1$ see ___?

Surprisingly, the bound interpretation is also licensed in (3b), despite the fact that *every girl* fails to c-command *herself* in the surface structure of the sentence. However, the bound interpretation is expected if the anaphor is interpreted in its underlying position, where it is c-commanded by *every girl*.

There are very few previous studies that have examined children's knowledge of reconstruction. Those that have tend to focus on interpretations of sentences with fronted prepositional phrases (Guasti & Chierchia, 1999/2000; Lust & Clifford, 1986; Lust, Loveland & Kornet, 1980). The current study adds to the literature on children's knowledge of reconstruction by instead examining their interpretations of structures that they are highly familiar with, namely, wh-questions. It aims to establish whether children's grammars include reconstruction, and if so, whether their ability to access a reconstructed reading varies across different syntactic environments.

Specifically, it has been noted that reconstruction of moved arguments seems to behave differently with respect to Principle A than Principle C:

(4) a. Bill$_1$ knew which picture of himself$_{1/2}$ John$_2$ liked ___.
     b. Bill$_1$ knew which picture of John$_{1/*2}$ he$_2$ liked ___.

In (4a), either John or Bill can serve as antecedents for the anaphor. If *himself* is interpreted in its surface position, it is bound by Bill, and if interpreted in its reconstructed position, it is bound by John. In contrast, in (4b), *he* may not be interpreted as coreferential with John, only as coreferential with Bill, suggesting that reconstruction is obligatory; Principle C only rules out coreference between *he* and John if *John* is interpreted in its original position. So there seems to be a reconstruction asymmetry for moved arguments with respect to Principles A and C: reconstruction is optional for Principle A, but obligatory for Principle C.

On the other hand, when the moved item is a predicate, there is no asymmetry: reconstruction is obligatory for both Principles A and C. For example, in (5a), the anaphor may only be interpreted as bound by John, revealing that it is obligatorily interpreted in its reconstructed position. In (5b), a reading where *he* is coreferential with John is ruled out, which again only occurs if *John* is interpreted in its underlying position.

(5) a. Bill$_1$ knew how proud of himself$_{*1/2}$ John$_2$ was ___.
     b. Bill$_1$ knew how proud of John$_2$ he$_{1/*2}$ was ___.

Therefore for moved arguments, there is an asymmetry between Principles A and C, but for moved predicates there is not.

This is quite a complex system for children to learn, especially given that there is no direct evidence for reconstruction in the input to children. In a study of child-directed speech in the CHILDES database (MacWhinney, 2000), evidence for reconstruction was virtually absent: of the first 10,000 wh-questions uttered by parents to children, not a single one had a wh-phrase that contained an anaphor, pronoun or name. In other words, there were no questions of the type that might reveal reconstruction through the interaction of movement with binding theory, as in the above examples.

Given this lack of evidence in the input, the goal of the current study is to establish whether children have reconstruction as part of their grammar, and whether they show an asymmetry for reconstruction of moved arguments versus moved predicates. Furthermore, it aims to show whether children demonstrate a reconstruction asymmetry for Principles A versus C, and attempts to better understand this asymmetry in by investigating it in the adult grammar as well.

1. Experiment 1

The first study in this series examines children's knowledge of reconstruction in structures subject to Principle C, as in (6) and (7):

(6)   a. *He_1 was very proud of $Andy_1$.
       b. *How proud of $Andy_1$ was he_1 ___?

(7)   a. *She_1 put up the red painting of Miss $Cruella_1$.
       b. ?*Which painting of Miss $Cruella_1$ did she_1 put up ___?

Note that Principle C rules out coreference in (6a) and (7a) because the pronoun c-commands the name. Coreference is likewise ungrammatical in the predicate question in (6b), as expected if *Andy* is interpreted in its reconstructed position, again resulting in a Principle C violation. However, while coreference is clearly ruled out in (6b) due to obligatory reconstruction of the moved predicate, there is some debate in the linguistics literature about whether it is ruled out in (7b), since some speakers seem to allow for coreference (Barss, 1986; Heycock, 1995; Huang, 1993; among others). Given these murky judgments, it was important to test adults this experiment to establish whether reconstruction actually is obligatory for moved arguments in Principle C environments, as suggested earlier. In addition to investigating adults' interpretations, children's knowledge of reconstruction is also examined to establish whether they show the predicted predicate/argument and Principles A versus C asymmetries.

