**Adjunct control and the poverty of the stimulus:**

**availability vs. evidence**

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Subject control in non-finite adjuncts is observed across languages (as in 'John called Mary before running to the store'). Research on the acquisition of adjunct control has generally focused on the relevant grammatical components and when they are acquired. This paper considers these components in the context of the linguistic input to ask how control in adjuncts is acquired.

Although adjunct control is available in the input, the instances themselves do not provide evidence for abstract syntactic relations. Implications are considered for linguistic dependencies and the evidence in the input.

## 1. Introduction

This paper focuses on obligatory control in non-finite adjuncts, as in (1):

(1) $John_1$ called $Mary_2$ after $PRO_{1/*2/*3}$ drawing a picture.

In particular, adjunct control is used as a case study for the role of the linguistic input in acquiring dependencies: while some properties of adjunct control are observed across languages, others are language-specific. Additionally, exceptions to canonical control structures raise questions about the type of information needed from the input.

In (1), the adjunct subject PRO is obligatorily controlled by the main clause subject *John*. This pattern is observed across languages, and is captured by high attachment of the adjunct clause and c-command by the controller (Chomsky, 1981).[1] Therefore, evidence for these features must be available in the linguistic input or they must be innate (Chomsky, 1965).

The goal of this paper is to evaluate these features and their predictions for the linguistic input, and the primary question is how the features of obligatory control are acquired. As abstract features, they cannot be observed directly. Therefore, if evidence is available in the input then this evidence must be inferred from observable features or patterns in the input. For example, this inference may be possible based on the context or distribution of the surface features (Pullum & Scholz, 2002; Scholz & Pullum, 2006; Ambridge et al., 2008; Ambridge, 2019; Tomasello, 2009; Regier & Gahl, 2004; Perfors et al., 2011; Pullum, 2020, i.a.), or on

[1] This paper is based on these components, but may also be considered in the context of other frameworks; importantly, adjunct control involves a locality constraint which is structurally defined. This constraint is the focus of this paper.

frequencies of n-grams that make up a complex structure (Pearl & Sprouse, 2013b, 2013a; Pullum & Scholz, 2002; Mintz et al., 2002).

For adjunct control, this question depends on the availability of adjunct control in the input, children's perception of the input, and the relevant form of evidence for the abstract features of control. If evidence is available for attachment height and the c-command dependency, this evidence may be observed in sentences with adjunct control, specifically; alternatively, the features may be generalized from other structures. However, if evidence is not available in the input, then some aspects of these features must be innate (i.e. specified in Universal Grammar, or UG), and evidence is needed for language-specific aspects of the dependency.

These factors are considered for adverbial adjuncts like (1) with obligatory control.[2] The analysis is based on a critical review of predictions from previous studies, with support from novel corpus data. Importantly, while the input does include sentences with adjunct control, it does not provide evidence for the abstract components of adjunct control, i.e. attachment height and a c-commanding controller. This includes both direct evidence (from observing instances of adjunct control in the input) and indirect evidence (by generalizing from similar structures).

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[2] These are the most frequently used adjuncts in previous acquisition studies. Other adjuncts with obligatory control are not discussed in this paper (e.g. rational clauses, purpose clauses, telic clauses), although the paper's conclusions have broader implications for control in general.

If attachment height and c-command are innate, this makes further predictions about the linguistic input. Finally, implications are considered for the acquisition of non-obligatory control, linguistic dependencies in general, and the role of evidence in the input.

## 2. What is evidence?

The primary question of this paper is how control in adjuncts is acquired. The following sections consider two preliminary issues: first, evidence for adjunct control must be available in the input; and second, children must be receptive to this evidence when they encounter it.

This raises the question, what kind of input constitutes evidence for adjunct control? Attachment height and c-command cannot be observed directly; therefore, the availability of adjunct control in the input does not equate to evidence in the input. Additionally, this question *cannot* be answered solely by observing children's behavior, either in naturalistic productions or in an experimental context: although children's behavior can be indicative of their linguistic knowledge, it does not reveal how that knowledge is acquired. At the same time, children's perception of the input depends on their linguistic knowledge: for example, a child with a non-adult

grammar will access non-adultlike interpretations of the input; this has consequences for the evidence that's needed for the adult grammar.

The above issues therefore depend both on external factors – here, the syntactic structures in the input – and internal factors – the grammatical competence needed for interpreting the input. These factors are discussed in the following sections.

## 2.1 *Considerations for the input*

If evidence for adjunct control is available in the input, then the relevant input will depend on several factors. First, the timeframe for the input is determined by the ages when a child is receptive to the evidence. Next, the relevant input within this timeframe depends on the source of the evidence. Also important is the signal to noise ratio, with multiple sources of noise to consider.

### *2.1.1 The input: timeframe*

In previous studies, children have showed non-adultlike behavior for adjunct control at age 4, but were generally adultlike by age 7 (Goodluck, 1981; Hsu et al., 1985; Goodluck & Behne, 1992; Janke & Bailey, 2017;

Janke & Perovic, 2017; Janke, 2018). Therefore, evidence for the adult grammar must be available before this.

Meanwhile, a lower limit may be considered based on prerequisite knowledge and parsing capacity (Sutton, 2015). For example, evidence for attachment height requires a distinction between arguments and adjuncts, while a c-commanding controller assumes hierarchical structure and involves the deployment of binding relations. Additionally, identifying control in non-finite (rather than finite) adjuncts involves language-specific realization of tense.

Children are sensitive to argument structure by 24 months (Naigles, 1990; Gertner et al., 2006; Arunachalam et al., 2011; for a review see Fisher et al., 2010); if this is indicative of a distinction between arguments and adjuncts, then evidence may be available for some properties of adjunct control at this age. Moreover, some binding relations may be computed by 30 months (Lukyanenko et al., 2014; Sutton et al., 2012). However, evidence may also be limited by children's parsing capacity at a given age. For example, even when binding is available within clauses, cross-clausal binding relations may not yet be a reliable source of evidence.

In general, if evidence is available for adjunct control in the input then it should be available before age 7, but a lower limit will depend on the form of the evidence: more salient, early-acquired forms like tense are likely to be available earlier than more complex elements of control, like binding relations. As a tradeoff, complex elements may provide more information

about abstract features than the early acquired forms. Either way, this evidence must be provided by a reliable source in the input.

### *2.1.2 The input: sources of evidence*

This paper is concerned primarily with evidence in the linguistic input. Importantly, this is not the same type of evidence that is provided by an experiment for testing children's knowledge. This second type of evidence – experimental evidence – is based on children's behavior, and can be used by researchers to make inferences about children's grammatical knowledge at the time of testing.

Meanwhile, evidence in the input is used by children to acquire the adult grammar. This evidence is therefore not based directly on children's behavior, and does not allow for direct inferences about children's knowledge. However, since children's experience of the input depends on their grammatical knowledge, experimental evidence can help to identify a potential mismatch between the input and children's perception of the input – i.e. the linguistic *intake* (Lidz & Gagliardi, 2015; Omaki & Lidz, 2015); this mismatch can have implications for the evidence in the input (discussed further below).

Another relevant contrast is between children's own productions and the input that they receive (from caretakers, sibling, etc.). Like experimental evidence, children's productions may be used to make inferences about their

grammatical knowledge; for example, if children produce only adultlike utterances at a given age, this is likely evidence that children have acquired the adult grammar by that age.

