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Structural intervention effects in the acquisition of sluicing

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ABSTRACT
Experimental studies show that children have greater difficulty with *wh*-extraction from object position than subject position, arguably an intervention effect (e.g., Relativized Minimality). In this study we provide additional evidence of a S/O asymmetry in A′-dependencies from a novel source—sluicing. The results of our first comprehension study show that English-speaking 3–6-year-olds obey the "identity condition" on sluicing—that is, they disallow interpretations in which the elided verb or arguments are distinct from their antecedent. Importantly, our results also show a subject > object asymmetry and thereby support syntactic theories of sluicing that posit a fully articulated (but unpronounced) TP at the ellipsis site from which the *wh*-phrase has been extracted, e.g., *Someone wrote this paper, but I don't know who <_ wrote this paper>*, as opposed to certain semantic/pragmatic theories that posit no such structure. Our second comprehension study investigates the role of animacy. We find that children's comprehension of object sluices, but not subject sluices, improves significantly when there is a mismatch in animacy features. Our results are incompatible with models that are solely frequency based but rather provide evidence for structure-based intervention effects. We conclude that subject > object asymmetries can be found even in instances in which the intervener is not overt, such as sluicing, and that [animacy] may be a feature involved in the computation of intervention.

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1. Introduction

Ellipsis—meaning without sound—poses an obvious and extreme poverty of the stimulus problem for language acquisition. To arrive at the correct interpretation, children must recognize that part of a sentence is missing, and they must assign a meaning to the elided material by associating the ellipsis site to its antecedent. It is not immediately obvious how or when they learn to do this.

Although ellipsis has not been widely studied in acquisition overall, some forms of ellipsis have received more attention than others. The development of VP ellipsis (VPE) has been looked at in a number of languages, most prominently English (Foley et al. 2003; Matsuo & Duffield 2001; Thornton 2010; Thornton & Wexler 1999), but also Japanese (Matsuo 2007), European Portuguese (Santos 2009), and Mandarin (Guo et al. 1996). Argument ellipsis has also been studied in several "object drop" languages, including Mandarin (Su 2013; Zhou 2014), Cantonese (Cheung 2008), Japanese (Matsuo 2007), and European Portuguese (Santos 2009).

In this study, we investigate children's acquisition of a different type of ellipsis—sluicing, which involves the ellipsis of TP in a *wh*-question that leaves a "remnant" *wh*-phrase overt, as illustrated in (1).[1]

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[1]As per convention, the elided material is given between angled brackets.

(1) a. Someone is drawing a flower, but I can't see who <_ is drawing a flower >.
b. Ben is kissing someone, but I can't see who < Ben is kissing _>.

Although sluicing is more widely distributed across languages than VPE and other kinds of ellipsis (Merchant 2001), there have been relatively few acquisition studies of the phenomenon. Lindenbergh, van Hout & Hollebrandse (2015), Sugisaki (2016), Wood (2009), Ohba (2017), and Liu, Hyams & Mateu (2020) are notable exceptions. Lindenbergh, van Hout & Hollebrandse (for Dutch) and Wood (for English) focused on whether children respect the "identity condition" on sluicing—that is, whether they can correctly pick out the antecedent to the missing TP, for example, the individual who is drawing a flower in (1a). Our study also tested the identity condition, but we were primarily interested in a separate question: Given that English-speaking (and other) children generally find subject extraction easier than object extraction in various types of A'- movement constructions, would they show a similar subject advantage with sluices where the TP containing the extraction site is silent? Previous studies have found a subject advantage in *wh*-questions (Avrutin 2000; De Vincenzi et al. 1999; Friedmann, Belletti & Rizzi 2009; Yoshinaga 1996), relative clauses (Friedmann, Belletti & Rizzi 2009; Friedmann & Novogrodsky 2004; McKee, McDaniel & Snedeker 1998), and topicalizations (Friedmann & Lavi 2006). If a subject > object asymmetry also shows up in sluices, it would support theoretical claims that sluicing involves full TP structure at the ellipsis site and syntactic movement (e.g., Merchant 2001). It would also support the acquisition hypothesis that children's greater difficulty with object A'-extracted structures is due to the "intervention" of the subject (e.g., *Ben* in (1b)) between the moved element and its gap or trace (Adani et al. 2010; Belletti et al. 2012; Friedmann, Belletti & Rizzi 2009, a.o.). Thus, whereas previous studies tested only subject sluices, as in (1a), we tested and compared children's performance on subject and object sluices (1a,b).

One grammatical principle that formally captures intervention effects, Relativized Minimality (RM; Rizzi 2004), holds that intervention effects are triggered when the moved element and the intervening argument share some crucial morphosyntactic feature that plays an active syntactic role, i.e., that can trigger movement (Rizzi 1990; Starke 2001). Previous studies have investigated the role of different morphosyntactic features in children's comprehension of relative clauses (RCs) and *wh*-questions—for example, lexical NP restriction (Hebrew: Friedmann, Belletti & Rizzi 2009; Greek: Varlokosta, Nerantzini & Papadopoulou 2015), Number, Gender (Italian: Adani et al. 2010; Hebrew: Belletti et al. 2012), and Case (Basque: Gutierrez-Mangado 2011; German: Arosio et al. 2012; Greek: Varlokosta, Nerantzini & Papadopoulou 2015), and whether performance is enhanced when subject and object NPs are not matched with respect to these features. In our second study, we focus on the role of animacy features. Previous work has shown that performance on object relatives (OR) improves significantly when the relativized object is inanimate and the embedded subject is animate (e.g., Adani 2010; Arosio, Guasti & Stucchi 2011; Bentea, Durrleman & Rizzi 2016; Brandt et al. 2009; Corrêa 1995; Kidd et al. 2007). We wanted to see if a similar facilitating effect would show up in object sluices but not subject sluices.

Our study thus addresses three interrelated questions: (i) do English-speaking children obey the "identity condition," i.e., can young children successfully recover the antecedent to a sluiced clause; (ii) do they show a subject>object asymmetry with respect to sluicing, as they do with other types of (overt) A'-movement; and (iii) would a mismatch in animacy features facilitate children's interpretation of object-extracted structures? Our aim is to increase the sparse literature on the acquisition of sluicing and to shed light on children's grammar of ellipsis and the possible effects of intervention in sluiced TPs and also on the theoretical debate surrounding the underlying structure of sluices in adult (and child) grammars.

The article is organized as follows: In section 2 we review previous experimental studies of sluicing in children. We will also briefly review acquisition work on other A'-structures, *wh*-questions in particular, that seem to induce intervention effects in children and which are therefore directly relevant to the questions we pose in this study. In section 3 we discuss competing theoretical accounts of sluicing and how acquisition results may bear on the debate. We then present our two experimental

studies in sections 4 and 5. The first experiment tests children's knowledge of the identity condition and compares their performance on subject versus object sluices. Experiment 2 follows up by looking at the effects of animacy features. In section 4, we also present the results of a corpus study of sluices produced by children (and their adult interlocutors) in 51 English CHILDES corpora (MacWhinney 2000). This analysis provides important information about the distribution of (in)animate NPs in children's spontaneously produced sluices and also in the adult input and informed the design of our second experiment. In the final section (section 6), we conclude this article with a summary.

2. Previous acquisition studies

As mentioned in the previous section, the goal of previous acquisition studies has been to investigate the relationship between the ellipsis site and its antecedent, what is known as the *Identity Condition*. This condition can be heuristically characterized as the requirement that the sluiced material and the antecedent mutually entail each other (Barker 2013; Chung 2013; Merchant 2013). In other words, intuitively, the continuation of (2) must be interpreted as (2a) and not (2b), where "someone is cooking turkey" is the antecedent and the angled brackets denote the ellipsis site.

(2) Someone is cooking turkey, but I don know who < ... >
  a. ... is cooking turkey.
  b.. . . is bringing lasagna.

Wood (2009) tested English-speaking children aged 4;05–5;05 and 6;08–7;08 in a grammaticality judgment task and found that the younger group judged grammatical sluices as ungrammatical 40% of the time, suggesting that they had not yet learned the syntax of sluicing. However, the same children also rated grammatical controls, which consisted of full structures, as ungrammatical 35% of the time. These results cast some doubt on the methodology used.

More recently, Lindenbergh, van Hout & Hollebrandse (2015) tested 25 Dutch-speaking children ages 4;09 to 6;01 in a picture-matching task. Each picture array contained four pictures (see Figure 1) and was coupled with a sentence as in (1a); one picture matched the sentence and one controlled for the reading in which the child only paid attention to the first part of the sentence, i.e., someone visible is drawing a flower. The other two "distractor" pictures were meant to test the Identity Condition: One had a different object (e.g., a woman drawing a guitar) to test argument identity, and the other had a different action (e.g., a woman holding a flower) to test verb identity.

Lindenbergh, van Hout & Hollebrandse (2015) obtained much better results than Wood (2009) with a mean percentage correct of 94%. However, the children in this study could have arrived at the correct choice using a non-adult-like strategy—a "two-clause strategy." That is to say, they may have interpreted the two clauses in, e.g. (1a), separately, viz. someone is drawing a flower, and there is someone who cannot be seen, a confound which the authors also recognize (van Hout p.c.).

Lindenbergh, van Hout & Hollebrandse (2015) also administered an elicited production task using pictures and questions designed to elicit a sluiced sentence (e.g., *Is er iemand een bootje aan het trekken?* 'Is someone pulling a boat?'; *Ja, maar ik zie niet wie*. 'Yes, but I can't see who.') (though other answers were also possible). The majority of the children's responses were sluices (63%), and even though 5 of 25 children produced no sluices, none of them produced illicit elliptical sentences.

Sugisaki (2016) tested 4- to 6-year-old Japanese-speaking children on their knowledge of the voice identity requirement on Japanese case-marked sluices (Merchant 2013). Sugisaki showed that the children categorically respect the requirement that an elided constituent and its antecedent match in voice (active/passive).