A combination of the truth value judgment (Crain & McKee, 1985; Crain & Thornton, 1998) and questions after stories tasks (de Villiers & Roeper, 1996) were used in this study. In this method, two experimenters are present. One

experimenter acts out a story using toys, while the other controls a puppet. Participants are told that it is their job to help the puppet understand the story. For the questions after stories part of the task, after the story is acted out, the puppet asks one question, which the subject then answers. After this, the puppet says what he thinks happened in the story, as in the truth value judgment task. The participant has to decide if the puppet is right or wrong based on what happened in the story, and reward the puppet accordingly. Participants are periodically asked to justify their answers, ensuring they reflect grammatical knowledge, and are not being guided by extra-linguistic factors.

This combination task was used in order to test both questions and statements. Statements were tested to verify knowledge of Principle C, which was crucial to establish since participants can only demonstrate knowledge of reconstruction if they have this principle in place. Questions were included to establish knowledge of reconstruction. Participants responded to a mix of questions and statements, and a mix of predicate and argument structures, for a total of 8 items. After each story, only one of the items given was a test item, either the question or the statement. The other item was considered a filler, and was designed to ensure children were following the stories. Participants who missed more than one filler were excluded from the final analysis.

An example story will help illustrate the task. For the stories corresponding to predicate items, one example features a boy named Andy and his friend Mr. Monkey. Mr. Monkey wants to see if Andy can jump over his new couch. Andy wants to try, but says the new couch is so big, he's not sure if he will be able to make it all the way over. Mr. Monkey is more confident in Andy's abilities, and thinks it will be easy for Andy. Andy agrees to try, and they both are anxious to see how proud Andy can make them. So Andy jumps and just makes it onto the couch, he does not make it all the way over. Andy says he is very proud of himself, because just jumping onto a couch that big was really hard. Mr. Monkey, however, is surprised Andy did not make it over. He is still a little proud that Andy made it onto the couch, but not very proud.

After the story, if the participant hears the question in (6b) and has reconstruction, they should answer "a little bit proud," since coreference is ruled out by Principle C (forcing *he* to refer to Mr. Monkey, who was only a little proud of Andy). Without reconstruction, nothing rules out coreference, so participants would be expected to answer "very proud" a significant portion of the time. Likewise, participants should reject the statement in (6a) if they have Principle C, since Mr. Monkey was only a little proud. If they do not have Principle C, they should allow for coreference and thus accept this statement.

It was predicted that adults would assign the free interpretation to the pronoun across all conditions: for statements, because they have Principle C, and for questions, because reconstruction seems to be obligatory. For children, it was expected that they would replicate previous results by demonstrating knowledge of Principle C and assigning the free interpretation to all statement items (Crain, 1991; Crain & McKee, 1985; Crain & Thornton, 1998; Guasti & Chierchia, 1999/2000; among others). For the question conditions, if children

have reconstruction, they should assign the free interpretation, because Principle C rules out coreference. But without reconstruction, nothing rules coreference out, so children would be expected to assign a coreferential interpretation a significant portion of the time.

1.1. Results

Twenty-six 4-year old children (14 females, 12 males; mean age 4;4) and 24 Northwestern undergraduates participated in this study (two children were excluded from the final analysis for incorrectly responding to more than one filler item). Due to the small number of observations in each condition (only two per participant for argument statements, argument questions, predicate statements, and predicate questions), a continuous normal distribution could not be assumed, and non-parametric statistical analysis was used. Using the Wilcoxon signed-ranks test, both adults and children were shown to perform equally well on predicate questions versus statements ($Z = 1$, $p = .317$ for adults; $Z = .246$, $p = .806$ for children) with adults at ceiling and children assigning the expected disjoint interpretation 75% of the time in both structural contexts. An asymmetry was observed in the argument results, however, for both children and adults: a significant difference was found between questions and statements for both groups ($Z = 2.070$, $p = .038$ for adults; $Z = 3.001$, $p = .003$ for children).