In contrast, evidence in the input occurs in speech *to* children. Therefore, for a given child, the relevant evidence for adjunct control will not depend on their own utterances.

### *2.1.3 The input: signal to noise*

Before moving on to internal factors, a final external consideration is the noise in the input from extragrammatical sources (Lidz & Gagliardi, 2015; Omaki & Lidz, 2015; Phillips, 2013; for a review, see Pearl, 2019). In addition to children's grammatical competence, important factors include speech errors in the input and parsing errors in the intake, with implications for input frequency and the relative contribution of a single instance.

While non-adult interpretations are expected from a non-adult grammar, errors may also be observed for adjunct control with the adult grammar, due to extra-grammatical factors (Parker et al., 2015; Kwon & Sturt, 2014; Kush & Dillon, 2020; Gerard et al., 2017). For example, speech errors like disfluencies may disrupt encoding of the input (Banbury et al., 2001), while a non-subject antecedent of PRO will introduce noise for adjunct control, specifically.

In addition, noise is likely to result from the deployment of immature parsing mechanisms, independent of children's grammatical knowledge. For sentences with adjunct control, the antecedent of PRO must be retrieved from memory; however, a similar referent in memory can interfere with the retrieval mechanism (Gordon et al., 2001, 2004; Warren & Gibson, 2002, 2005; Gordon et al., 2006; for a review, see Gordon & Lowder, 2012). This interference may occur for any grammar (adultlike or non-adultlike), and the resulting interpretation may be consistent or inconsistent with the child's grammar.

If an interpretation in the intake is inconsistent with the adult grammar, this is a problem: such an interpretation should be taken as evidence against the adult grammar (Belletti, 2017; Pearl, 2019). To avoid this conclusion, a learning strategy is needed which can filter the input, depending on the likelihood of a parsing error in the intake (Perkins et al., 2017). For any single utterance in the input, this likelihood is non-zero, with a higher likelihood of a parsing error for more complex utterances (Boyle & Coltheart, 1996). As a result, the relevant evidence may also require multiple observations.

This strategy is important for adjunct control, since a single observation in the input may be inconsistent with the adult grammar in the intake. Consequently, the relative frequency of adultlike interpretations must be high enough to override the non-adultlike ones, regardless of how they arise (non-adult grammar, speech error, or parsing error). A further

implication of this strategy is that a single observation is not sufficient for acquiring the adult grammar. This also avoids a transition to a non-adult grammar for every non-adult observation in the intake.

This section has discussed several considerations for adjunct control in the input. If evidence is available in the input, it is expected within a certain timeframe, from an external source (rather than the child themself), and at a high enough frequency to override expected noise in the input. These factors are important for determining the availability of evidence. In addition to availability, however, children must also be receptive to this evidence to acquire the adult grammar.

## 2.2 *Considerations for grammatical competence*

Previous studies on children's acquisition of adjunct control have generally used sentences with a structure like in (1), repeated below:

(1) John$_1$ called Mary$_2$ after PRO$_{1/*2/*3}$ drawing a picture.

Importantly, there are two animate antecedents in the main clause, both of which are a semantically plausible antecedent for PRO (Goodluck, 1981; Hsu et al., 1985; McDaniel et al., 1991; Goodluck & Behne, 1992; Cairns et al., 1994; Broihier & Wexler, 1995; Adler, 2006; Janke & Bailey, 2017;

Janke & Perovic, 2017; Gerard et al., 2017, 2018; for a review see Janke, 2018).

This isolates children's syntactic knowledge as the source of their interpretation:[3] in (1), the adult grammar identifies the main clause subject as the antecedent of PRO; however, for a non-adult grammar which does not rule out the main clause object as an antecedent, (1) is ambiguous since there are multiple plausible antecedents. That is, a non-adult grammar of adjunct control can generate an adultlike (subject control) interpretation of (1), or a non-adultlike (object control) interpretation.

In previous studies on adjunct control, children have allowed both adultlike and non-adultlike interpretations of (1). This is consistent with a non-adult grammar which generates both interpretations. However, with a non-adult grammar, evidence is required at some point for the adult grammar. Importantly, this evidence must be available not only in the linguistic input, but also in the *intake*.[4]

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[3] See work by Janke (2017; 2018) and Gerard (2017, 2018) for pragmatic and extragrammatical sources of children's interpretations.

[4] One concern with sentences like (1) is that both plausible antecedents are sentence-internal, making the sentence ambiguous for a non-adult grammar that allows object control. In contrast, the following sentences have just one plausible sentence-internal antecedent:

(i) $\text{John}_1$ called a $\text{taxi}_2$ after $\text{PRO}_{1/*2/*3}$ drawing a picture.
(ii) $\text{John}_1$ called after $\text{PRO}_{1/*2}$ drawing a picture.

These sentences make contrasting predictions for different grammars: with a non-adult grammar that allows any internal antecedent for PRO, but not an external antecedent, (i) and (ii) may be disambiguated based on plausibility alone. However, a grammar which does allow external antecedents, i.e. a free reference grammar, may still generate a non-adultlike interpretation for (i) and (ii), if another referent is available in the discourse.

The fact that a non-adult grammar generates non-adultlike interpretations presents a puzzle: for adjunct control in the input, if children have a non-adult grammar, then they will access both adultlike *and* non-adultlike interpretations, as in previous experimental contexts (Wexler, 1990).

Another consideration, however, is that the antecedent of PRO is a realization of the abstract features of control, i.e. attachment height and c-command by the controller. In previous studies, children's interpretations were non-adultlike if they identified a non-subject antecedent of PRO; accordingly, non-adult grammars have been proposed with the incorrect attachment height (Goodluck, 1981; Hsu et al., 1985; McDaniel et al., 1991; Cairns et al., 1994; Adler, 2006) or an immature representation of the control relation (Goodluck, 2001; Goodluck & Behne, 1992; Broihier & Wexler, 1995; Wexler, 2019). Evidence for the adult grammar would therefore relate to attachment height or the correct control relation, respectively.

These features cannot be observed directly, so this evidence must be available indirectly, from observable features of the input. Additionally, the evidence must be robust to children's non-adultlike interpretations – that is,

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In previous studies, children who accepted a non-adultlike internal antecedent also tended to accept an external antecedent for PRO, consistent with a free reference grammar (McDaniel et al., 1991; Cairns et al., 1994; Broihier & Wexler, 1995; Adler, 2006). Therefore, if children need evidence for the adult grammar of adjunct control, this evidence must be available even with the interpretations allowed by a free reference grammar, i.e., with any referent in the discourse.

a non-subject antecedent must not interfere with evidence for the adult grammar. Evidence for the adult grammar must therefore involve other features of adjunct control, instead of (or in addition to) the antecedent of PRO.

In this section, several issues have been considered for the linguistic input, as well as children's perception of the input. These have implications in general for the relevant input where evidence would be observed, and the form of evidence for the adult grammar. The next sections consider these implications for adjunct control, focusing first on the availability of adjunct control in the input, followed by evidence in the input.

## 3. Availability

The linguistic input is represented here by transcripts of speech to children from CHILDES (MacWhinney, 2000). The analysis included all transcripts from the North American English corpus[5], with the exception of transcripts from children older than age 7 as discussed above, and transcripts with interviews between a parent and interviewer with no child present.