More recently, Ohba (2017) tested Japanese-speaking 3- to 6-year-olds on two kinds of sluices—standard sluicing, much like what we find in English (also tested by Sugisaki 2016), and pronominal sluicing. Standard sluicing allows both a strict and sloppy reading of *zibun* 'self' in the elided TP, while pronominal sluicing allows only a strict reading. Ohba found that the children were largely adultlike in accepting the grammatical, strict readings in both kinds of sluices and, though not fully

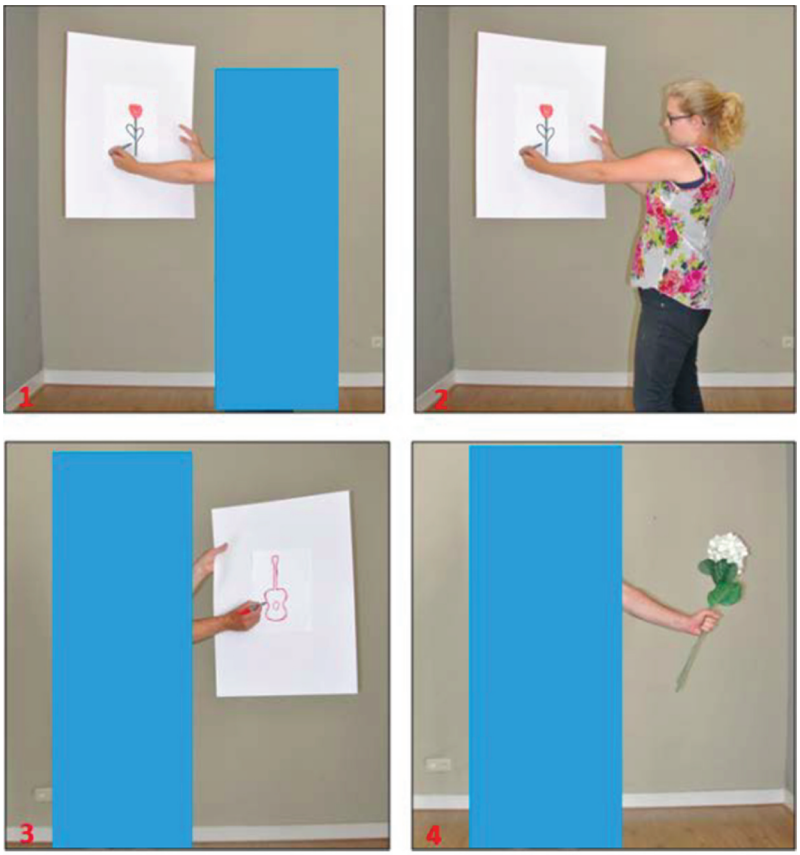

Figure 1. Pictures array for item "Someone is drawing a flower, but I can't see who" in Lindenbergh, van Hout & Hollebrandse (2015) picture-matching task.

adultlike, they also seemed to distinguish Japanese pronominal sluices from standard sluices in allowing sloppy reading in the latter but not the former. These results lead Ohba to argue that Japanese children as young as 3 know the structures associated with the two kinds of sluices in their language.

As we see, the literature on children's acquisition of sluicing is rather slim, and the single study with English-speaking children (Wood 2009) seems to conflict with the findings for Dutch (Lindenbergh, van Hout & Hollebrandse 2015) and Japanese-speaking children (Ohba 2017; Sugisaki 2016). Thus, our study was designed to enrich the empirical data in this area and to help resolve the conflicting findings.

2.1. The subject advantage in A′ structures

An additional question we wanted to address is whether children show an asymmetry between subject- (3a) and object-extracted sluices (3b).

(3) a. Someone is calling Mary, but I can't see who <_ is calling Mary>.
b. Mary is calling someone, but I can't see who <Mary is calling _>.

This question has not been previously investigated in the sluicing acquisition literature. However, there is now considerable evidence that children perform more poorly on object versus subject-extractions in other instances of A' movement including *wh*-questions (Avrutin 2000; De Vincenzi et al. 1999; Friedmann, Belletti & Rizzi 2009; Yoshinaga 1996), relative clauses (Friedmann & Novogrodsky 2004; McKee, McDaniel & Snedeker 1998), and topicalizations (Friedmann & Lavi 2006).

For example, Ervin-Tripp (1970) studied children's responses to various types of *wh*-questions, including subject *who*-questions (e.g., "Who is feeding him?") and object *who*-questions (e.g., "Who is he feeding?"). Twenty-four children ranging in age from 2;06 to 3;01 at the beginning of the study participated in the study. The study continued until the children reached age 3;03 to 4;02. The results indicated that more children mastered subject *who*-questions at an early age (19/24 by age 3;01) than mastered object *who*-questions (11/24 by age 3;01).[2]

Tyack & Ingram (1977) also examined children's comprehension of subject and object *wh*-questions. In their study, 100 children aged 3–5;05 were tested. They found that overall children performed much better with subject *who*-questions (e.g., "Who is helping the boy," 80%) than object *who*-questions (e.g., "Who is the boy helping?," 56%).[3]

More recently, Seidl, Hollich & Jusczyk (2003) used a split-screen preferential looking paradigm to test 13-, 15-, and 20-month-olds' developing understanding of *what*- and *where*-questions of the forms "What hit the X?" (subject *what*-question), "What did the X hit?" (object *what*-question), and "Where is the X" (*where* questions). At 15 months of age, infants responded appropriately to *where*-questions and subject *wh*-questions but not to object *wh*-questions. By 20 months, they looked significantly longer to the target object for *where*-questions, as well as subject and object *wh*-questions.

A similar S > O asymmetry is found in production. Yoshinaga (1996) elicited subject and object *wh*-questions from 2–4-year-old English-speaking children. Children performed quite well on subject questions (e.g., "Who is pushing the monkey?," 90%–100%) and poorly on object questions (e.g., "Who is the monkey pushing?") until the age of 4, with 2-year-olds scoring 8.3% correct, 3-year-olds 41.7%, and 4-year-olds 79.6%.

As noted, to explain the S > O asymmetry it has been proposed that children are particularly susceptible to "intervention effects" (e.g., Friedmann, Belletti & Rizzi 2009; Hyams & Snyder 2005; Mateu 2016, 2019; Snyder & Hyams 2015). One way of characterizing intervention effects is by appealing to Relativized Minimality (Rizzi 1990), viz. the dependency between the moved element, and the gap is blocked if the intervening element is structurally similar to, and hence a potential antecedent for, the gap.

With this background in mind, we hypothesized that if sluices involve *wh*-movement, we should find a similar subject > object asymmetry. However, whether sluices involve syntactic movement is not a settled issue. In the following section, we briefly review the competing claims.

3. Theoretical background

There are various theoretical proposals concerning the status of the elided material in sluicing and ellipsis more generally. Analyses differ primarily with respect to the issue of how much structure is posited in the ellipsis site and whether there is movement or not. One prominent analysis is that sluices involve the generation of a full *wh*-question in which the *wh*-element has moved to Spec-CP, as in (4a). Other approaches also posit structure but no movement, (4b-c), and still others posit no structure at all, (4d).

[2]Ervin-Tripp (1970:88-89) defines "mastery" as "the first of successive appropriate replies [...], allowing one 'performance' error if it followed more than two successes."

[3]Note that a number of studies have not found an asymmetry in comprehension of unrestricted *wh*-questions, i.e., those with no NP following the *wh* element (e.g., Cairns & Hsu 1978; Friedmann, Belletti & Rizzi 2009; Hanna & Wilhelm 1992; Varlokosta, Nerantzini & Papadopoulou 2015). We will address this question in more depth in the discussion.

(4) a. Someone is drawing a flower, but I can't see [$_{CP}$ who$_i$ <[$_{TP}$ t$_i$ is drawing a flower]>].
b. Someone is drawing a flower, but I can't see [$_{CP}$ C$_{[Q]}$ [$_{TP}$ who <is drawing a flower>]].
c. Someone is drawing a flower, but I can't see [$_{CP}$ who$_i$ <[$_{TP}$ someone$_i$ is drawing a flower]>].
d. Someone is drawing a flower, but I can't see who.

Under the "full structure/movement" analysis represented in (4a), a *wh*-question is generated. The *wh*-phrase moves to Spec-CP, as in other *wh*-constructions, and the remnant TP is deleted at PF (Merchant 2001; Ross 1969).

The primary support for this kind of analysis comes from connectivity effects that show that the *wh*-phrase "remnant" in the embedded CP behaves like its *wh*-phrase counterpart in full sentential, nonelliptical structures and does so across a range of different kinds of grammatical dependencies such as case-marking, preposition stranding, and binding phenomena. To illustrate, in (5) we provide a case-marking example from German. In the sluiced clause in (5a), as in the full indirect question counterpart (5b), dative case is required, presumably reflecting a full underlying clausal structure of (5a).

(5) a. *Er will jemandem schmeicheln, aber sie wissen nicht,*
he wants someone.DAT flatter but they know not
*{*wer/ *wen/ wem}*
who.NOM who.ACC who.DAT
'He wants to flatter someone, but they don't know who.'
b. *Sie wissen nicht, { *wer/ *wen/ wem} er schmeicheln will.*
They know not who.NOM who.ACC who.DAT he flatter wants
'They don't know who he wants to flatter.'

The second group of analyses does not implicate movement. Under structural approaches, the *wh*-element either remains in situ (Abe 2015; Kimura 2010) or is base-generated in Spec-CP and binds an indefinite in the elided TP (Chung, Ladusaw & McCloskey 1995). Under nonstructural approaches, there is no structure at all, as in (4d) (e.g., Culicover & Jackendoff 2005; Ginzburg & Sag 2000; Jäger 2001).

The motivation for no-movement analyses is the fact, first noted by Ross (1969), that sluicing does not seem to respect islands. That is to say, the *wh*-remnant in the sluice can bind a variable in a position that corresponds to an island-internal position in the antecedent TP, illustrated in (6). In (6a) the *wh*-phrase has ostensibly moved out of a relative clause, which would be impossible in its nonelided counterpart in (6b).

(6) a. They want to hire someone who speaks a Balkan language, but I don't remember which.
b. *I don't remember which Balkan language they want to hire someone who speaks.

Advocates of nonstructural approaches to ellipsis (e.g., Culicover & Jackendoff 2005) propose that a sluicing example like that in (4d) contains no syntactic material corresponding to the antecedent. Instead, the *wh*-phrase is the sole daughter of an S node ("orphan") which is the complement to *see* (7a); the semantics are then constructed with a free variable F, whose value is constructed from the context via "indirect licensing" (IL).