Figure 1.

Adult and Child Responses: Principle C
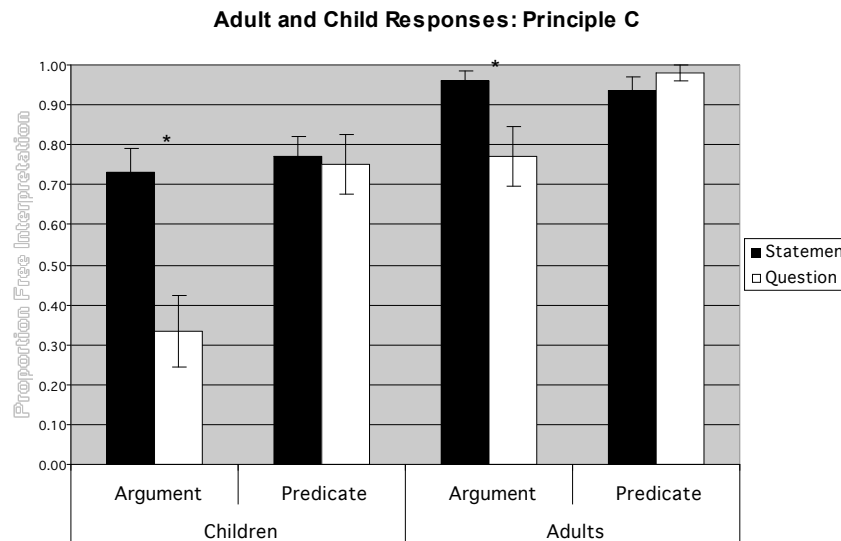
Mean proportion free interpretation responses for child (n = 24) and adult (n = 24) groups for statements and questions subject to Principle C in argument and predicate conditions

Unlike their performance in the predicate condition, both children and adults fail to consistently assign a free interpretation in the argument question condition. In fact, children are shown to actually prefer coreference for argument questions: while they chose the free interpretation for the pronoun in the argument statements over 70% of the time, they only chose the free interpretation for the corresponding question items 33% of the time (assigning coreference 67% of the time). Likewise, adults' overwhelming preference for the free interpretation is weakened for the argument question items (although it remains preferred): in contrast to their ceiling performance on the argument statements, they only judged the corresponding questions to have the free interpretation 77% of the time. Furthermore, their coreferential responses were evenly distributed across both subjects and items.

Therefore these results demonstrate that children's grammars do include reconstruction, as they consistently assign the free interpretation consistent with reconstruction to the predicate question items, just as adults do. For argument questions, in contrast, adults prefer a reconstructed interpretation, but still allow for coreference, which is only compatible with a non-reconstructed reading. Children are stronger in this preference, and actually fail to reconstruct moved arguments most of the time. So it appears that reconstruction for moved arguments may actually be optional: for adults it clearly is not obligatory (like it is for moved predicates), and children actually disprefer it in this environment.

There are at least two possible explanations for children's failure to assign a reconstructed interpretation to the moved argument items. One is that their grammars actually do not allow for it: they never reconstruct moved arguments. A second hypothesis proposes that children's grammars allow reconstruction of moved arguments, and their dispreference for reconstruction can be explained by performance factors, such as their parsing preferences. These hypotheses are further explored in Experiment 2.

2. Experiment 2: Principle A

Experiment 2 aims to establish whether child grammars allow for reconstruction of moved arguments by comparing children's and adults' interpretations of sentences subject to Principle A, as in (8) and (9):

(8) a. Every boy$_1$ was very proud of himself$_1$.
     b. How proud of himself$_1$ was every boy$_1$ ___?

(9) a. Every dancer$_1$ put up the red painting of herself$_1$.
     b. Which painting of herself$_1$ did every dancer$_1$ put up ___?