[5] All transcripts from the following corpora: Bates, Bernstein, Bloom, Braunwald, Brent, Brown, Clark, Garvey, Gathercole, Gelman, Gleason, Hall, HSLLD, Kuczaj, MacWhinney, Morisset, Nelson, NewEngland, NewmanRatner, Peters, Post, Sachs, Snow, Soderstrom, Suppes, Tardif, Valian, VanKleeck, and Weist

Instances of adjunct control were identified by searching for each complementizer followed by the string "ing" (Broihier & Wexler, 1995). Non-finite complementizers included in the search were *after, before, while, when, without,* and *instead of,* which were then hand coded to exclude false positives (e.g. "what happens after spring"). The results for each complementizer are presented in Table 1, which shows the number of utterances with adjunct control in the input (adult), and the number produced by the target child.

| **complementizer** | **adult** | **target child** |
|---|---|---|
| after | 35 | 5 |
| before | 31 | 1 |
| while | 11 | 3 |
| when | 5 | 3 |
| without | 128 | 26 |
| instead of | 121 | 23 |
| **Total** | **331** | **61** |

Table 1. Adjunct control in North American CHILDES, raw counts

Based on these counts, the following observations can be made for adjunct control in this timeframe:

- Adjunct control is available in the input before age 7.

- Children produce adjunct control before age 7.
- The instances with *without* and *instead of* are much more frequent than with *after, before, while* and *when,* for both children and adults; this contrast reflects the optionality for the lower frequency set of complementizers between a non-finite or finite frame, compared to *without* and *instead of,* which can only appear in a non-finite frame:

(2) a. John called Mary $\left\{\begin{matrix}\text{after}\\ \text{before}\\ \text{while}\\ \text{when}\end{matrix}\right\}$ PRO drawing a picture.

b. John called Mary $\left\{\begin{matrix}\text{after}\\ \text{before}\\ \text{while}\\ \text{when}\end{matrix}\right\}$ he drew a picture.

(3) a. John called Mary $\left\{\begin{matrix}\text{without}\\ \text{instead of}\end{matrix}\right\}$ PRO drawing a picture.

b. *John called Mary $\left\{\begin{matrix}\text{without}\\ \text{instead of}\end{matrix}\right\}$ he drew a picture.

Therefore, adjunct control is available in the input, and children are sensitive to at least some aspects of the dependency, particularly the respective frequency by complementizer.

Meanwhile, the counts in Table 1 do not illustrate the frequency of the utterances with adjunct control compared to other utterances in the input, or the distribution of these counts over time (Gries, 2008, 2010; Wang &

Trueswell, 2019). This information is represented in Figure 1, which plots children's and adults' utterances with adjunct control by two measures of development: children's age in years and children's mean length of utterance (MLU). These measures are correlated, although in children's own productions, adjunct control is better predicted by MLU than by age. To illustrate the frequency of these utterances, Figure 1 also shows all transcripts in the corpus plotted by the age and MLU of the target child; a mean of 341 utterances were produced in each transcript.

Importantly, adjunct control is available in the input at all ages, although at a relatively low frequency throughout: from the ages of 2-5 years, children encounter one utterance with adjunct control for every 2,000-3,000 utterances. For comparison with other complex structures, this less than 10% of the frequency of passive constructions (Nguyen & Pearl, 2018, 2019), which in turn are less frequent than object relative clauses (Roland et al., 2007).[6] That is, adjunct control does occur in the input, but at a lower frequency than other structures for which non-adultlike behavior is reported at similar ages (for reviews, see Huang et al., 2013; Adani et al., 2017).

[6] In an analysis of the Brown and Valian corpora, Nguyen & Pearl (2018, 2019) reported 361 passive utterances in 113,024 total utterances, or 1 passive for every 313 utterances. Meanwhile, Roland et al (2007) reported even greater raw counts for object relative clauses in the Brown corpus alone, with 608 object relatives, 1,460 reduced object relatives, and 658 object infinitive relatives.

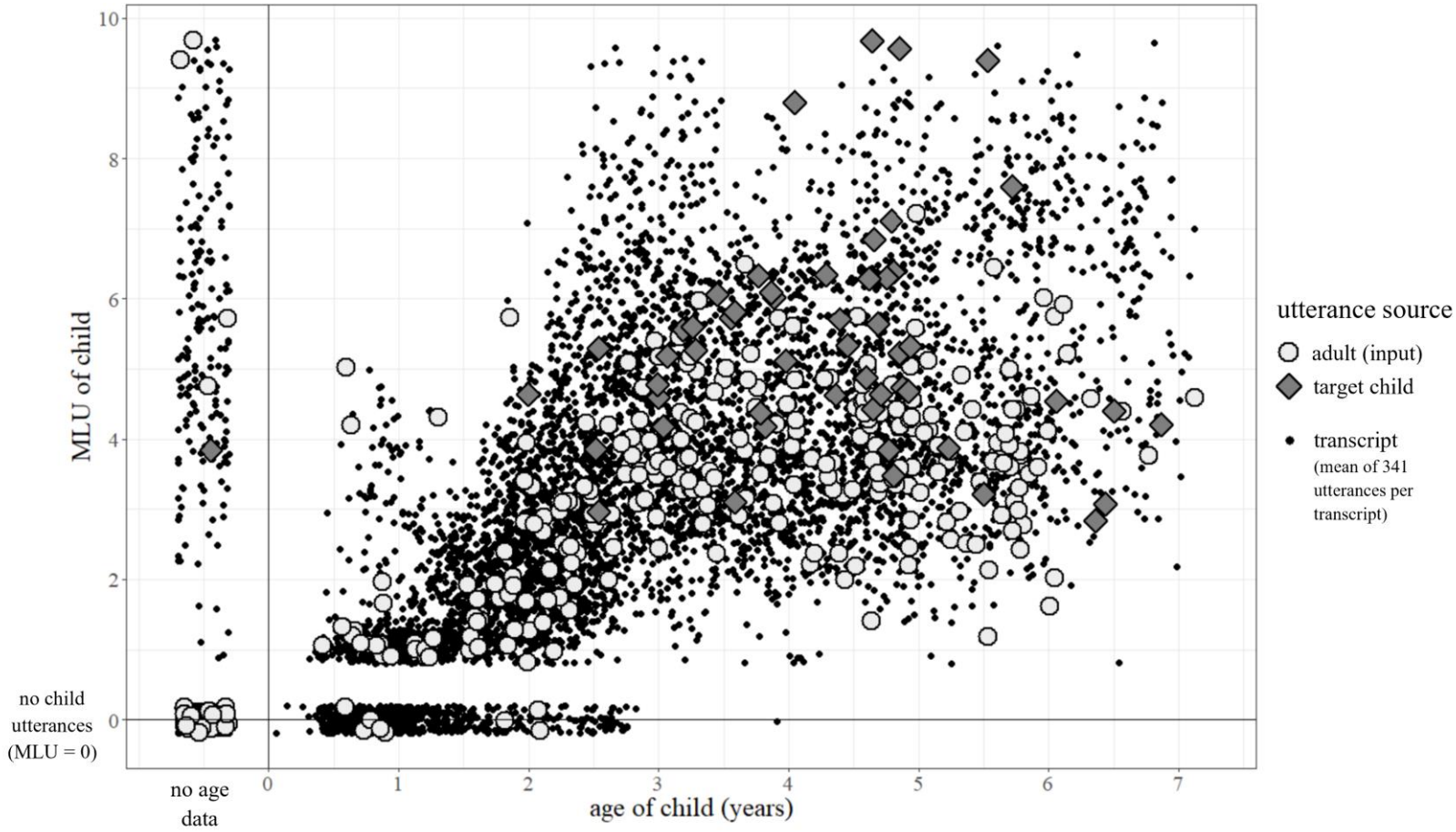
MLU of child
10
8
6
4
2
0
no child utterances (MLU = 0)
no age data
0
1
2
3
4
5
6
7
age of child (years)
utterance source
adult (input)
target child
transcript
(mean of 341 utterances per transcript)

Figure 1. Instances of adjunct control in the input (produced by adults and siblings of the target child), and instances produced by the target child, plotted by age and mean length of utterance (MLU) of the target child. For comparison with the overall of utterances in the input, each transcript is plotted as a single point, also by age and MLU of the target child, with a mean of 341 utterances produced in each transcript.

