Intervention Effects in Early Grammar: Evidence from Sluicing

Victoria E. Mateu, Nina Hyams, and Lauren Winans

1. Introduction

Ellipsis (meaning without sound) poses an extreme 'poverty of the stimulus' (POS) 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 and when they learn to do this. In this study we investigate children's acquisition of one type of ellipsis – sluicing. One of the central goals is to determine whether children show a subject-object asymmetry with respect to sluicing, as they do with other types of (overt) A'-movement, arguably an effect of intervention.

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 (Thornton & Wexler, 1999; Matsuo & Duffield, 2001; Foley et al., 2003; Thornton, 2010), but also Japanese (Matsuo, 2007), European Portuguese (Santos, 2009), and Mandarin (Fangfang et al., 1996). Argument ellipsis (AE) 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).

There has been far less investigation of the acquisition of sluicing (Lindenbergh et al., 2013; Sugisaki, 2016; Wood, 2009), which involves the ellipsis of TP in a *wh*-question that leaves a "remnant" *wh*-phrase overt, as in (1).

(1) Someone is drawing a flower, but I can't see who __.

*Victoria E. Mateu, University of California, Los Angeles, victoria.e.mateu@gmail.com; Nina Hyams, University of California, Los Angeles, hyams@humnet.ucla.edu; Lauren Winans, University of Southern California. Many thanks to everyone who offered guidance and assistance on this project, particularly Angeliek van Hout and Charlotte Lindenbergh, as well as the audiences of GALA 13 and BUCLD 42. We are also greatly indebted to the children, parents, and school teachers who participated, and special thanks to the UCLA Lab School and the UCLA Language Acquisition Lab. This work was supported by a National Science Foundation grant to V.M. (BCS-145158), and by a UCLA Faculty Senate Grant to N.H. (2016-2107). All errors are our own.

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Sluicing appears to be more widely distributed across languages than other kinds of ellipsis such as VPE (Merchant, 2001). Also, broadly speaking, *wh*-questions are acquired earlier than English auxiliaries (e.g. *do* support), which act as the licensers to VPE. For these reasons sluicing seems like a good vehicle for exploring the acquisition of ellipsis. Additionally, children's behavior with subject vs. object sluices has the potential to inform the theoretical debate surrounding the underlying structure of sluicing.

1.1. Previous acquisition studies

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't know who <…>
  a. … is cooking turkey.
  b. *… is bringing lasagna.

Wood (2009) tested English-speaking children ages 4;5-5;5 and 6;8-7;8 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.

Lindenbergh et al. (2014) tested Dutch-speaking children ages 4;9 to 6;1 in a picture-matching task. Each picture array contained 4 pictures and was coupled with a sentence as in (1); 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 (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 guitar) to test verb identity. Lindenbergh et al. obtained much better results than Wood 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', namely, by interpreting the two clauses separately, i.e., someone is

drawing a flower, and there is someone who cannot be seen, a confound which the authors also recognize (van Hout p.c.).[1]

1.2. Our study

Our study was designed to enrich the sparse literature in this area and help resolve the conflicting findings of the two previous studies. 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 _>.

Several studies have found that children perform more poorly on object vs. subject *wh*-questions (Avrutin, 2000; de Vincenzi et al., 1999; Friedmann et al., 2009; Yoshinaga, 1996), relative clauses (Friedmann & Novogrodsky, 2004; McKee, McDaniel, & Snedecker, 1998), and topicalizations (Friedman & Lavi, 2006). Various authors have proposed that children are particularly susceptible to 'intervention effects' (e.g. Friedmann et al. 2009; Mateu, 2016; 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 a potential antecedent for the gap. Thus, *if* sluices involve *wh*-movement, we may find a similar subject>object asymmetry. However, this is not a settled issue.