Note that in the above structures there is no predicted asymmetry between moved predicates and moved arguments: both must reconstruct in order for the anaphor contained in the wh-phrase to be bound. In other words, even for a

moved argument as in (9b), reconstruction is required, because the subject fails to c-command the anaphor in the surface structure of the sentence. Principle A may only be satisfied by interpreting the anaphor in its reconstructed position, where it may be bound by *every dancer*.

The design of Experiment 2 closely follows Experiment 1, using the truth value judgment and questions after stories tasks. It was predicted that adults would assign a bound interpretation to all items, and that children's performance in the statement conditions would replicate previous studies demonstrating their knowledge of Principle A (Chien & Wexler, 1990; Grodzinsky & Kave, 1993/1994; Wexler & Chien, 1985; among others). In the crucial question conditions, if children allow for reconstruction, they should assign a bound interpretation. If they fail to reconstruct, there is no way for the anaphor to be bound, so children may be expected to allow the free interpretation, or answer at chance.

2.1. Results

Twenty-six preschool-aged children (15 female, 11 male; mean age 4;6) and 24 Northwestern undergraduates participated in this study. Two children were excluded from the final analysis for incorrectly judging the truth or falsity of more than one filler item. As expected, the adults were at ceiling in accepting the bound interpretation of the reflexive across all conditions. Using the Wilcoxon signed-ranks test, no significant differences were found between adult performance on questions versus statements for argument items ($Z = 1$, $p = .317$) or for predicate items ($Z = 1$, $p = .317$).

Children patterned with adults in consistently accessing the bound interpretation of the reflexive equally across all conditions, even if their performance was not quite as perfect. As with the adults, no significant differences were found for the children's performance on questions versus statements for argument items ($Z = .258$, $p = .796$) or for predicate items ($Z = .758$, $p = .448$).

Figure 2.

Adult and Child Responses: Principle A
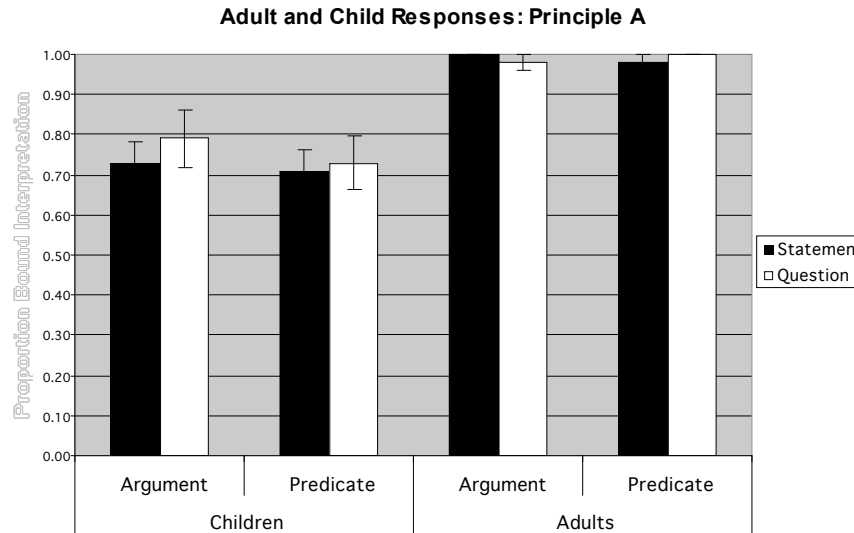
Mean proportion bound interpretation responses for children (n = 24) and adults (n = 24) for Principle A statements and questions in argument and predicate conditions

Thus like adults, children performed equally well on statements and questions in both conditions.

Recall that the open question from Experiment 1 was whether children would ever reconstruct a moved argument. Experiment 2 provides evidence that children do assign a reconstructed reading to moved arguments when required to do so by their grammar: in this case, it is required to satisfy Principle A, and children consistently do so. Nevertheless, while they allow reconstruction of moved arguments, children in Experiment 1 demonstrated a clear dispreference for it. In the next experiment, children's preferences when reconstruction is not obligatory are explored further. In particular, Experiment 3 examines the strength of their preference for the surface interpretation, and what factors, especially with respect to children's parsing mechanism, may underlie it.