(7) a. Someone is drawing a flower, but I can't see [$_S$ who].
b. Syntax: [$_S$ who ^{ORPH}]^{IL} Semantics: Q[F(what)]

To explain the "island repair" phenomena in (6), some proponents of the movement analysis (Lasnik 2001; Merchant 2001, following ideas of Chomsky 1972; Ross 1969) have argued that islands are essentially a PF phenomenon and thus that ellipsis can repair an otherwise ungrammatical structure by deleting the

offending *wh*-copy/trace inside the island, or in more recent linearization theories (e.g., Fox & Pesetsky 2005)—islands are the result of spell-out rule violations so they do not arise when the island is not spelled out.

The competing analyses of sluicing make different predictions about children's acquisition of these structures. Given the evidence that children do better with subject A'-extraction than object A'-extraction, positing a structured ellipsis site involving *wh*-movement, as in (4a), leads us to expect the same kind of asymmetry in sluicing: Children should perform worse on object-extracted sluices than on subject-extracted sluices. On the other hand, if no movement (or structure) is involved, we should find no such asymmetry, all else being equal.[4]

Thus, a central goal of this study is to provide evidence from child language relevant to the "movement/structure – no-movement/no structure" debate.

4. Identity and intervention: Experiment 1

In our first study, we address the following questions: (i) can young children successfully recover the antecedent to a sluiced clause, i.e., do they respect the "identity condition"?; and (ii) do they show a subject-object asymmetry with respect to sluicing as they do with other types of (overt) A'-movement, arguably an effect of intervention?

4.1. Subjects

We tested 40 English-speaking children aged 3;00–6;11 (M = 5;03), 10 in each year interval in Los Angeles, CA. Four additional subjects were tested, but they were excluded because they did not pass the control conditions. The excluded children were aged 3;05, 3;05, 3;08, and 3;11.

4.2. Materials and procedure

In a "*yes-no*-question task," modeled after a Truth-Value Judgment Task (TVJT; Crain & McKee 1985), children were shown a single image on a screen. The images were created by the first author using Pixton (Pixton Comics Inc. 2015). Each time a new verb or action setting appeared (characters in lineup or circle setting, see more in the following), the experimenter described the scenario with the help of the child to ensure he or she understood what was taking place and who was doing what to whom. A computer-simulated puppet then popped up and commented on what she could see and then asked a question about what the child could see. Children were instructed to wait until the end of the puppet's question before responding. This ensured children were not resolving the "someone" before hearing the sluiced *wh*-question. If a child responded or pointed before the puppet had finished talking, we played the question again.

There were three different sluicing conditions. Condition 1, e.g., (8a), was used to correct for the potential confound in Lindenbergh, van Hout & Hollebrandse's (2015) study by testing the "two-clause strategy", i.e., interpreting (8a) as (8b). In this condition, we used intransitive verbs, and the images contained two characters, one performing the action described in the sentence and one standing or sitting. Thus, for a sentence such as (8a), Figure 2 was used to elicit a "yes" answer, and Figure 3, was used to elicit a "no" answer.[5] However, if they interpreted (8a) as (8b), they would say "yes" given Figure 3. Note that all of the images used in Experiment 1 (and 2) contained a partially hidden character in order to make "no" answers felicitous.

(8) a. I can see that someone is jumping, can you see who <_ is jumping>?
b. *I can see that someone is jumping. Can you see someone?

[4]Of course, all else may not be equal. We return in the following to other possible causes of a S > O asymmetry.
[5]Children often chose to resolve the sluice by pointing to the relevant hidden or visible person, rather than responding with "yes" or "no." We counted their answers as correct if they pointed to the appropriate character on the screen.

Figure 2. "Yes" scenario for (8a).

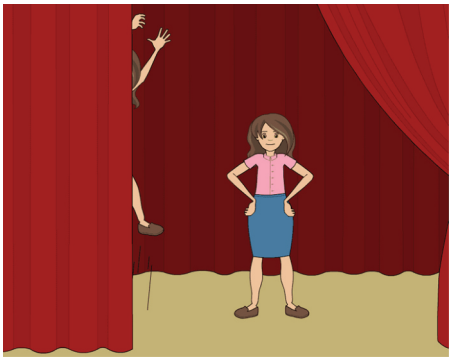

Figure 3. "No" scenario for (8a).

Condition 2 served to test verb identity. We used transitive verbs, and items were split between subject and object sluices. In this condition, one character was performing the action described by the transitive verb and the other one was performing a different transitive action. An example subject sluice test trial is given in (9a). Figure 4 was used to elicit a "yes" answer; Figure 5 was used to elicit a "no" answer. However, if verb identity is not obeyed, (9a) could receive the non-adult-like interpretation in (9b), in which case, Figure 5 would elicit a "yes" response.

(9) a. I can see that someone is brushing Ben, can you see who <_ is brushing Ben>?
b. *I can see that someone is brushing Ben, can you see who <_ is washing Ben>?

An example object sluice test trial is given in (10a). Figure 6 was used to elicit a "yes" answer, Figure 7 was used to elicit a "no" answer. Again, if verb identity is not obeyed, (10a) could receive the non-adult-like interpretation in (10b), in which case, Figure 7 would elicit a "yes" response.

(10) a. I can see that Ben is brushing someone, can you see who <Ben is brushing _>?
b. *I can see that Ben is brushing someone, can you see who <Ben is washing _>?

Condition 3 tested argument identity. We again used transitive verbs and items were split between subject and object sluices. In this condition children were shown a picture with multiple characters all performing the same action on each other—for example, brushing hair. This tested whether children

Figure 4. "Yes" scenario for (9a).

Figure 5. "No" scenario for (9a).

Figure 6. "Yes" scenario for (10a).

allowed a sentence like (11a) to have the non-adult-like interpretation in (11b), which would incorrectly elicit a "yes" response given Figure 9.[6]

[6]We used a "circle" setting, as in Figure 8, to elicit a "yes" answer to (11a), as opposed to a "lineup" setting like the one in Figure 11, which would also elicit a "yes" answer under an adultlike interpretation, because in the latter case it would be pragmatically infelicitous for children to be asked that question if they interpret (11a) as (11b), as no one is brushing the girl in yellow in Figure 11. Moreover, these scenarios also detect if children allow a reversal of arguments, e.g., "I can see someone is brushing Ben, can you see who <Ben is brushing _>?"

Figure 7. "No" scenario for (10a).

(11) a. I can see that someone is brushing Ben, can you see who <_ is brushing Ben>?
b. *I can see that someone is brushing Ben, can you see who <_ is brushing the girl in yellow/green>?

An example object sluice is given in (12), and the relevant pictures are in Figures 10 and 11.

(12) a. I can see that Ben is brushing someone, can you see who <Ben is brushing _>?
b. *I can see that Ben is brushing someone, can you see who <the girl in yellow/green is brushing _>?

The controls were also divided into three conditions. Condition 1 controls were full *wh*-questions with identical intransitive verb and argument, (13a). Conditions 2 and 3 were full subject and object *wh*-questions with mismatched verb (13b) and argument (13 c). These mismatched controls ensured that children were paying attention to both clauses and not just to the first clause, i.e., resolving the "someone." Children who did not perform above chance in the mismatched controls (i.e., 8/12 or more of the transitive trials given three potential characters to choose from according to a binomial test) were excluded from the study ($N = 4$).

Figure 8. "Yes" scenario for (11a).

(13) a. I can see that someone is jumping, can you see who _'s jumping?
b. I can see that someone is brushing Ben, can you see who _'s washing Ben?
c.I can see that someone is brushing Ben, can you see who _'s brushing the girl in yellow?

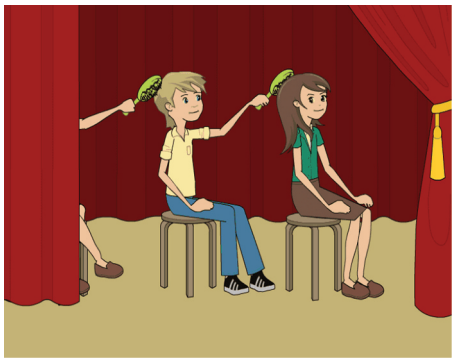

Figure 9. "No" scenario for (11a).

Figure 10. "Yes" scenario for (12a).

Figure 11. "No" scenario for (12a).

In total, there were six training items and 29 trials consisting of 15 sluiced sentences and 14 nonsluiced control *wh*-questions. Each child was tested on three Condition 1 (intransitive) sluices, six Condition 2 (transitive, verb mismatch) sluices, and six Condition 3 (transitive, argument mismatch) sluices. The control *wh*-questions were similarly divided into three Conditions, except we only had two (as opposed to three) Condition 1 controls. Condition 2 and 3 had an equal number of subject- and object-extracted sluices and control *wh*-questions. In terms of response, for Condition 1 there were two "yes" and one "no" answer for the sluices or one "yes" and two "no"

answers for the sluices (depending on the group, A or B, the child was randomly assigned to). For the other two conditions it was balanced, three "yes" and three "no" responses (see Appendix A). All items were prerecorded by a phonetically trained native English speaker to control for potential differences in prosody.

4.3. Results and discussion

Our overall results are given in Table 1. We see first that even the youngest children in our study easily understand sluiced sentences, obtaining over 80% correct answers in all the sluice conditions. This is in line with previous results from Dutch (Lindenbergh, van Hout & Hollebrandse 2015) and Japanese (Ohba 2017; Sugisaki 2016). Moreover, we know that children are not relying on a "two-clause strategy," a confound in the Lindenbergh, van Hout & Hollebrandse (2015) results, because of their high scores (100% correct) on the Condition 1 sluiced trials that were meant to elicit a "no" answer. If children interpreted "I can see that someone is jumping, can you see who?" as "I can see that someone is jumping. Can you see someone (else)?," then they would have said "yes," even in the "no" scenario, where the character who is jumping is mostly hidden behind a curtain. Moreover, children's high scores in Conditions 2 and 3 indicate that 3- to 6-year-old children respect the "identity condition" and do not allow for verb or argument mismatches, replicating Lindenbergh, van Hout & Hollebrandse (2015).