Next, sentences with adjunct control are generally produced by children with an MLU of at least 4 (with the earliest productions between the ages of 3 and 4). This shows that children produce the relevant non-finite contexts far younger than age 7; however, children's non-adultlike behavior in previous studies was determined based on interpretation (of the antecedent), rather than form (of the non-finite adjunct). Therefore, evidence in the input may also depend on the availability of subject control, compared to other antecedents.

To assess this availability, the utterances from Table 1 were hand coded for the antecedent of PRO. In addition to subject control, possible antecedents included the following categories (Wexler, 1992; Goodluck, 2001; Williams, 1992; Landau, 2015, 2017; Green, 2018a):

- a non-subject antecedent in an otherwise expected subject control context, e.g. *Mary* in (1)

- arbitrary PRO, as in (4)
- logophoric PRO, as in (5)
- an unclear antecedent – although this could be resolved in most cases by referring to previous discourse, this was not possible in a few cases when the utterance wasn't coherent, or when the speaker switched topics in the conversation before completing the utterance

(4) It was good to call after PRO drawing a picture.

(5) The flower wilted after PRO drawing a picture of it.

Of the 392 utterances with adjunct control from Table 1, nearly all had a subject control interpretation. The instances which did not are presented in Table 2 (input utterances) and Table 3 (target child's utterances):

| **child age (years)** | **PRO referent** | **utterance** |
|---|---|---|
| 1 | arb | that would be a good way to get <to things>. instead of reaching. |
| 2 | arb | I have a good rule that we have at school. to raise our hand instead of yelling. |
| | unclear | without finishing it. |

| | | |
|---|---|---|
| | unclear | <look up Hannah's girl> nothing without spelling anything. |
| 3 | non-subject | I thought we could give her some tea before going to bed from this pretty little tea pot. (from discourse, PRO clearly refers to “her”) |
| | logophoric | so it won't fall down without tying it to your chin. |
| | unclear | after (.) sliding though. |
| 4 | unclear | &-um when you're here alone with, when you, after reading the four seasons get him to just tell me for a few minutes about something that you did and then we'll do the same thing with Jake. |
| | unclear | eleven o'clock at night after sitting up in bed for two and three hours. |
| | unclear | even after being here all this time. |
| | unclear | maybe after (.) coming back xxx. |
| 5 | logophoric | an(d) I knew that if anyone would takes this home it would take up too much room, so it would be easier to carry without dropping. |
| | arb | going three days without making a juice circle really blew your mind. |
| | arb | humming while eating noodles. |
| | arb | there's no <breaking> without breaking. |
| | arb | it helps to show that maybe these are muscles. without having to draw all the in, all the muscles |

there.

Table 2: adjunct control with non-subject antecedent, input utterances

| child age (years) | PRO referent | utterance |
|---|---|---|
| 2 | unclear | and after playing +... with with all my |
| 3 | non-subject | yeah but when trying to catch daddy (.) daddy put me under the water. |
| | arb | instead of eating a lot (.) that would be good. |
| 5 | logophoric | (in)stead of walking, car is better going to school. |
| | arb | and [/] and that was the most impor^portant [: important] [* d] job instead of doing the prayer. |
| | arb | there's [<] no making [>] without breaking. |
| | unclear | without catching. |
| | unclear | maybe after (.) coming back xxx. |
| 6 | arb | that's what's fun about xxx looking out the window without having to be driving. |

Table 3: adjunct control with non-subject antecedent, target child's utterances

The utterances in Table 2 demonstrate that non-subject antecedents occur in the input, both due to speech errors, and also in non-obligatory control constructions. In children's own productions in Table 3, the counts of these

categories occur in similar proportions. Further conclusions from Tables 2 and 3 are limited, however, before considering the evidence that would be available from observations with obligatory control, or other forms of evidence in the input. This evidence is the focus of the following sections, which consider the following hypotheses:

(a) evidence for attachment height and c-command is available in the input, either
    i. by observing instances of adjunct control directly or
    ii. by generalizing the relevant features from similar structures.

(b) evidence for these features is not in the input, and the features are specified in UG.

## 4. Evidence

If either attachment height or c-command by the controller are acquired from the linguistic input, then explicit predictions are made about the evidence in the input. Two types of evidence will be considered here: first, the conditions are spelled out for inferring the correct attachment height or c-command by observing instances of adjunct control directly. Next, these

features may be generalized to adjunct control from similar structures, which may be more frequent or salient in the input.

### 4.1 *Direct observation*

For attachment height or c-command to be inferred by observing instances of adjunct control, there must be instances of adjunct control available in the input. Based on the CHILDES data in §3 above, this requirement is satisfied. However, while adjunct control is necessary, it is not sufficient; other factors to consider include the prerequisite linguistic knowledge and children's perception of the input. These factors are discussed in the following sections.

#### *4.1.1 Attachment height*

If children need evidence for adjunct attachment height, then incorrect attachment is predicted before the relevant evidence is encountered in the input. During this stage of incorrect attachment, non-adultlike interpretations are predicted for adjunct PRO.[7] Indeed, children in previous

[7] Crucially, this is not reversable: if children have non-adultlike attachment, then non-adultlike interpretations of PRO are expected. However, if children have non-adultlike interpretations of PRO, this does *not* entail that they have attached the adjunct incorrectly - this is one possibility, among others.

studies have accepted a range interpretations, and one prominent account is misattachment of the adjunct to the main clause (Goodluck, 1981; Hsu et al., 1985; McDaniel et al., 1991; Cairns et al., 1994; Adler, 2006). Two primary forms of evidence have been considered for attachment height in previous studies, which make different assumptions about children's pre-existing knowledge.

#### 4.1.1.1 Lexical learning (Cairns et al., 1994)

To account for children's behavior, Cairns et al (1994) propose different non-adult grammar types, which predict non-adultlike interpretations before children acquire the adult grammar. These grammar types involve high attachment of the adjunct to the main clause (coordination) or low attachment (with c-command by the main clause object). Here, an important distinction is made between types of accounts: these non-adult grammar types can explain children's *behavior* in the study; however, the grammar types alone do not provide an account of *acquisition* - i.e. how a learner can transition from a non-adult grammar to the adult grammar.