1.3. 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. One prominent analysis is that a full underlying embedded *wh*-question is generated and the *wh*-phrase moves to Spec,CP of the matrix clause. This would be analogous to the formation of standard *wh*-questions, except that a sluicing rule deletes the remainder of the embedded clause, i.e. the embedded TP, and any structure below it, as in (4a) (Merchant, 2001; Ross, 1969). The second group of analyses does not implicate movement. Under such approaches, the full *wh*-question is not present in the syntactic derivation. Instead, operations are posited at the level of interpretation, LF. Within this group, some analyses posit minimal structure at the ellipsis site, such as a null pronoun, as in (4b) (e.g. Hardt, 1993;

[1] Sugisaki (2016) also looked at Japanese children's comprehension of a construction which is similar, though not identical to English sluicing, in which the sluice is derived from a cleft construction in which the CP subject of the cleft has been elided (e.g. Saito, 2004).

Chung et al., 1995), and some posit no structure at all, as in (4c) (e.g. Culicover & Jackendoff, 2005).

(4) a. Someone is drawing a flower, but I can't see who$_i$ < t_i is drawing a flower>.
b. Someone is drawing a flower, but I can't see who *pro*.
c. Someone is drawing a flower, but I can't see who.

The competing analyses of sluicing make different predictions about children's acquisition of these structures. If we posit a structured ellipsis site involving *wh* extraction, as in (4a), children should show an asymmetry, performing worse on object-extracted sluices than on subject-extracted sluices. On the contrary, if no movement (or structure) is involved, children should perform similarly on both. One of the goals of this study is to provide evidence relevant to the 'movement/no-movement' debate from child data.

Additionally, assuming an identity condition, as outlined above, children must recover the antecedent of the ellipsis site. Our study also aims to investigate children's ability to recover the elided verb and argument(s).

2. Experimental study

2.1. Subjects

We tested 40 English-speaking children aged 3;0-6;11 (M = 5;3), 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.

2.2. Materials and Procedure

In a '*wh*-question task' modeled after a truth-value judgment task (Crain & McKee 1985) children were shown an image on a screen. A computer-simulated puppet commented on what she could see and then asked a question about what the child could see. There were six training items and 29 trials consisting of 15 sluiced sentences, and 14 unsluiced control *wh*-questions.

There were three different conditions. Condition 1, e.g., (5a), was used to correct for the potential confound in Lindenbergh et al.'s (2013) study by testing the "two-clause strategy", interpreting (5a) as (5b). In this condition, we used intransitive verbs, and images contained two characters, one performing the action described in the sentence, and one standing or sitting. Figure 1 was used to elicit a 'yes' answer for (5a), Figure 2, was used to elicit a 'no' answer for (5a).[2]

[2] 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 answer as correct if they pointed to the appropriate character on the screen.

(5) 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?

Figure 1. 'Yes' scenario for (5a)

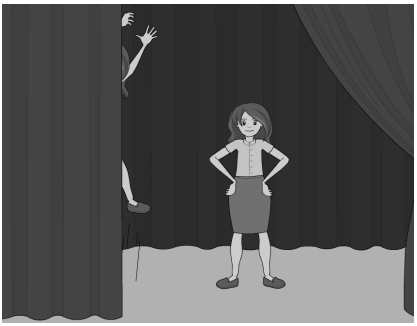

Figure 2. 'No' scenario for (5a)

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 (6a). Figure 3 was used to elicit a 'yes' answer, Figure 4, was used to elicit a 'no' answer. However, if verb identity is not obeyed, (6a) could receive the non-adult-like interpretation in (6b), in which case, Figure 4 would elicit a 'yes' response.

(6) 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>?

Figure 3. 'Yes' scenario for (6a)

Figure 4. 'No' scenario for (6a)

An example object sluice test trial is given in (7a). Figure 5 was used to elicit a 'yes' answer, Figure 6, was used to elicit a 'no' answer. Again, if verb

identity is not obeyed, (7a) could receive the non-adult-like interpretation in (7b), in which case, Figure 6 would elicit a 'yes' response.

(7) 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 _>?