In order to verify statistically that children obey the "identity condition," we used a mixed effects logistic regression model with score as a binary dependent variable (correct, incorrect), age (continuous variable, 3.0 through 6.9), TrialType (Control, Sluice), Condition (2, 3), and TrialType by Condition as fixed effects and random intercept for subject. As expected, we found a significant effect of Age, $\chi^2(1) = 17.09$, $p < .001$, so that children get progressively better as they age. Importantly, we did not find an effect of Condition, $\chi^2(2) = 4.38$, $p = .11$, meaning children did just as well in the verb mismatch condition (Condition 2) as in the argument mismatch condition (Condition 3), no effect of TrialType, $\chi^2(3) = 7.51$, $p = .06$,[7] and no interaction between Condition and TrialType, $\chi^2(1) = 2.81$, $p = .09$.

Turning to our primary concern, which was to investigate whether children show a subject > object asymmetry (Conditions 2 and 3), as we see in Figure 12, in the full *wh*-questions (controls) children showed a trend but no significant difference in performance between subject and object extraction. Crucially, however, children showed a more pronounced (and statistically significant) subject > object asymmetry in the sluiced trials.

In order to statistically verify the potential interaction between TrialType (Control, Sluice) and ExtractionSite (Subject, Object), we ran another mixed effects logistic regression model with score as a binary dependent variable (correct, incorrect), age (continuous variable, 3.0 through 6.9), TrialType (Control, Sluice), ExtractionSite (Subject, Object), TrialType by ExtractionSite as fixed effects, and random intercept for subject. As expected in light of the results observed in Figure 12, we found a significant effect of Age, $\chi^2(1) = 16.93$, $p < .001$, so that children become progressively better as they get older. Importantly, we also found an effect of ExtractionSite, $\chi^2(2) = 24.73$, $p < .001$, so that children did better in the subject-extracted constructions than object-extracted ones, and an interaction between TrialType and ExtractionSite, $\chi^2(1) = 7.65$, $p = .006$, so that children showed a significant subject > object asymmetry in the sluices ($p < .001$) but not the control *wh*-questions ($p = .137$). Thus, overall,

[7]The fact that children do marginally (though not significantly) better in the sluices than the *wh*-question controls seems to be an effect of Condition 3 (see Table 1). The somewhat more depressed performance may be related to the fact that these control sentences were longer and involved modified NPs (e.g., *I can see that Ben is brushing someone; can you see who the girl in green is brushing _?*). Indeed, in Experiment 2, where we do not have this additional NP modification, we see children do very well overall in the control *wh*-questions.

Table 1. Results of Experiment 1 by condition and age group.

	Controls			Sluices		
Age	**1**	**2**	**3**	**1**	**2**	**3**
3yo	100%	90%	75%	100%	83.33%	83.33%
4yo	100%	95%	86.25%	96.67%	91.67%	91.67%
5yo	100%	85%	87.5%	100%	93.33%	95%
6yo	100%	97.5%	97.5%	100%	98.33%	100%
AVG	**100%**	**91.9%**	**86.6%**	**99.17%**	**91.67%**	**92.5%**
GRAND AVG		**92.81%**			**94.45%**	

younger children have more difficulties with object sluices than subject sluices, but this asymmetry disappears by the time they are 6.[8]

The overall S > O asymmetry in the sluicing conditions (Figure 12) aligns with the hypothesis that children (like adults) derive sluices via *wh*-extraction, arguably showing intervention effects, as observed in other kinds of movement constructions. In the following section we present the results of Experiment 2, which provide further support for the intervention hypothesis. To the extent that the children are indeed showing intervention effects, our results provide novel acquisition evidence for grammatical analyses that posit movement (e.g., Merchant 2001) and against various proposals that do not (e.g., Chung, Ladusaw & McCloskey 1995; Culicover & Jackendoff 2005; Lobeck 1995).[9]

Our intervention hypothesis raises the question of why children show a S > O asymmetry in the sluices but not in the full *wh*-questions that also involve an intervention configuration. Indeed, we know from previous studies (e.g., Ervin-Tripp 1970; Seidl, Hollich & Jusczyk 2003) that by age 3 children have mastered simple object *wh*-questions, and so it is expected that they would also do well on our control trials. We believe that intervention effects show up in the sluiced condition in older children because of the cumulative complexity of movement and ellipsis: The sluicing operation (representing the elided TP) coupled with the A'-movement operation across an intervener may exceed children's computational resources until they are approximately 6 years old.[10,11]

[8]It is interesting to observe that several adult processing studies of sluicing (Frazier & Clifton 1998; Harris 2015; Lawn & Harris 2017) have found an *object* advantage, arguably due to the shorter linear distance between the (overt) remnant *wh*-element and the more local, object correlate. We believe that for young children, any potential linear locality effect between the indefinite and the remnant is being masked by the difficulties they have with structural intervention in A'-dependencies.

[9]This proposal raises the following theoretical question: If sluicing can repair island violations (see section 3), why does it not also repair the intervention violation in child grammar? The answer may relate to cyclic linearization and the view that island violations are conflicts between linearization statements and spell-out (Fox & Pesetsky 2005). Assuming RM does not interact with spell-out (or linearization), and that what ellipsis removes linearization statements, and consequently, ordering contradictions, that would explain why sluicing voids islands but RM does not. In other words, impenetrability/cyclicity and intervention are separate phenomena, and while ellipsis salvages phase theory/linearization violations, it does not repair RM violations, at least in children. (Our thanks to Jeff Lidz for first bringing this question to our attention and to Kyle Johnson for discussion of this issue.)

[10]More precisely, children may be unable to implement the grammatical operation (e.g., smuggling) necessary to circumvent intervention when other processes are competing for computational resources. For example, Mateu (2016) tested children's comprehension of subject-to-subject raising *seem* and subject control *promise* and found two groups of children. One group lacked the grammatical mechanism to circumvent the intervening argument (experiencer or benefactive) and thus performed consistently poorly. The other group, which showed more variable performance, had an adultlike rule system (by hypothesis) but lacked the computational resources to parse those structures. The latter, but not the former, group showed a positive correlation with verbal processing memory score.

[11]Other factors may also contribute to computational complexity. Aravind, Hackl & Wexler (2018) find that children do significantly better on object clefts such as *It's a cat that the dog is chasing* in felicitous (presupposition satisfaction) versus infelicitous (presupposition failure) contexts. Clefts involve an A'-dependency and previous studies found the now familiar S > O advantage (Bever 1970; Dick et al. 2004; Lempert & Kinsbourne 1980). Aravind, Hackl & Wexler attribute children's poor performance on object clefts in the earlier studies to the fact that sentences were presented to children without a felicitous supporting context. Interestingly, however, they also show that felicity is not a factor in subject clefts where children perform well in both felicitous and infelicitous contexts. They therefore conclude that object extraction *and* presupposition failure incur independent processing costs and the combination overburdens the child processor. We would argue the processing cost of objects clefts is the cost associated with crossing an intervening subject.

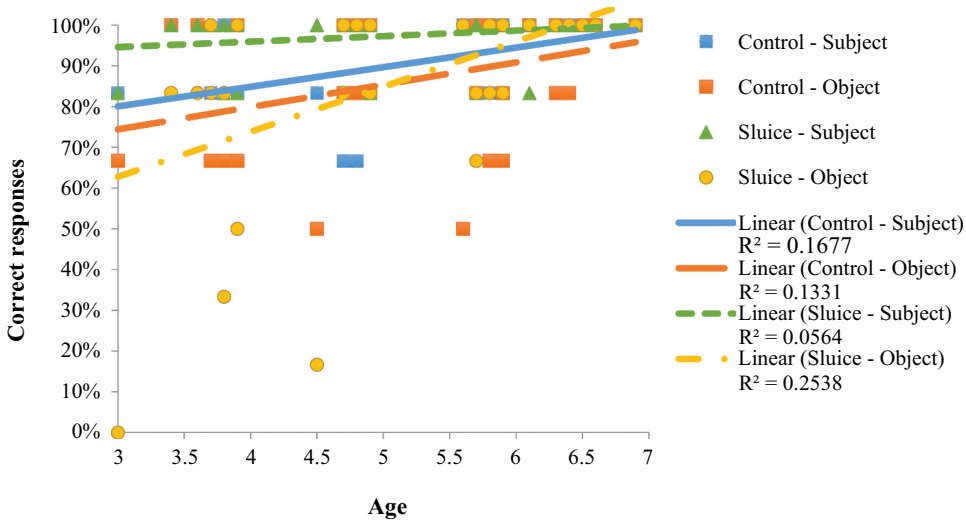

Figure 12. Individual results of the subject/object control and sluice trials (Conditions 2 and 3) in Experiment 1 with linear estimates and R-squared values (fit accuracy).

4.4. Corpus study

We are proposing that the S > O advantage that children show in sluicing reflects the difficulty they have with extraction across an intervening argument. However, there are other possible explanations. One is that children do better with subject sluices because they hear more of them in the input. To test a frequency-based explanation, we conducted a corpus study to see the nature of the sluicing input to young English-speaking children. We were also curious to know at what age children spontaneously produce sluices.

Our corpus study included all 51 American English CHILDES corpora (MacWhinney 2000) (0;10–10;02). We used CLAN to search for certain verbs that typically appear in sluiced constructions (*know, say, see, tell, guess*, and *remember*) that were immediately or otherwise followed by a *wh*-phrase (*who, what, which, where, when, why, how* [*much/many*]). Our findings may therefore underrepresent the frequency of sluices in child language and adult input. We did not include in the analysis: (i) predicative constructions (e.g., "I don't know who <it is>"); (ii) set phrases (e.g., "Guess what?"; "I'll tell you what"), or (iii) cases where we could not determine the extraction site.

We note first that subject sluices (14) appear earlier than object sluices (15):

(14)
a.MOT: I don't know what happened.
CHI: You never know what.(2;04)
b.MOT: I wonder who put it up there.
CHI: I know who.(3;05)

(15)
a.MOT: Tell daddy what you did in school today.
CHI: Do you know what?(2;08)
b.ADU: What are we gonna do with the sheep?
CHI: I know what. (3;11)

Further analyses produced two results that bear on our experimental findings: First, children produce many more object sluices than subject sluices, in fact, three times as many (see Table 2). This is in marked contrast to our comprehension data, which showed better overall performance on subject sluices. We return to this production-comprehension discrepancy in the following. Second, we

Table 2. Number of spontaneously produced sluices by type.

	Subject (*who, what, which*)	Object (*who, what, which*)	Adjunct – Temp. (*when*)	Adjunct – Reason (*why*)	Adjunct – Quant. (*how much*)	Total
Children	**6**	**18**	17	80	2	123
Adults	**18**	**32**	25	202	24	301

find that adults (also) produce many more object sluices than subject sluices, almost twice as many. Thus, the subject advantage we found in our comprehension study cannot be an effect of input frequency.