To account for children's acquisition, Cairns et al (1994) cite the Lexical Learning Hypothesis (Wexler & Chien, 1985), noting that children must link each complementizer form with its selectional properties. They suggest that incorrect attachment results from mapping a complementizer

form first to a coordinating structure, before acquiring the correct mapping for a non-finite adjunct. Evidence for the correct attachment would therefore be available with any instance of a given complementizer (not just as a non-finite adjunct), with the transition to the adult grammar resulting from "accretion of lexical and semantic knowledge" for each complementizer (Cairns et al., 1994, p. 264).

This description accounts for the transition to the adult grammar; however, it does not involve the acquisition of syntactic structure. It assumes instead that children already have the relevant abstract knowledge of coordination and subordination, with incorrect form-structure mappings. If adjunct attachment height is assumed as preexisting knowledge, then another source of evidence is needed for attachment height, or it is innate.

#### 4.1.1.2 Adjunct misanalysis (Adler, 2006)

In a different misattachment account, Adler (2006) suggests that the syntactic contrasts between non-finite adjuncts and coordinated clauses may be used as cues to attachment height. For example, the verb form in non-finite adjuncts contrasts with the finite form in coordinated clauses:

(6) a. John eats cake before $\left\{\begin{matrix}\text{opening} \\ \text{*opens}\end{matrix}\right\}$ presents.

b. John eats cake and (then) $\left\{\begin{matrix}*\text{opening} \\ \text{opens}\end{matrix}\right\}$ presents.

adapted from Adler (2006)

Other contrasts involve transformations; for example, cleft structures are possible with adjuncts but not coordinate clauses:

(7) a. It was before opening presents that Mary cut the cake.

b. *It was and John opened presents that Mary cut the cake.

Similarly, different profiles are observed for extraction:

(8) a. What$_i$ did you eat $t_i$ before John opened presents?

b. *What$_i$ did you eat $t_i$ and (then) John open presents?

Importantly, these examples involve positive evidence (Berwick, 1985): in (6) the contrast in verb form (or finiteness) is a cue to the contrast in clause type, while in (7) and (8), the transformation itself is a cue - since the sentences are not possible with a coordinated clause, any instances in the input would need to be represented with an adjunct clause (Adler, 2006).

However, the above evidence is still problematic for learning attachment height. In (6), the contrast in verb form aligns with the contrast

in attachment height: that is, coordinated clauses and non-finite clauses have different verb forms and different attachment heights. This strategy makes the wrong predictions for finite adjuncts, though, which also have a finite verb form (grouping finite adjuncts with coordinated clauses):

(9) John eats cake before he $\left\{\begin{matrix}*\text{opening} \\ \text{opens}\end{matrix}\right\}$ presents.

This miscategorization may be avoided if the contrast in (6) is applied to a subset of the input data. However, this would involve domain-specific knowledge about which data to use for learning, merely shifting the learning problem rather than addressing it.

Meanwhile, the sentences in (7) and (8) must be represented accurately in order to be used as evidence for the correct attachment height. However, the influence of an immature parser, along with high sentence processing costs may affect the reliability of this evidence.

More broadly, both types of evidence discussed by Adler (2006) rely on prior knowledge of a contrast in attachment height between adjuncts and coordinated structures. Moreover, similar to the approach by Cairns et al (1994), the relevant learning strategies involve mapping a lexical item (complementizer) to abstract structure (adjunct clause), by abandoning an initial incorrect mapping (coordinated clause). These mappings are important, but they require the attachment height for adjuncts to have

already been acquired. Again, attachment height must either be innate here, or acquired using another form of evidence. A final possibility for attachment height is discussed in the following section.

#### 4.1.1.3 Binding across clauses

The next type of evidence to consider for attachment height involves binding relations across clauses, as in (10) and (11):

(10) $He_1$ called Mary before $John_{*1/2}$ left for the store.

(11) John called $her_1$ before PRO meeting $Mary_1$ at the store.

In (10), the pronoun *he* c-commands *John*, and co-reference is ruled out by Principle C (Chomsky, 1981). However, co-reference is possible if the adjunct is attached high. Thus, if children have a grammar with high attachment, negative evidence is needed against co-reference in sentences like (10), which may then be used to infer the correct (lower) attachment height.[8]

Meanwhile, syntactic evidence against a low attaching adjunct is seen in sentences like (11), with co-reference between *her* and *Mary*. If

[8] As (10) is finite, this strategy involves an additional generalization from finite to non-finite adjuncts (discussed further below).

children have a grammar with low attachment, then coreference in the input with this configuration would provide positive evidence for the correct (higher) attachment height.

For both (10) and (11), the relevant evidence involves several assumptions which are problematic for acquisition. First, evidence against the coreference in (10) might be available in the form of indirect negative evidence (Xu & Tenenbaum, 2007); however, previous research on children's acquisition of Principle C finds that children already reject coreference in this configuration from as young as 3 years of age (Crain & McKee, 1985; Crain & Thornton, 1998; for reviews, see Lust et al., 1992; Guasti, 2017). This timeline is inconsistent with studies on adjunct control, where children's non-adultlike interpretations were observed until 5-6 years of age.

Alternatively, children might acquire a high attachment grammar initially but get evidence for the adult grammar before age 3. However, if the relevant evidence involves referential dependencies across multiple clauses, the timeframe is further limited by children's parsing abilities at this age.

More importantly, using binding across clauses as evidence for attachment height involves the crucial assumption that the relevant configurations will be available in the linguistic input. However, for both (10) and (11), the critical anaphoric relations are highly infrequent, especially if the relevant timeframe is limited by other factors like the

developing parser (Sutton, 2015; Gerard, 2016). Furthermore, this type of evidence depends on the coreference interpretation, which children may not always access: if a different referent is assigned the intake than from the input, then this will provide evidence for the incorrect attachment height. (Lidz & Gagliardi, 2015; Omaki & Lidz, 2015). Thus, it is unlikely that binding relations alone are used as evidence for attachment height for non-finite adjuncts.

Attachment height will be addressed again in the section on generalization; the following section considers the evidence for inferring a c-commanding controller.

### *4.1.2 C-command by the controller*

Inferring the c-command relation between the main clause subject and adjunct PRO is a two-step process:

1. Identify the set of possible antecedents for adjunct PRO (i.e. the main clause subject).
2. Determine that the dependency is due to c-command, as opposed to e.g. a discourse or agent preference or based on a property like animacy, which are also likely to involve the main clause subject

It is assumed that before reaching step 2, a learner has already acquired the correct attachment height, either from other evidence in the input, or attachment is specified in UG (Goodluck & Behne, 1992). Otherwise, the inference in step 2 cannot be made based on a hierarchical relation.

Meanwhile, these steps must be indirect on some level: with just a single instance of adjunct control in the input, the interpretation of PRO is consistent with multiple grammars. For example, in addition to a strict subject (adult) grammar, the coreference in (1), repeated below as (12), is also consistent with an agent grammar, a sentence-internal grammar, a free reference grammar, and others.

(12) $John_1$ called $Mary_2$ after $PRO_{1/*2/*3}$ drawing a picture.

All things equal, inferring that the antecedent of PRO is the main clause subject therefore requires multiple instances of adjunct control. However, children's interpretations in previous studies suggest that this inference will be problematic, for any type of learning mechanism (domain-specific or domain-general).