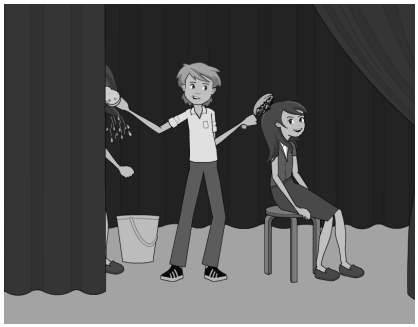

Figure 5. 'Yes' scenario for (7a)

Figure 6. 'No' scenario for (7a)

Condition 3 tested argument identity. We 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 allowed a sentence like (8a) to have the non-adult-like interpretation in (8b), which would incorrectly elicit a 'yes' response given Figure 8.

(8) 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>?

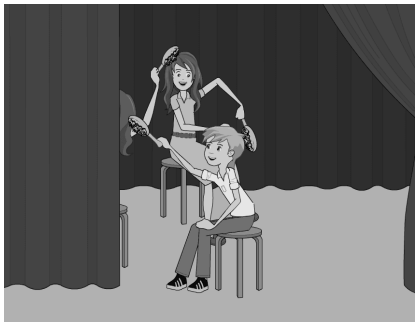

Figure 7. 'Yes' scenario for (8a)

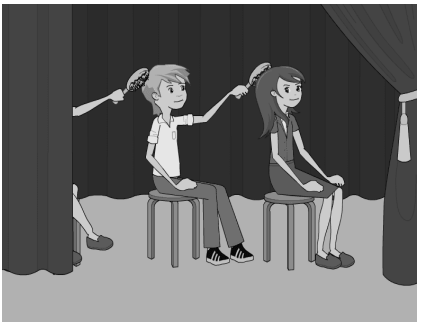

Figure 8. 'No' scenario for (8a)

An example object sluice is given in (9) and the relevant pictures are in Figures 9 and 10.

(9) 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 _>?

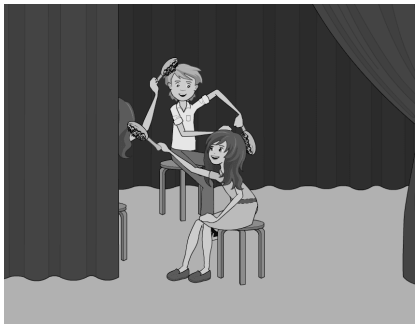

Figure 9. 'Yes' scenario for (9a)

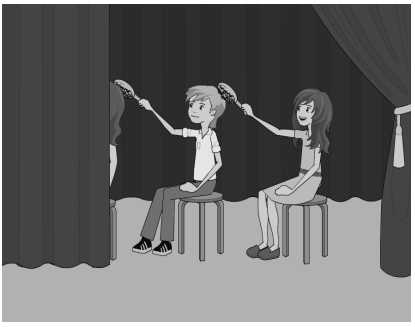

Figure 10. 'No' scenario for (9a)

The controls were also divided into three conditions. Condition 1 controls were full *wh*-questions with identical intransitive verb and argument, (10a). Conditions 2 and 3 were full subject and object *wh*-questions with mismatched verb (10b) and argument (10c). These mismatched controls ensured that children were paying attention to both clauses and not just to the first clause.

(10) 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?

All the items were pre-recorded by a phonetically trained native English-speaker in order to control for potential differences in intonation.

2.3. Results and Discussion

The 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. Given their near perfect score on the Condition 1 sentences we know that children are not relying on a "two-clause strategy", a confound in the Lindenbergh et al. results. 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 children 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 four- to six-year-old children respect the identity condition and do not allow for verb or argument mismatches. Thus, our results seem to replicate those of Lindenbergh et al.'s (2014).

Table 1. Results of the *wh*-question task by Condition.