Returning to the first observation, the discrepancy between children's higher production of object sluices (Table 2), but better comprehension of subject sluices (Figure 12), prompted us to look more closely at the pattern of individual sluices. Our investigation revealed a crucial difference between the production and comprehension data—namely, the object sluices children produced (18 in total) *all* had animate subjects and inanimate objects, i.e., a mismatch in animacy features. We found no instance of an object sluice with matching animacy features on the subject and object.[12] Table 3 shows the breakdown of sluices produced by the children in the CHILDES database broken down by animacy features.

Notably, *all* the test sentences in our comprehension study contained both animate subjects and animate objects. This suggested to us the possibility that it was in fact this match in animacy features that induced a strong(er) intervention effect, while in the production data intervention was circumvented due to the mismatch in animacy features resulting in a higher proportion of object sluices.

In one sense, animacy effects should not be surprising. A number of previous studies have shown that subject-object mismatches in animacy facilitate children's comprehension of other A'-dependencies such as relative clauses (Adani 2012; Adani, Stegenwallner-Schütz & Niesel 2017; Arosio, Guasti & Stucchi 2011; Bentea, Durrleman & Rizzi 2016; Brandt et al. 2009; Corrêa 1995; Durrleman, Bentea & Guasti 2016), and a similar facilitation is also found in adult processing (Mak, Vonk & Schriefers 2002; Traxler, Morris & Seely 2002; among many others) and Broca's aphasics (Garraffa & Grillo 2008; Varlokosta et al. 2014). However, the suggestion that animacy features enter into the computation of intervention is not harmless. Some theories of intervention (e.g., Relativized Minimality, Belletti et al. 2012; Friedmann, Belletti & Rizzi 2009; Rizzi 1990) propose that only syntactically "active" features count for intervention—for example, features that are part of the T system and thus constitute attracting features for movement. It is not at all obvious that animacy is such a feature in English and related languages.[13]

There is of course another, nonstructural, explanation for the discordant comprehension-production results, which is that children want sentences to have animate subjects and inanimate objects because this represents a universally unmarked pattern (e.g., the Animacy Hierarchy, Silverstein 1976) and is (therefore) by far the most common distribution of (in)animate arguments

Table 3. Number of sluices produced by children by animacy features.

	[+ Animate] Subject			[-Animate] Subject		
	[+ani] object	[-ani] object	No object	[+ani] object	[-ani] object	No object
Subject sluices	2	2	0	0	0	2
Object sluices	**0**	**18**	N/A	0	0	N/A

[12]Subject sluices, on the other hand, though far fewer in number, were evenly divided between matching (2) and mismatching (2) animacy features on subject and object.
[13]See footnote 20.

in their input (Diessel 2004, 2007, 2009; Mak, Vonk & Schriefers 2002; Roland, Dick & Elman 2007; Stromswold 1995). Thus, left to their own devices, children produce the more frequent unmarked pattern and had difficulty with the object sluices in our study because our test sentences violated this pattern. In other words, it could be the case that children in Experiment 1 did better in the subject sluices because all trials involved *who*-questions, and *who* is most often associated with the subject, not the object argument. The results of Experiment 2 bear on this alternative hypothesis.

5. Animacy and intervention: Experiment 2

Experiment 1 tested children on their knowledge of the identity condition on sluicing and also on whether they would show the same subject advantage we find in other A'-extraction structures. We found that by age 3, children do not have difficulties comprehending sluiced *wh*-questions and generally respect the identity condition, disallowing both verb and argument mismatches. Interestingly, and despite their high scores, we also found that children performed significantly better in sluiced subject *wh*-questions than sluiced object *wh*-questions. We hypothesize that this is an effect of intervention and thus provides acquisition evidence for a structured TP at the ellipsis site. Our corpus study lent further support to the intervention hypothesis insofar as children's spontaneous production of object sluices all involved mismatching animacy features. On the other hand, our experimental comprehension study included only sentences in which both subject and object were animate, and while this combination appears in the spontaneous production of subject sluices, it does not appear in object sluices (see Table 3). Thus, our second experiment aims to explore the effects of animacy in a more systematic way.

In English, animacy is grammaticalized in nonreferential *wh*-elements (Alexopoulou & Keller 2014), i.e., the difference between the two *wh*-elements *who* and *what* is the presence or absence of the feature [animacy] (in relation to an argumental element). Thus, in order to explore the effects of the animacy feature, Experiment 2 again tests children on subject and object sluices, but this time we use both "who" and "what." We predict that even when we include [–animate] "what" in addition to [+animate] "who," thereby controlling for the effects of the more natural "who"-subject association, children will still perform better in subject sluices than object sluices. Moreover, we believe that whether [animacy] features are matching or mismatching will be irrelevant in the subject sluices (where there is no potential intervener). On the other hand, we predict children will perform significantly better in the mismatched trials of the object condition compared to the matched trials.

As noted, various studies have found that children perform better in A'-constructions when the subject is animate and the extracted object is inanimate than when both arguments are animate. However, to our knowledge, there are no acquisition studies that also examine within-subject performance in the remaining two logical combinations: (i) when both arguments are inanimate, and (ii) when the subject is inanimate and the moved object is animate.[14] Our study includes all four conditions in order to enable a balanced number of "who" and "what" subject and object sluices. If children perform significantly worse in the object-extracted sluices when both arguments match in animacy features compared to when they do not match in such features, this would provide further support for an intervention account. It would also suggest that animacy features figure into the computation of dependencies with implications for various theories of intervention.

5.1. Subjects

In Experiment 2 we tested 60 English-speaking children aged 3;00–6;11 (M = 5;03), 15 in each year interval, in Los Angeles, CA. Three additional subjects were tested, but they were excluded because

[14]Varlokosta, Nerantzini & Papadopoulou (2015) examine Greek-speaking children's performance on subject *wh*-questions that have an inanimate subject and an animate object, but not object *wh*-questions that have an inanimate subject and an animate object.

they did not pass the control conditions ($N = 2$, aged 3;05, and 3;10) or failed to finish the task ($N = 1$, aged 3;10).

5.2. Materials and procedure

Using the same *yes/no* question task as in Experiment 1, children were shown an image on a screen (also created by the first author using Pixton, Pixton Comics Inc., 2015), and they were asked whether they could see a particular person or object. We used three reversible transitive verbs: *poke, push*, and *lift*. These verbs were chosen because they could be used with both animate and inanimate subjects. The children were given sentences with sluiced subject and object *wh*-questions in which the animacy of subject and object were manipulated. The design of the experiment in given in Table 4.

Examples of our experimental sentences follow: subject/object sluices in the various animacy conditions (examples 16-20), followed by the pictures (Figures 13–20) that were designed to elicit a "yes" or "no" response. For example, if children are correctly interpreting the sentence in (16b), Figure 13 should elicit a "yes" response, while Figure 14 should elicit a "no" response. The sentences in (16) and (17) were matched for animacy – in (16) the subject (S) is [+animate] and the object (O) is [+animate], while in (17) both S and O are [−animate]; the sentences in (18) and (19) had arguments that mismatched in animacy features – in (18) the S is [+animate] and the O is [−animate], in (19) it is vice-versa.

(16) S[+animate] O[+animate]
a. I can see that someone is pushing the boy, can you see who <_is pushing the boy>?
b. I can see that the boy is pushing someone, can you see who <the boy is pushing _ >?

(17) S[−animate] O[−animate]
a. I can see that something is pushing the car, can you see what <_ is pushing the car>?
b. I can see that the car is pushing something, can you see what <the car is pushing _ >?

Table 4. Design of Experiment 2.

Subject/object sluices		
	Subject	Object
Match	[+animate]	[+animate]
	[−animate]	[−animate]
Mismatch	[+animate]	[−animate]
	[−animate]	[+animate]

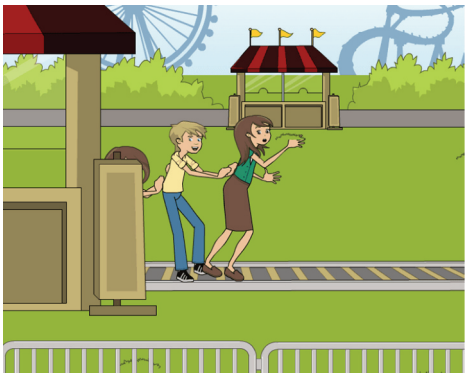

Figure 13. "Yes" scenario for (16b).

Figure 14. "No" scenario for (16b).

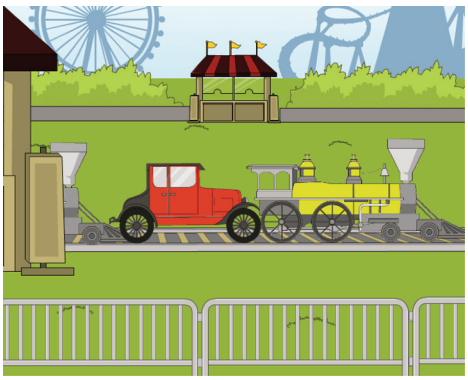

Figure 15. "Yes" scenario for (17b).

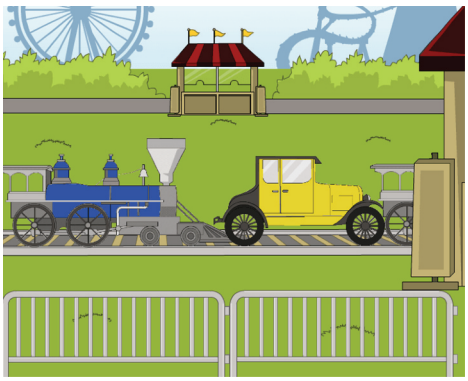

Figure 16. 'No scenario for (17b).

(18) S[+animate] O[−animate]

a. I can see that someone is pushing the car, can you see who <_ is pushing the car>?

b. I can see that the boy is pushing something, can you see what <the boy is pushing _ >?