3. Experiment 3

Experiment 3 aims to establish whether children will ever accept a reconstructed interpretation when a competing surface reading is available, as below:

(10) Mr. Monkey$_1$ figured out how proud of himself$_{*1/2}$ Andy$_2$ was ___.
(11) Miss Cruella$_1$ knew which painting of herself$_{1/2}$ Janie$_2$ put up ___.

As discussed earlier, there's only one possible antecedent for the anaphor in (10): reconstruction is obligatory for predicates, and therefore *himself* must be bound by the embedded subject antecedent *Andy*. In contrast, for (11), there are two possible antecedents. If the anaphor is interpreted in its surface position it is bound by Miss Cruella, and if it is interpreted in its reconstructed position, it is bound by Janie. This observation was the first clue that reconstruction may be optional for moved arguments, which gained further support in Experiment 1.

Once again, the design of Experiment 3 closely followed that of the two earlier experiments. Because no matrix questions were involved, the questions after stories task did not have to be used, and the regular truth value judgment methodology was followed. To stay in line with the previous two experiments, participants judged the truth of two statements after each story, again responding to 8 test items: 4 predicate, 4 argument. The stories were varied so that half of the time the story made the test statement true if the participant assigned the matrix subject as the antecedent (and made the test story false if they assigned the embedded subject as the antecedent), and the other half vice versa.

Adults were expected to accept either the matrix or the embedded subject as the antecedent for moved arguments, since they have the option to reconstruct or not. In contrast, for moved predicates, where reconstruction is obligatory, both adults and children should only accept the low antecedent, and reject the high antecedent. For moved arguments, it was expected that children would easily accept the high antecedent, if they indeed prefer not to reconstruct. The key question was whether they would accept the low antecedent when the story made that antecedent true; they may only do so if they allow reconstruction of moved arguments even when a competing surface reading is available.

3.1. Results

Thirty 4-year-old children (16 males, 14 females; mean age 4;5) and 24 Northwestern undergraduates participated in this study (six children were excluded from the final analysis). The Wilcoxon signed-ranks test was once again used to analyze this data. As expected, for the predicate items, where the embedded subject is the only licensed antecedent due to obligatory reconstruction, both children and adults accepted the test sentence when the story made the embedded antecedent true, and rejected it when the story made the matrix subject antecedent true: significant differences between acceptance rates for predicate items where the matrix antecedent was made true versus the embedded antecedent were found for both groups ($Z = 3.411$, $p = .001$ for children; $Z = 4.239$, $p < .001$ for adults). In the argument condition, both groups consistently accepted the argument test sentences as true when the context made the matrix antecedent true. Interestingly, however, adults did not have as high of an acceptance rate when the story made the embedded antecedent true, although they clearly were above chance in assigning this reading, and any rejections in this condition were evenly distributed across subjects and items. Children, on the other hand, generally rejected the embedded antecedent for the

argument items, accepting that reading only 33% of the time. Significant differences were found for both groups between rates of acceptance for argument items where the story made the matrix antecedent true versus the embedded antecedent for both groups ($Z = 3.311$, $p = .001$ for children; $Z = 2.021$, $p = .043$ for adults).

Figure 3.