	CONTROLS			**SLUICES**		
	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%**		

In order to investigate the precise predictive value of each variable we manipulated, we ran a linear mixed-effects model with Age (3, 4, 5, 6), Condition (1, 2, 3), TrialType (Control, Sluice), Construction (Subject, Object) as Fixed Effects, and Subject and Verb as Random Intercepts. Importantly, we found that TrialType (Control vs. Sluice) did *not* contribute significantly to the model fit ($\chi^2(1) = 2.84, p = 0.09$). Children did just as well on the full *wh*-question controls as on the sluices. However, and crucially to us, Construction (Subject vs. Object) ($\chi^2(1) = 21.61, p < 0.001$) did contribute significantly to the model fit; that is, children did significantly better on the subject-extracted constructions than on the object-extracted constructions. Age ($\chi^2(1) = 14.96, p < 0.001$) and Condition ($\chi^2(1) = 5.71, p = 0.02$) also contributed to the model fit.

Interestingly, we found that in the control condition alone, children showed a trend, but no significant difference in performance between the subject and object *wh*-questions, $F(1, 36) = 3.15, p = .085$, Figure 11.

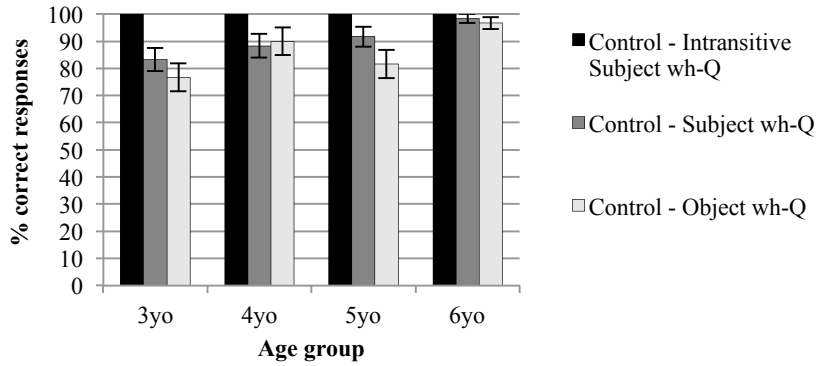

Figure 11. Results of the *wh*-question task in the control trials by age.

However, in the sluice conditions children performed significantly worse on the object sluices than the subject sluices, $F(1, 36) = 11.39$, $p = .002$, Figure 12.

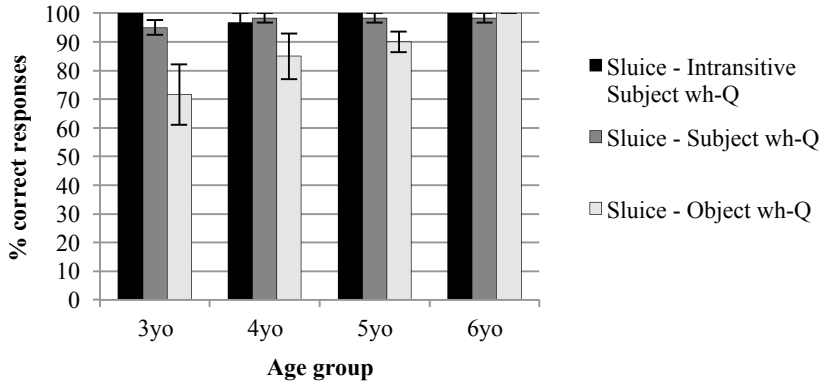

Figure 12. Results of the *wh*-question task in the sluice trials by age.

The subject>object asymmetry in the sluicing conditions supports the hypothesis that children (like adults) derive sluices via *wh*-extraction, showing intervention effects as observed in other kinds of movement constructions. Our acquisition results provide novel support for syntactic analyses that posit movement (e.g. Merchant 2001), and against various semantic treatments that do not postulate movement (e.g., Culicover & Jackendoff, 2005). We hypothesize that a 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. In other words, children do not have much difficulty with simple object *wh*-questions by age 3, i.e. the control trials. However, the sluicing operation (representing the elided TP) *coupled* with the A'-movement operation across an

intervener may exceed their computational resources until they are approximately 6 years old.