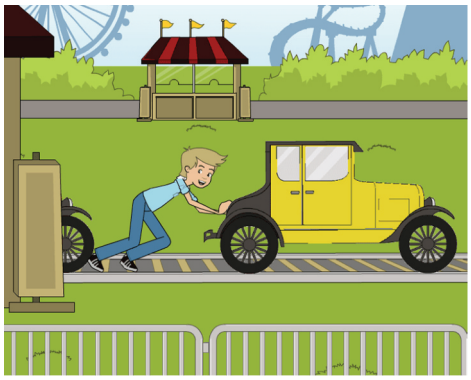

Figure 17. "Yes" scenario for (18b).

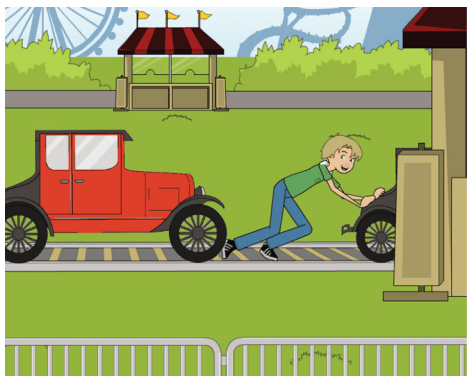

Figure 18. "No" scenario for (18b).

(19) S[−animate] O[+animate]
a. I can see that something is pushing the boy, can you see what <_is pushing the boy>?
b. I can see that the train is pushing someone, can you see who <the train is pushing _ >?

In order to ensure that children were paying attention to the entire sentence, we included full (nonsluiced) subject and object *wh*-questions with mismatched arguments, as is (20).

(20) a. I can see that someone is pushing the hidden boy, can you see who is pushing the girl?
b. I can see that someone is pushing the boy in yellow, can you see who is pushing the girl?

There were six training items and 24 test trials consisting of 16 sluiced sentences, and 8 control full *wh*-questions. These were divided equally between subject- and object-trials (i.e., eight subject sluices, eight object sluices, and four subject control *wh*-questions, four object control *wh*-questions) as well as match and mismatch trials (e.g., for the eight subject sluices, four were matching (in two both arguments were animate, in two both were inanimate) and four mismatching (in two the subject was animate and object inanimate, in two the reverse). They were also balanced in terms of "yes" and "no" responses (see Appendix B). Children who did not perform above chance in the controls (i.e., 6/8 or more given three potential characters to choose from according to a binomial test) were excluded from the study ($N = 3$).

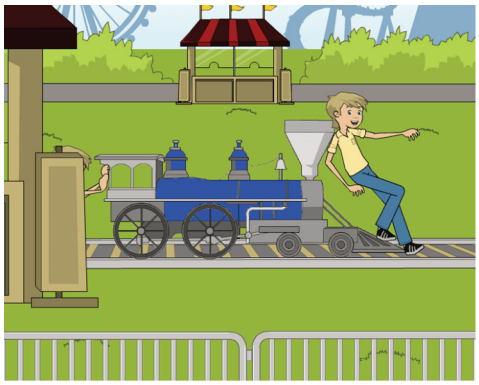

Figure 19. "Yes" scenario for (19b).

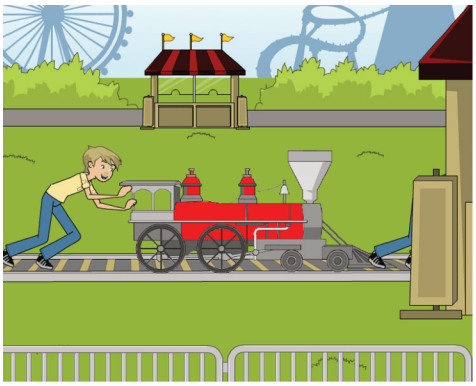

Figure 20. "No" scenario for (19b).

5.3. Results and discussion

The overall results of Experiment 2 are presented in Table 5 (and Figures 21 and 22).

We see that, as in Experiment 1, even the youngest children performed at a very high rate and showed no significant subject/object differences in the control trials. On the other hand, they again showed a more pronounced (and statistically significant) subject > object asymmetry in the sluices (see Figure 21).

In order to statistically confirm this interaction between TrialType (Control, Sluice) and ExtractionSite (Subject, Object), we ran a mixed-effects logistic regression model with score as a binary dependent variable (correct, incorrect), age (continuous variable, 3.4 through 6.6), TrialType (Control, Sluice), ExtractionSite (Subject, Object), and TrialType by ExtractionSite as fixed effects, and random intercept for subject, paralleling the one from Experiment 1. We found a significant effect of age, $\chi^2(1) = 16.04$, $p < .001$, so that children became progressively better with age. We also again found an effect of TrialType, $\chi^2(2) = 27.23$, $p < .001$, an effect of ExtractionSite, $\chi^2(2) = 33.98$, $p < .001$, and importantly, an interaction between TrialType and ExtractionSite, $\chi^2(1) = 5.59$, $p = .019$, so that children showed a significant subject > object asymmetry in the sluices, $p < .001$, but not in the full *wh*-questions, $p = .705$. These results confirm that English-speaking children have more difficulties with object sluices than subject sluices.[15]

[15]It is worth noting that in Experiment 1, the subject > object asymmetry in sluices essentially disappears by age 6, while in Experiment 2 even the 6-year-olds experienced greater more difficulty with object sluices than subject sluices (compare Figures 12 and 21). Experiment 2 involved more characters and included inanimate subjects, which are very infrequent in children's input. We believe that these factors may have made Experiment 2 more cognitively demanding, resulting in asubject > object asymmetry even in the oldest children tested. In this regard we note that even with respect to the subject sluices, which are overall much easier for children than object sluices, the younger children did better in Experiment 1 than in Experiment 2.

Let's consider the theoretical implications of these results. First, the S > O asymmetry in the sluicing conditions in Experiment 2 provides further support for our hypothesis that children (like adults) derive sluices via *wh*-extraction, performing more poorly on object sluices as an effect of intervention. As suggested in connection with the results of Experiment 1 (see section 4.3), we believe that the subject > object asymmetry shows up in the sluices, but not in the (control) *wh*-question conditions, because of the cumulative complexity of movement and ellipsis. Intervention effects arise in this more complex configuration where children computational capacity is taxed.[16] This proposal receives some support from the fact that even in the *wh*-question control condition younger children do better with subject questions than object questions (Table 6). Though these differences do not reach significance, they trend in the S > O direction with the subject advantage gradually decreasing over time as computational resources increase. We suspect that younger children with even fewer computational resources than those in our study would show a significant subject advantage in the control conditions as well.

Moving on to the question of animacy, children performed significantly worse when both subject and object matched in animacy features, but crucially, they did so only in the object-extracted sluices. This effect of animacy (mis)match was not observed in the subject-extracted sluices. Table 6 shows the average scores for subject versus object sluices in the animacy match and mismatch conditions. For the object sluices, children had an average score of 73.75% in the match condition, while in the mismatch condition they performed at a rate of 85% correct. See also Figure 22.[17]

In order to assess the effect of this interaction, we ran a new mixed-effects logistic regression model. Given the lack of asymmetry in the control trials, and in order to simplify our model, we built a model with the sluiced trials alone. This model included score as a binary dependent variable (correct, incorrect), Age (continuous variable, 3.4 through 6.6), ExtractionSite (Subject, Object), and ArgumentMatch by ExtractionSite as fixed effects, and random intercept for subject. We again found a significant effect of Age, $\chi^2(1) = 12.65$, $p < .001$, so that children became better with age. We also found an effect of ExtractionSite, $\chi^2(2) = 39.76$, $p < .001$, ArgumentMatch, $\chi^2(2) = 11.02$, $p = .004$, and crucially, an interaction between ExtractionSite and ArgumentMatch, $\chi^2(1) = 4.23$, $p = .03$. That is, a mismatch in animacy on the arguments improves children's performance on object sluices, $p = .001$, but not in the subject sluices, $p = .86$, exactly as predicted under an intervention account.[18]

Table 5. Percentage correct on sluices and *wh*-question controls in Experiment 2.

	Controls		Sluices	
	Subject	Object	Subject	Object
3yos	93.33%	85%	82.5%	69.17%
4yos	91.67%	95%	92.5%	76.5%
5yos	93.33%	95%	95.83%	83.33%
6yos	96.67%	96.67%	96.67%	87.5%
AVG	**93.75%**	**92.92%**	**91.88%**	**79.38%**

[16]In an analogous way, normal adults show a subject > object asymmetry in relative clauses in *online* tasks (by their nature more cognitive taxing) in, for example, reading time measures, often accompanied by slightly higher error rates in comprehension questions after reading object relative clauses (Gordon, Hendrick & Levine 2002; Just & Carpenter 1992; King & Just 1991; Mak, Vonk & Schriefers 2002; Traxler, Morris & Seely 2002; Warren & Gibson 2002, a.o.), and also show more performance errors in lexical decision and word recall tasks taking place during or after reading object relative clauses (David & Waters 1999, a.o.; Waters, Caplan & Hildebrandt 1987).

[17]See Appendix C for a breakdown of the results by subcondition, i.e. (i) [+animate] subject and [+animate] object, (ii) [−animate] subject and [−animate] object, (iii) [+animate] subject and [−animate] object, and (iv) [−animate] subject and [+animate] object, for both the subject and object sluices.

[18]Though not included in this article, we also conducted a Relative Clause experiment manipulating animacy in the same way as Experiment 2, with the same children in a separate session. We found that children performed significantly worse with object RCs than subject RCs and that animacy mismatches improved their performance in the object RCs but not subject RCs, corroborating the hypothesis that [animacy] mismatches improve children's comprehension of object A′-constructions. We also found a significant correlation in performance between the two, $r_S(58) = .501$, $p < .001$, further supporting the hypothesis that sluices are also derived via A′-movement (Merchant 2001).