Traditionally, children with a non-adult grammar will encounter some form in the input which is consistent with the adult grammar but not with the non-adult grammar, and this form will be evidence for the adult grammar (Gold, 1967; Grimshaw & Pinker, 1989; Pinker, 1979, 2009). This

logic is discussed in section 4.1.1.2 above for encountering syntactic evidence against a coordination grammar. However, as discussed in §2.2 above, children with a non-adult grammar of adjunct control will access adultlike interpretations *and* non-adult interpretations of the linguistic intake. As a result, the set of interpretations generated by the non-adult grammar is a superset of the interpretations generated by the adult grammar. These relations are illustrated in Figure 2.

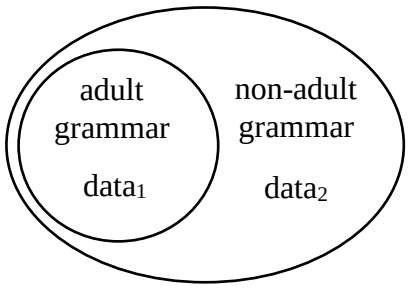


Figure 2. Subset-superset relation between the adult grammar (strict subject) and non-adult grammars for adjunct PRO (sentence-internal and free reference). While the adult grammar includes $data_1$ but not $data_2$, the non-adult grammar includes both $data_1$ and $data_2$.

This is inconsistent with the Subset Principle, which posits that children will select the subset language over the superset language (Berwick, 1985; Manzini & Wexler, 1987; Wexler & Manzini, 1987; Wexler, 1990). Additionally, transitioning to the adult grammar requires

negative evidence (Berwick, 1985; Gold, 1967; Baker, 1979; Manzini & Wexler, 1987; Pinker, 2013; Heinz & Riggle, 2011).

One potential option for this involves the size principle, where smaller hypotheses are considered to be more likely than larger hypotheses (which generate a superset of the data generated by a smaller hypothesis), and exponentially more likely as more data that is observed that is compatible with both hypotheses (Tenenbaum, 1999; Tenenbaum & Griffiths, 2001; Xu & Tenenbaum, 2007). However, this logic does not work with evidence for the subject as the antecedent of PRO, and highlights a more general problem with acquiring syntactic constraints on anaphora.

A non-adult grammar which allows a superset of the interpretations in the adult grammar is represented in Figure 2 - for example, a free reference grammar. The subset grammar is the strict subject (adult) grammar, which allows only a subject control interpretation. Under the size principle, children should transition from the superset grammar to the subset grammar by observing instances of adjunct control in the input with a subject control interpretation, represented by $data_1$ in Figure 2. The subset grammar should be considered to be more likely if data like $data_1$ occur in the input. Other than the few instances of speech errors and non-obligatory control in Table 2, $data_1$ (subject control) was indeed be the only type of data in the input. However, this overlooks the additional noise introduced in the intake from extragrammatical factors, and the finding from previous studies that children allowed non-adultlike interpretations of adjunct PRO.

If these children's grammars were not adultlike, then they would also allow non-adultlike interpretations of the input, represented by $data_2$ in Figure 1. Crucially, $data_2$ will provide evidence against the adult grammar *and* for the non-adult grammar (Fodor, 1989, 1994; Grodzinsky, 1989).

As a result, children's interpretations of adjunct PRO are not a reliable cue for inferring the c-command relation. Moreover, other syntactic dependencies face a similar dilemma: if children accept a wider range of interpretations in an experimental context, then the same interpretations are likely to be available in the linguistic input. Further implications are discussed in the final sections.

If the grammatical components of adjunct control are not inferred directly - from instances of adjunct control in the input - then evidence may instead be available from other structures, which may be generalized to structures with adjunct control.

### 4.2 *Generalization from similar structures*

The following sections will consider the possibility of generalizing attachment height and c-command to sentences with adjunct control from two similar structures: complement control, where the dependent element has the same form; and finite adjuncts, with a similar syntactic context.

### *4.2.1 Complement control*

In sentences with complement control (as in (13), below), the same c-command relation is generally observed for the controller - that is, the closest c-commanding NP - with the same (null) form of PRO:

(13) a. $John_1$ wanted $PRO_1$ to run to the store.

b. $John_1$ told $Mary_2$ $PRO_{*1/2}$ to run to the store.

In previous studies, children have exhibited adultlike behavior for complement control before adjunct control (Hsu et al., 1985; McDaniel et al., 1991; Cairns et al., 1994); however, children still accepted a wider range of interpretations initially, albeit at a younger age than for adjunct control. This suggests that children do not infer the antecedent of PRO from sentences with complement control, since the non-adultlike interpretations would provide incorrect evidence in the input in the same way as discussed above for adjunct control.

A generalization strategy also makes several assumptions: first, if children did infer the antecedent for complement control, then the same inference must not also be made for adjunct control. Next, if children generalize from complement control to adjunct control, this assumes that the relevant generalization is not made in the reverse direction, from adjunct

control to complement control. Finally, adjunct control and complement control share various features; if children do generalize the correct features, then they must avoid generalizing others (e.g. attachment height or verb form).

These arbitrary assumptions about what is generalized suggest that children do not generalize from complement control to adjunct control, at least for a property like the antecedent of PRO.

### *4.2.2 Finite adjuncts*

For the purposes of identifying the controller, finite adjuncts have the same attachment height as non-finite adjuncts, as demonstrated by the co-reference in (14) between *her* and *Mary*:

(14) John$_1$ called her$_2$ before he$_1$ met Mary$_2$ at the store.

Therefore, if children could acquire the attachment height for finite adjuncts from the linguistic input, then this might then be generalized to non-finite adjuncts.

However, the evidence needed for attachment height with finite adjuncts has the same problems discussed above for non-finite adjuncts - for example, evidence in the form of binding relations across clauses is unlikely

to occur in the input, falling short of explaining how attachment height is acquired in general.

Additionally, the same assumptions are made for finite adjuncts as the ones outlined above for complement control: if children did infer attachment height for finite adjuncts, then the same inference must not also be made for non-finite adjuncts. Next, if children did generalize from finite adjuncts to non-finite adjuncts, this assumes that the relevant generalization is not made in the reverse direction, from non-finite adjuncts to finite adjuncts. Finally, finite adjuncts and non-finite adjuncts share various features; if children do generalize the correct features, then they must avoid generalizing other ones (e.g. the antecedent of the adjunct subject, or the verb form).

For example, the subject in finite adjuncts can grammatically corefer with any sentence-internal NP (barring contexts that would result in a Principle C violation, as in (10)), or sentence-external NP. Based on the input distribution in CHILDES (MacWhinney, 2000), these interpretations are realized in the linguistic input (Table 4), with relatively matched frequencies for internal and external antecedents. Therefore, generalization from the antecedent of subjects in finite adjuncts would result in the wrong conclusion about adjunct PRO.

| | | coreference with | | |
|---|---|---|---|---|
| | Total | main clause subject | other internal referent | external referent |
| after | 346 | 193 | 25 | 128 |
| before | 717 | 383 | 83 | 251 |
| while | 307 | 92 | 30 | 185 |

Table 4: Frequencies of finite adjunct subjects in the input, by complementizer and subject antecedent. Counts are from the CHILDES transcripts discussed in §3. Finite adjuncts were identified by searching for each complementizer followed a pronoun, a bare noun, or determiner, and coded by hand for the antecedent.