Adult and Child Reponses: Principle A Embedded Questions
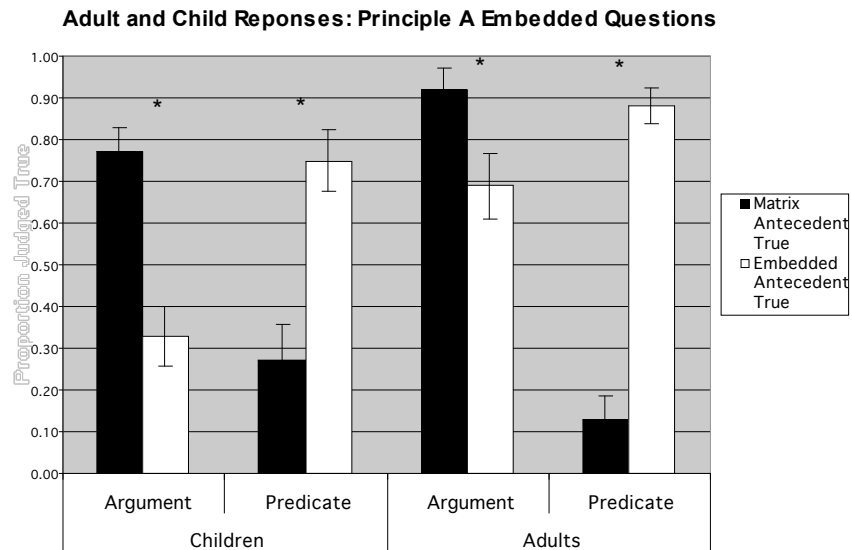
Mean proportion of Principle A embedded questions judged true when the story makes the matrix versus the embedded antecedent true for child (n = 24) and adult (n = 24) groups in argument and predicate conditions

Therefore Experiment 3 once again shows that children, like adults, obligatorily assign a reconstructed interpretation to moved predicates. For moved arguments, it demonstrates that children consistently reject the reconstructed interpretation in favor of the surface interpretation. Even when the scenario makes the reconstructed reading true, children reject the sentence as false. In other words, children appear to only access the non-reconstructed, surface interpretation. This surface reading is always available, and that is the interpretation children consistently choose. Interestingly, while adults allow binding by either the high or low antecedent, they also seem to have a preference for the surface interpretation.

Taken together with the results of Experiments 1 and 2, we may now conclude that there actually is no difference in the grammar of reconstruction with respect to Principles A versus C, as postulated earlier. Moved predicates obligatorily reconstruct, and moved arguments optionally reconstruct, regardless

of the binding theoretic environment. Both children and adults show that reconstruction is optional for moved arguments, even in Principle C environments, where it was thought to be obligatory. Furthermore, these experiments also clearly demonstrate children's preference for the non-reconstructed reading of moved arguments when reconstruction is optional. This preference is strong enough that children actually reject the reconstructed interpretation in favor of the non-reconstructed reading in Experiment 3. In other words, children have a preference for interpreting items where they are pronounced, or a preference for the surface structure interpretation.

4. Conclusions

The results of this study show that children do have reconstruction as part of their grammar. In all cases where reconstruction is obligatory, say because the wh-phrase is a predicate, or because it contains an anaphor that requires binding, children consistently reconstruct. Therefore children are adult-like in making a grammatical distinction between moved predicates and moved arguments. That they have this distinction in place, and assign the reconstructed interpretation whenever required to do so, suggests children have the correct grammar.

However, children's interpretations of moved arguments, which are not required to reconstruct, appear to differ from adults'. Children demonstrate a clear preference for the surface structure interpretation when licensed by their grammar. This finding follows previous results that demonstrate children to prefer the surface interpretation of scopally ambiguous sentences (Lidz & Musolino, 2002; Musolino, 1998; Musolino, Crain & Thornton, 2000; among others). Those studies show that what initially appears to be a grammatical difference between children and adults is actually better explained by performance factors. In the same way, the results of the current study suggest children have the correct grammar, maintaining continuity between children and adults. Where children appear to differ from adults, their differences seem best explained by parsing mechanisms. Specifically, it is likely that children initially assign the simplest possible parse to a given sentence, interpreting items where they are pronounced, or in other words, assigning a surface structure reading. Previous psycholinguistic studies have shown that children have difficulty revising their initial parse of a sentence (Trueswell, Sekerina, Hill, & Logrip, 1999). So with respect to the current results, if their surface parse is grammatical, that is the interpretation children will persist with. Being unable to revise their surface parse, they reject the reconstructed interpretation, even in cases where this reading is made true, as in Experiment 3. Thus the parser effectively masks children's knowledge of reconstruction in cases where reconstruction is optional. Children are thus shown to have acquired quite a complex system with respect to reconstruction, despite the fact that sentences revealing it are virtually absent from their input.

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