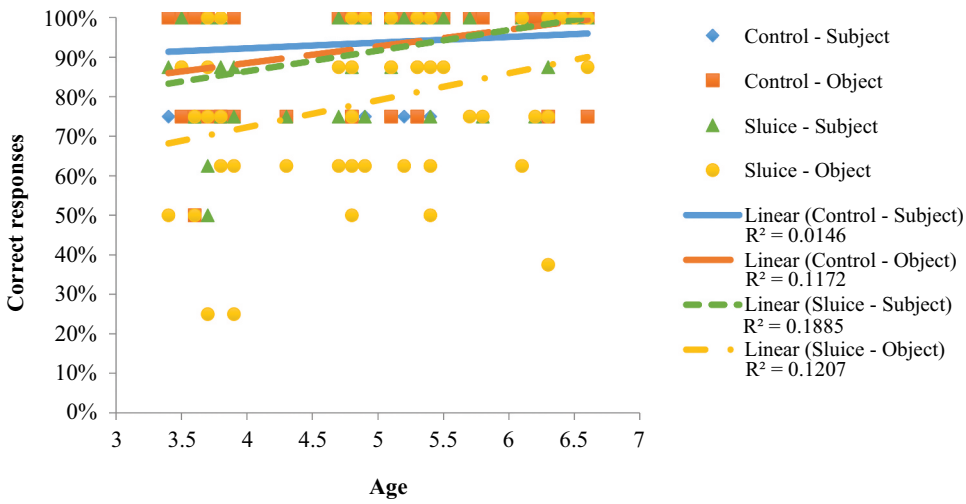

Figure 21. Individual results of the subject/object control and sluice trials in Experiment 2 with linear estimates and R-squared values (fit accuracy).

Table 6. Experiment 2: Percentage correct sluices by subject/object sluice x animacy (mis) match.

	Subject		Object	
	Match	*Mismatch*	*Match*	*Mismatch*
3yos	81.67%	83.33%	60.00%	78.33%
4yos	91.67%	93.33%	70.00%	85.00%
5yos	98.33%	93.33%	78.33%	88.33%
6yos	96.67%	96.67%	86.67%	88.33%
AVG	**92.08%**	**91.67%**	**73.75%**	**85.00%**

An alternative explanation for the improved performance in the mismatched condition of the object sluices might be that this combination is most frequent in their input (and hence easier to process). Various corpus and experimental studies show that both children and adults are overwhelmingly more likely to produce sentences that conform to an unmarked "animate subject-inanimate object" pattern (Swedish: Dahl 2000; Norwegian: Øvrelid 2004; English child directed speech: Scott & Fisher 2009). An immediate problem with this nonstructural, "frequency/naturalness hypothesis" (e.g., Arnon 2009; Brandt et al. 2009; Gennari & MacDonald 2008) is that it does not explain why the children in our experimental studies performed virtually at ceiling with subject sluices, even in cases with two inanimate arguments, or an inanimate subject and an animate object.

Summing up, Experiment 2 replicated the results of Experiment 1: Despite overall high scores on sluices, children perform significantly better in sluiced subject *wh*-questions than sluiced object *wh*-questions. That is, they show the same subject advantage that has been found in other A'-extraction structures. We hypothesize that this is an effect of intervention, providing acquisition evidence for A'-movement and a structured TP at the ellipsis site.

Our second experiment also showed that the S > O advantage is mitigated when the arguments mismatch in features, specifically [+/−animacy]. That is, children's performance on object sluices improves significantly when subject and object do not share the same value for animacy. This finding parallels results from studies of other A'-structures showing that mismatching features for NP type

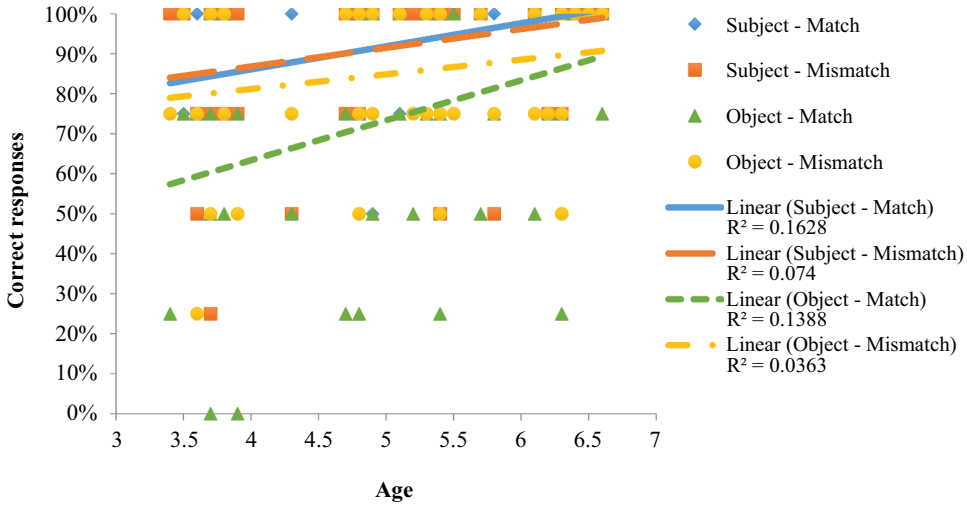

Figure 22. Individual results of the subject/object sluices by animacy match/mismatch in Experiment 2 with linear estimates and R-squared values (fit accuracy).

(+/–lexical NP restriction), Gender, Number, and Case, as well as animacy improve children's comprehension of object RCs and questions (Adani et al. 2010; Arosio et al. 2012; Belletti et al. 2012; Bentea, Durrleman & Rizzi 2016; Friedmann, Belletti & Rizzi 2009; Gutierrez-Mangado 2011; Kidd et al. 2007; Varlokosta, Nerantzini & Papadopoulou 2015, a.o.). The finding that the featural, i.e., structural, composition of the arguments matters provides additional support for the intervention hypothesis.[19,20]

6. Conclusion

The research questions that motivated our first experiment were: (i) do children respect the "identity condition" in sluiced *wh*-questions, and (ii) do they show a subject>object asymmetry? We found children as young as 3 years old obey the identity condition and disallow interpretations in which the verb or the arguments are mismatched in the elided TP. With regard to our second question, our results indicate that, as in other instances of A'-movement, children below the age of 6 exhibit greater difficulty with object-extracted constructions than subject-extracted ones. Theoretical analyses of sluicing that involve syntactic structure at the ellipsis site as well as movement (Merchant 2001) thus find support in our empirical findings.

Our second experiment investigated the role of animacy features in children's comprehension of sluiced *wh*-questions. The results replicated those of our first experiment in that object sluices were more difficult for children than subject sluices, as predicted by structural intervention accounts.

[19]Processing (e.g., memory)-based approaches such as Similarity-based Interference (Gordon, Hendrick & Levine 2002; Lewis, Vasishth & Van Dyke 2006; Van Dyke & McElree 2006; 2011, a.o.) also appeal to a notion of intervention but differ from RM in that they are nonstructural and do not rely specifically on morphosyntactic features. Such proposals argue instead that it is simpler to keep dissimilar expressions in memory than similar ones and importantly, the dissimilarities may be along any dimension, i.e., morphosyntactic, or purely semantic or phonological. Our study was not designed to disentangle a grammar-based approach from such processing-based approaches. However, to our knowledge, processing approaches do not predict interference if the distractor is not overtly realized, as is the case in sluiced *wh*-questions.

[20]Some structural-based accounts of intervention, such as RM, propose only features associated with T and overtly realized on the verb can figure into the computation of intervention in a specific language (Belletti et al. 2012). Insofar as [animacy] is not a movement-triggering feature in English, these claims are incompatible with our results. They are similarly incompatible with findings in other languages in which [animacy] is not active in the T system but which nevertheless find that animacy mismatches improve comprehension of intervening structures (e,g., Arosio, Guasti & Stucchi 2011; Durrleman, Bentea & Guasti 2016 for Italian; Costa, Grillo & Lobo 2012; Corrêa 1995 for Portuguese; Adani 2012 for German; Varlokosta, Nerantzini & Papadopoulou 2015 for Greek).

Moreover, we also found that this difficulty with object sluices was mitigated when the subject and object were mismatched in animacy features, providing additional support for structural intervention. The results of this study not only contribute to our understanding of children's grammatical development but also illustrate how language acquisition research can inform debates over the syntactic description of particular constructions and more generally contribute to the development of linguistic theory.

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Appendix A. Experiment 1 materials by group and condition

Table A1. Group A materials for Experiment 1.

Cond	S/O	Type	Sentence	Y/N
1	Subject	Control	I can see that someone is sleeping; can you see who is sleeping?	N
1	Subject	Control	I can see that someone is jumping; can you see who is jumping?	Y
2	Object	Control	I can see that Ben is painting someone; can you see who Ben is poking _?	N
2	Object	Control	I can see that Ben is brushing someone; can you see who Ben is washing _?	Y
2	Subject	Control	I can see that someone is brushing Ben; can you see who _ is washing Ben?	N
2	Subject	Control	I can see that someone is spraying Ben; can you see who _ is kicking Ben?	Y
3	Object	Control	I can see that Ben is painting someone; can you see who the girl in pink is painting _?	N
3	Object	Control	I can see that Ben is spraying someone; can you see who the girl in green is spraying _?	Y
3	Subject	Control	I can see that someone is brushing Ben; can you see who _ is brushing the girl in yellow?	N
3	Subject	Control	I can see that someone is painting Ben; can you see who _ is painting the girl in green?	Y
3	Object	Control	I can see that Ben is painting someone; can you see who _ is painting Ben?	N
3	Object	Control	I can see that Ben is spraying someone; can you see who _ is spraying Ben?	Y
3	Subject	Control	I can see that someone is brushing Ben; can you see who Ben is brushing _?	N
3	Subject	Control	I can see that someone is spraying Ben; can you see who Ben is spraying _?	Y
1	Subject	Sluice	I can see that someone is sleeping; can you see who <_ is sleeping>?	N
1	Subject	Sluice	I can see that someone is jumping; can you see who <_ is jumping>?	N
1	Subject	Sluice	I can see that someone is sitting; can you see who <_ is sitting>?	Y
2	Object	Sluice	I can see that Ben is painting someone; can you see who <Ben is painting _>?	N
2	Object	Sluice	I can see that Ben is spraying someone; can you see who <Ben is spraying _>?	Y
2	Object	Sluice	I can see that Ben is brushing someone; can you see who <Ben is brushing _>?	Y
2	Subject	Sluice	I can see that someone is brushing Ben; can you see who <_ is brushing Ben>?	N
2	Subject	Sluice	I can see that someone is painting Ben; can you see who <_ is painting Ben>?	N
2	Subject	Sluice	I can see that someone is spraying Ben; can you see who <_ is spraying Ben>?	Y
3	Object	Sluice	I can see that Ben is painting someone; can you see who <Ben is painting _>?	N
3	Object	Sluice	I can see that Ben is spraying someone; can you see who <Ben is spraying _>?	N
3	Object	Sluice	I can see that Ben is brushing someone; can you see who <Ben is brushing _>?	Y
3	Subject	Sluice	I can see that someone is brushing Ben; can you see who <_ is brushing Ben>?	N
3	Subject	Sluice	I can see that someone is painting Ben; can you see who <_ is painting Ben>?	Y
3	Subject	Sluice	I can see that someone is spraying Ben; can you see who <_ is spraying Ben>?	Y

Table A2. Group B materials for Experiment 1.