These concerns suggest that children do not generalize a feature like attachment height from finite adjuncts to non-finite adjuncts. Furthermore, the sources of evidence considered above are not evidence for the abstract features of control (lexical learning and adjunct reanalysis), or they are not reliable (binding across clauses and negative evidence from the size principle). Nevertheless, all children acquire a grammar with the correct attachment height and c-command by the controller. These abstract features must then be innate, i.e. part of Universal Grammar.

## 5. Universal Grammar

Even though adjunct control itself is available in the input, evidence is not available for the main syntactic components of adjunct control, attachment height and c-command by the controller. This suggests that these properties are part of UG, which has implications for the hypothesis space of possible grammars considered by a learner. In particular, a learner will only consider the grammars where these properties are adultlike.[9]

If evidence for attachment height and c-command is not in the input, this raises the question of what *is* in the input. What features of adjunct control must be acquired? Predictions are also made for children's acquisition which may be tested empirically.

### 5.1 *Role of the input*

If the properties of adjunct control are abstract universals, then the input is needed for any variation. For example, finiteness distinguishes non-finite adjuncts from finite adjuncts and conjoined clauses. If tense can be used as a

[9] A reviewer notes that these two properties alone may not be sufficient for obligatory control, as a learner must also recognize that control occurs in non-finite clauses. However, acquisition from the perspective of the learner does not distinguish between adjunct control contexts and non-finite adjuncts: in the input, a learner will perceive a non-finite adjunct with an empty subject, prompting a search for an antecedent to the subject. The task for the learner is to recognize the non-finite context, while UG identifies the antecedent in this context as the closest c-commanding NP.

cue for the type of dependency, then it may be one of the features to acquire from the input for adjunct control.

### *5.1.1 Finiteness*

Compared to the abstract syntactic properties, morphological tense is more accessible in the input: the contrast between finite and non-finite verbs is generally realized overtly, and is not limited to adjunct control. For example, the contrast between finite and non-finite clauses is also relevant for complement control, as well as syntactic bootstrapping for verb learning (Harrigan et al., 2019).

An additional cue to adjunct control is the form of the subject - while finite adjuncts generally have an overt subject, in non-finite adjuncts the subject is not pronounced (from the point of view of the learner). Therefore, a learner may look for an empty subject *or* non-finite morphology to identify an adjunct control dependency. Of course, this raises an additional question: would these cues be weighted differently in a language depending on their availability or reliability (Kempe & MacWhinney, 1999)? For example, for languages which allow the subject to be dropped (e.g. pro drop, topic drop), the empty subject would not be as helpful for identifying an adjunct control dependency, since finite verbs may also appear without a subject (Haegeman, 2000; Holmberg et al., 2009; Huang, 1984; Sundaresan,

2014; Nunes, 2014; Wu, 1992). However, the probability of an empty subject is much higher in a non-finite clause than in a finite clause, even for languages which allow subject drop (since the probability of an overt subject in a non-finite clause is essentially zero). Children are sensitive to these contrasts in probability (for a review see Newport, 2016). Therefore, if children use tense or subject form as a cue for adjunct control, then cross-linguistic predictions may be made for acquisition based on (a) the availability of tense (for languages which express tense overtly vs covertly), and (b) the reliability for predicting an empty subject in non-finite vs finite verbs.

For example, the cue to retrieve an antecedent is the missing subject, but if a missing subject may occur in a finite or non-finite clause (as in languages which allow the subject to be dropped), then tense information is also needed to identify the grammatical antecedent. Meanwhile, in languages which do not allow subject drop, if empty subjects are associated with non-finite clauses then an antecedent may be identified without tense information. If the retrieval mechanism is deployed as soon as possible, then children's parsing strategies may vary depending on these cues (to be tested in future research).

### *5.1.2 Complementizers*

Another feature of adjunct control which varies cross-linguistically is the specific complementizers and the clauses that they select. For example, *without* may appear in a finite frame in both German and Dutch, but not in English:

Non-finite:

(15) a. John cooks without PRO sleeping

b. Fritz kocht ohne PRO zu schlafen
Fritz cooks without PRO to sleep
"Fritz cooks without sleeping"
adapted from Ller (1995)

c. Hij gaf, zonder $PRO_1$ het te weten,
He gave, without PRO it to know
het juiste antwoord
the right answer
"He gave, without knowing it, the right answer."
adapted from dutchgrammar.com

Finite:

(16) a. *John cooks without that he sleeps

b. Fritz kocht ohne dass er schläft

Fritz cooks without that he sleeps

"Fritz cooks without 'that he sleeps'"

c. Hij gaf, zonder dat hij het wist,

He gave, without that he it knew

het juiste antwoord

the right answer

"He gave, without 'that he knew it,' the right answer."

Therefore, children must learn the form for each complementizer, and whether it selects a finite clause, non-finite, or both. Alternatively, some complementizers may be categorized based on a particular feature to be learned in groups, although that would introduce the additional question of how this feature is acquired.

The issue of adjunct complementizers is relevant for any acquisition account of adjunct control: complementizers must be distinguished from conjoined clauses and complement clauses. If attachment height is an expected (innate) contrast, then the learning problem will involve identifying the complementizer forms and their selected clauses, and other lexical and semantic properties as discussed by Cairns et al (1994). This has implications, then, for children's competence and the expected developmental trajectory. These are discussed further in the following sections.

## 5.2 *Competence and acquisition*

In previous studies on the acquisition of adjunct control, children's behavior has generally been attributed to a non-adultlike grammar. However, if both attachment height and c-command by the controller are already part of UG, then these properties of adjunct control would not need to be acquired from the input. Instead, the input would be used for mapping overt forms (like tense and complementizers) to the abstract structure in UG. This predicts that children might sometimes make the wrong mappings, but no stage should be observed with non-adultlike attachment height or a non-adultlike controller.

This prediction presents a puzzle for explaining children's non-adultlike behavior in previous studies. If children's competence was adultlike, why would they access non-adultlike interpretations?

One option is that children's non-adultlike interpretations were indeed due to a non-adult grammar, and the adult grammar is acquired independent of the linguistic input, via language-specific maturation (Manzini & Wexler, 1987; Wexler & Manzini, 1987; Wexler, 1990, 1992, 2019). This is consistent with children's behavior, as well as the lack of evidence in the input.

Another consideration is that children's interpretations reflect their linguistic competence filtered through an immature parser. That is, children may have acquired the adult grammar, but processing limitations may interfere with the deployment of this grammatical knowledge in an experimental setting. These processing limitations may involve parsing mechanisms for antecedent retrieval (Gerard et al., 2017), as well as the complexity of the task itself (Gerard et al., 2018). For children to access adultlike interpretations consistently, development will then involve domain-general memory mechanisms, which can interface with language and with other specific domains (Nairne, 1988, 1990). This development is likely to affect children's interpretations (for reviews, see Feigenson, 2007; Cowan, 2001; Courage & Cowan, 2008).[10]

Finally, other processes may be more sensitive to specific input frequencies, as discussed above for potential cues for adjunct control in the input (for further discussion, see Van Dyke & Johns, 2012; Omaki & Lidz, 2015; Gerard, 2016). For example, children may not have a strong enough link between the overt forms of tense or complementizers and the corresponding structures.[11] This explanation may also be given along with an account of limited processing resources: in both cases, non-adultlike interpretations are due to problems with deploying adultlike syntactic

[10] See also Frank (1998) on non-adultlike behavior due to processing limitations with language-specific development.