3. Corpus study

We followed up with a corpus study to see whether, and at what age, children produce sluices. We included all 51 American English CHILDES corpora (MacWhinney, 2000). We then used CLAN to search for certain verbs that typically appear in sluiced constructions (*know, say, see, tell, guess, remember*) that were immediately or otherwise followed by a *wh*-phrase (*who, what, which, where, when, why, how, how much/many*). 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 tell the extraction site.

As expected, subject sluices (11) appear earlier than object sluices (12):

(11) a. MOT: *I don't know what happened.*
CHI: *You never know what.* (2;4)
b. MOT: *I wonder who put it up there.*
CHI: *I know who.* (3;5)

(12) a. MOT: *Tell daddy what you did in school today.*
CHI: *Do you know what?* (2;8)
b. ADU: *What are we gonna do with the sheep?*
CHI: *I know what.* (3;11)

However, as shown in Table 2, children produce many more object sluices than subject sluices (as do adults do), in contrast to our comprehension data, which showed better performance on subject sluices vs. object sluices.

Table 2. Results of the corpus study by construction.

	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

This discrepancy 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 produce all have animate subjects and inanimate objects, i.e., a mismatch in animacy features, Table 3.

Table 3. Corpus results by animacy features in children.

	[+ animate] subject			**[-animate] subject**		
	[+ani] O	**[-ani] O**	**No O**	**[+ani] O**	**[-ani] O**	**No O**
Subject sluices	**2**	**2**	0	0	0	2
Object sluices	**0**	**18**	N/A	0	0	N/A

By contrast, in our comprehension study both subject and object were animate. This suggests that the match in animacy features induced a strong(er) intervention effect, and hence poorer performance on the object sluices. In production, however, intervention is circumvented due to the mismatch in animacy features, allowing for object sluices. This is not surprising. Previous studies have shown that animacy mismatches facilitate children's comprehension (Adani et al., 2017; Bentea et al., 2016; Brandt et al., 2009; Corrêa, 1995; Durrleman et al., 2015; Philip et al., 2001) as well as adults' processing (Atkinson et al. 2016; Fanselow et al. 2011) of A'-dependencies.

A reasonable follow-up question would be to ask what these data say about the role of input frequency. We note first that the subject advantage in comprehension cannot be a frequency effect. As shown in Table 2, adults produce more object sluices than subject sluices. Moreover, we only found *one* adult production of a subject sluice with an [+animate] subject and a [+animate] object, as shown in Table 4, yet children performed at ceiling in this condition (Figure 12). Therefore, our comprehension results support a structural account.[3]

Table 4. Corpus results by animacy features in adults.

	[+ animate] subject			**[-animate] subject**		
	[+ani] O	**[-ani] O**	**No O**	**[+ani] O**	**[-ani] O**	**No O**
Subject sluices	**1**	**9**	6	0	0	2
Object sluices	**5**	**26**	N/A	0	1	N/A

[3]The preponderance of object sluices in production seems to reflect the higher frequency of such sluices the input, mediated by intervention such that only sluices with mismatching features occur.

We thus predict that children will perform better in a comprehension task with object sluices if there is a mismatch in animacy features between the subject and the object. We are currently testing this prediction. Finally, we also predict that as children get older, they will become less sensitive to intervention effects in A'-movement, and will behave more like adults (see Frazier & Clifton, 1998; Harris, 2015, Lawn & Harris, 2017).

4. Conclusions

This study investigated children's acquisition of sluicing in English. We found that by age three, 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 did find children performed significantly better in sluiced subject *wh*-questions than sluiced object *wh*-questions. We hypothesize this is due to intervention effects similar to those found in other A' constructions, providing evidence for a structured TP at the ellipsis site. Our corpus study additionally provided evidence for the active role of that the [animacy] feature plays in intervention in sluices as well. This study thus contributes to theories on the acquisition of ellipsis and also to the theoretical debate about the syntactic status of sluicing.

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