Cond	S/O	Type	Sentence	Y/N
1	Subject	Control	I can see that someone is jumping; can you see who is jumping?	N
1	Subject	Control	I can see that someone is sleeping; can you see who is sleeping?	Y
2	Object	Control	I can see that Ben is brushing someone; can you see who Ben is washing _?	N
2	Object	Control	I can see that Ben is painting someone; can you see who Ben is poking _?	Y
2	Subject	Control	I can see that someone is spraying Ben; can you see who _ is kicking Ben?	N
2	Subject	Control	I can see that someone is brushing Ben; can you see who _ is washing Ben?	Y
3	Object	Control	I can see that Ben is spraying someone; can you see who the girl in yellow is spraying _?	N
3	Object	Control	I can see that Ben is painting someone, can you see who the girl in yellow is painting _?	Y
3	Subject	Control	I can see that someone is painting Ben, can you see who _ is painting the girl in pink?	N
3	Subject	Control	I can see that someone is brushing Ben; can you see who _ is brushing the girl in green?	Y
3	Object	Control	I can see that Ben is spraying someone; can you see who _ is spraying Ben?	N
3	Object	Control	I can see that Ben is painting someone; can you see who _ is painting Ben?	Y
3	Subject	Control	I can see that someone is brushing Ben; can you see who Ben is brushing _?	Y
3	Subject	Control	I can see that someone is spraying Ben; can you see who Ben is spraying _?	N
1	Subject	Sluice	I can see that someone is sitting; can you see who <_ is sitting>?	N
1	Subject	Sluice	I can see that someone is sleeping; can you see who <_ is sleeping>?	Y
1	Subject	Sluice	I can see that someone is jumping; can you see who <_ is jumping>?	Y
2	Object	Sluice	I can see that Ben is brushing someone; can you see who <Ben is brushing _>?	N
2	Object	Sluice	I can see that Ben is painting someone; can you see who <Ben is painting _>?	N
2	Object	Sluice	I can see that Ben is spraying someone; can you see who <Ben is spraying _>?	Y
2	Subject	Sluice	I can see that someone is painting Ben; can you see who <_ is painting Ben>?	N
2	Subject	Sluice	I can see that someone is spraying Ben; can you see who <_ is spraying Ben>?	Y
2	Subject	Sluice	I can see that someone is brushing Ben; can you see who <_ is brushing Ben>?	Y
3	Object	Sluice	I can see that Ben is brushing someone; can you see who <Ben is brushing _>?	N
3	Object	Sluice	I can see that Ben is painting someone; can you see who <Ben is painting _>?	Y
3	Object	Sluice	I can see that Ben is spraying someone; can you see who <Ben is spraying _>?	Y
3	Subject	Sluice	I can see that someone is painting Ben; can you see who <_ is painting Ben>?	N
3	Subject	Sluice	I can see that someone is spraying Ben; can you see who <_ is spraying Ben>?	N
3	Subject	Sluice	I can see that someone is brushing Ben; can you see who <_ is brushing Ben>?	Y

Appendix B. Experiment 2 materials by group and condition

Table B1. Group A materials for Experiment 2.

S + ani	O + ani	S/O	Type	Sentence	Y/N
Yes	Yes	Subject	Sluice	I can see that someone is poking the boy; can you see who <_ is poking the boy>?	Y
Yes	Yes	Subject	Sluice	I can see that someone is lifting the girl; can you see who <_ is lifting the girl>?	N
Yes	Yes	Object	Sluice	I can see that the girl is poking someone; can you see who <the girl is poking _>?	Y
Yes	Yes	Object	Sluice	I can see that the boy is pushing someone; can you see who <the boy is pushing _>?	N
Yes	No	Subject	Sluice	I can see that someone is pushing the car; can you see who <_ is pushing the car>?	Y
Yes	No	Subject	Sluice	I can see that someone is lifting the fire truck; can you see who <_ is lifting the fire truck>?	N
Yes	No	Object	Sluice	I can see that the girl is poking something; can you see what <the girl is poking _>?	Y
Yes	No	Object	Sluice	I can see that the boy is pushing something; can you see what <the boy is pushing _>?	N
No	Yes	Subject	Sluice	I can see that something is poking the girl; can you see what <_ is poking the girl>?	Y
No	Yes	Subject	Sluice	I can see that something is lifting the boy; can you see what <_ is lifting the boy>?	N
No	Yes	Object	Sluice	I can see that the train is pushing someone; can you see who <the train is pushing _>?	Y
No	Yes	Object	Sluice	I can see that the bulldozer is lifting someone; can you see who <the bulldozer is lifting _>?	N
No	No	Subject	Sluice	I can see that something is pushing the train; can you see what <_ is pushing the train>?	Y
No	No	Subject	Sluice	I can see that something is lifting the bulldozer; can you see what <_ is lifting the bulldozer>?	N
No	No	Object	Sluice	I can see that the tree is poking something; can you see what <the tree is poking _>?	Y
No	No	Object	Sluice	I can see that the fire truck is lifting something; can you see what <the fire truck is lifting _>?	N
Yes	Yes	Subject	Control	I can see that someone is poking the hidden girl; can you see who <_ is poking the boy>?	Y
Yes	Yes	Object	Control	I can see that the boy in blue is poking someone; can you see who <the girl is poking _>?	N
Yes	No	Subject	Control	I can see that something is lifting the boy in yellow; can you see who <_ is lifting the fire truck>?	N
Yes	No	Object	Control	I can see that the hidden car is pushing someone; can you see what <the boy is pushing _>?	Y
No	Yes	Subject	Control	I can see that someone is lifting the hidden bulldozer; can you see what <_ is lifting the boy>?	Y
No	Yes	Object	Control	I can see that the hidden boy is pushing something; can you see who <the train is pushing _>?	Y
No	No	Subject	Control	I can see that something is poking the lemon tree; can you see what <_ is poking the statue>?	N
No	No	Object	Control	I can see that the square bulldozer is lifting something; can you see what <the fire truck is lifting _>?	N

Table B2. Group B materials for Experiment 2.

S + ani	O + ani	S/O	Type	Sentence	Y/N
Yes	Yes	Subject	Sluice	I can see that someone is poking the boy; can you see who <_ is poking the boy>?	N
Yes	Yes	Subject	Sluice	I can see that someone is pushing the girl; can you see who <_ is pushing the girl>?	Y
Yes	Yes	Object	Sluice	I can see that the boy is pushing someone; can you see who <the boy is pushing _>?	N
Yes	Yes	Object	Sluice	I can see that the boy is lifting someone; can you see who <the boy is lifting _>?	Y
Yes	No	Subject	Sluice	I can see that someone is poking the statue; can you see who <_ is poking the statue>?	N
Yes	No	Subject	Sluice	I can see that someone is lifting the fire truck; can you see who <_ is lifting the fire truck>?	Y
Yes	No	Object	Sluice	I can see that the boy is lifting something; can you see what <the boy is lifting _>?	N
Yes	No	Object	Sluice	I can see that the boy is pushing something; can you see what <the boy is pushing _>?	Y
No	Yes	Subject	Sluice	I can see that something is pushing the boy; can you see what <_ is pushing the boy>?	N
No	Yes	Subject	Sluice	I can see that something is lifting the boy; can you see what <_ is lifting the boy>?	Y
No	Yes	Object	Sluice	I can see that the tree is poking someone; can you see who <the tree is poking _>?	N
No	Yes	Object	Sluice	I can see that the train is pushing someone; can you see who <the train is pushing _>?	Y
No	No	Subject	Sluice	I can see that something is poking the the statue; can you see what <_ is poking the statue>?	N
No	No	Subject	Sluice	I can see that something is lifting the bulldozer; can you see what <_ is lifting the bulldozer>?	Y
No	No	Object	Sluice	I can see that the tree is poking something; can you see what <the tree is poking _>?	N
No	No	Object	Sluice	I can see that the car is pushing something; can you see what <the car is pushing _>?	Y
Yes	Yes	Subject	Control	I can see that someone is lifting the boy in yellow; can you see who <_ is lifting the girl>?	N
Yes	Yes	Object	Control	I can see that the hidden girl is pushing someone; can you see who <the boy is pushing _>?	Y
Yes	No	Subject	Control	I can see that something is poking the hidden girl; can you see who <_ is poking the statue>?	Y
Yes	No	Object	Control	I can see that the soldier statue is poking someone; can you see what <the girl is poking _>?	N
No	Yes	Subject	Control	I can see that someone is pushing the yellow train; can you see what <_ is pushing the boy>?	N
No	Yes	Object	Control	I can see that the boy in green is lifting something; can you see who <the bulldozer is lifting _>?	N
No	No	Subject	Control	I can see that something is pushing the hidden car; can you see what <_ is pushing the train>?	Y
No	No	Object	Control	I can see that the hidden statue is poking something; can you see what <the tree is poking _>?	Y

Appendix C. Experiment 2 results by animacy subcondition and age

Table C1. Percentage correct sluices by subject and object animacy. The left square bracket indicates the animacy of the subject. The right square bracket indicates the animacy of the object.

	SLUICES							
	Subject				Object			
	Matched		Mismatched		Matched		Mismatched	
	[+] [+]	[–] [–]	[+] [–]	[–] [+]	[+] [+]	[–] [–]	[+] [–]	[–] [+]
3yo	90.00%	73.33%	80.00%	86.67%	60.00%	60.00%	86.67%	70.00%
4yo	100.00%	83.33%	96.67%	90.00%	66.67%	73.33%	93.33%	76.67%
5yo	100.00%	96.67%	90.00%	96.67%	80.00%	76.67%	93.33%	83.33%
6yo	100.00%	93.33%	93.33%	100.00%	90.00%	83.33%	96.67%	80.00%
AVG	**97.50**%	**86.67**%	**90.00**%	**93.33**%	**74.17**%	**73.33**%	**92.50**%	**77.50**%
	92.08%		**91.67**%		**73.75**%		**85.00**%	
	91.88%				**79.38**%			