[11] This second option is similar to the account proposed by Cairns et al (1994) in that adultlike behavior is achieved by forming adultlike mappings between lexical forms and abstract structure.

knowledge. Also, their predictions can be tested in an experimental context (discussed further below).

Importantly, the source of children's non-adultlike interpretations does not affect the arguments above about the lack of evidence in the input for attachment height or a c-commanding controller; for example, children are still likely to access non-adultlike interpretations of adjunct control in the input, regardless of the source of these non-adultlike interpretations.

### 5.3 *Predictions for the input*

Although most types of adjunct control exhibit subject control, exceptions exist depending on various aspects of the dependency. To account for this variation, evidence must be available in the input in some form. For example, in (17), the controller is the main clause patient, rather than the subject:

(17) a. $John_1$ thanked $Mary_2$ for $PRO_{*1/2}$ running to the store.

b. $John_1$ was thanked by $Mary_2$ for $PRO_{1/*2}$ running to the store.

This exception with the complementizer *for* is observed across languages with the corresponding complementizer. This means that some aspect of the

meaning of *for* is associated with control by the patient, or that evidence in the input is available for this exception.

To test this prediction, an additional corpus search was conducted for non-finite adjuncts with the complementizer *for*, using the same methods as described above. The raw counts are presented in Table 5.

| | | coreference with | | |
|---|---|---|---|---|
| | Total | main clause subject | other internal referent | external referent |
| adult (input) | 326 | 42 | 281 | 3 |
| target child | 36 | 8 | 28 | 0 |

Table 51: Frequency of antecedents in non-finite *for* by adults (speech to children) and children (speech by children) in CHILDES.

The data here raise two main points. First, compared to the other non-finite complementizers, the adjuncts with *for* occur at a high frequency (comparable to *without* and *instead of*), and should therefore be more salient than the lower frequency adjuncts.

Next, unlike the other non-finite complementizers, which occurred in the input with only subject control interpretations, an overwhelming

majority of adjuncts with *for* have an object or other internal NP as the controller, as in the following examples:[12]

(18) a. Can you$_1$ scold Jennifer$_2$ for PRO$_{*1/2}$ stepping on the truck?

b. What did Aunt Carey$_1$ buy you$_2$ at the store for PRO$_{*1/2}$ being a good sharer?

c. You$_1$ yelled at him$_2$ today for PRO$_{*1/2}$ chewing your slippers.

d. I$_1$ have a little present for you$_2$ for PRO$_{*1/2}$ coming today.

If children are sensitive to different distributions of antecedents, this is the kind of striking contrast that might be relevant for acquisition. This would be in comparison to a contrast between strict subject control and e.g. a discourse bias for the subject interpretation, which would only be detectable in a minority of instances.

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[12] The search of *for* followed by the string "ing" also returned utterances such as the following:

(iii) They're not for eating.
(iv) Where're the songs for dancing?
(v) This one's for something else.
(vi) Mommies are not for hitting.

These instances were not included in the analysis.

However, while some variety is observed within the instances of *for* adjuncts, 70% of the instances occurred in the frame 'thank you for ___ing,' as in:

(19) a. Thank you for helping me.

b. Thank you for letting Mommy finish her breakfast.

c. Thank you for carrying socks.

This frequent frame may start out as a larger chunk, to be linked later to the *for* non-finite frame. Meanwhile, the discourse contexts for the utterances in (18) strongly support a patient interpretation for the adjunct subject. These utterances, along with the instances with the patient as the subject, may provide the relevant evidence against strict subject control for *for* adjuncts.

This predicts, however, that similar evidence will be available in the input for other languages. It also predicts that children would treat *for* adjuncts like the other non-finite adjuncts until the relevant evidence is available. Alternatively, the meaning of *for* as a complementizer may be associated already with the patient antecedent, so that identifying the complementizer form-meaning mapping would be sufficient for acquisition; this would involve additional language-specific information to be specified in UG.

## 6. Discussion

This paper has considered the options for acquiring adjunct control. Although adjunct control is available in the input, this is not sufficient for acquiring the main syntactic properties of adjunct control. Observing instances of adjunct control directly may provide information about overt features in the dependency, but not abstract features like the correct attachment height of the adjunct or the controller as the closest c-commanding NP. Similar issues arise when considering the possibility of generalizing from other structures, which involve arbitrary assumptions about generalization.

Without evidence in the input for these key components of adjunct control in the input, they must be innate - considered here as principles in UG. This argument from the poverty of the stimulus instead involves a different type of evidence in the input for acquiring adjunct control, and makes further predictions about the input. The following sections consider the implications of this account - for control, for other dependencies, and for acquisition.

## 6.1 *Other types of control*

Accounting for the adjunct control as a dependency requires a syntactically defined locality constraint. This is supported by crosslinguistic judgments, as well as in experiments which control for the discourse context (Parker et al., 2015; Kwon & Sturt, 2014; Kush & Dillon, 2020; Broihier & Wexler, 1995; Adler, 2006; Gerard et al., 2018; but see Green, 2018b). These judgments are also represented in the linguistic input, which consists nearly exclusively of subject control.

These instances of adjunct control are generally considered to be obligatory control in that they require a local antecedent. Meanwhile, non-obligatory control is also observed in temporal adjuncts (Williams, 1992; Landau, 2015, 2017; Green, 2018a) as in (4) and (5), repeated below as (20) and (21):

(20) It was good to call after PRO drawing a picture.

(21) The flower wilted after PRO drawing a picture of it.

As observed in §3, both of these occur in the input, and are produced by children. However, there are several reasons not to consider these occurrences as evidence in the input for non-obligatory control.

In previous studies, children have accepted an external antecedent for sentences with obligatory control (McDaniel et al., 1991; Cairns et al., 1994; Broihier & Wexler, 1995; Adler, 2006). Therefore, development must involve a change to strict subject interpretations for obligatory control, while still allowing external interpretations for non-obligatory control as in (20) and (21). If children's external interpretations are due to a non-adult grammar, then these interpretations in the input are of type $data_2$ in Figure 2. With a free reference grammar, sentences like (20) and (21) may also be parsed as $data_2$; that is, these sentences would be consistent with the non-adult grammar and would not provide evidence for non-obligatory control until after the adult grammar is acquired.

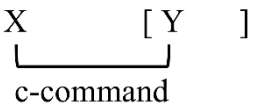
Meanwhile, regardless of the source of children's non-adultlike external interpretations, they are likely to occur at comparable frequencies to the counts in Table 2. Therefore, if a learner uses instances like those in Table 2 as evidence for non-obligatory control, then non-adultlike external interpretations are just as likely to provide incorrect evidence against obligatory control. Future research will further examine these implications for acquiring obligatory and non-obligatory control (Landau, forthcoming).

## 6.2 *Other dependencies*

This paper discusses the acquisition of adjunct control based on a hierarchical relation (c-command by the controller) and attachment height. In addition to adjunct control, other dependencies are also defined in terms of hierarchical relations, so much of the logic discussed here may be applied more generally.

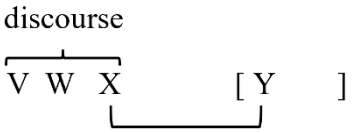
For example, for any referential dependency, an antecedent must be identified to resolve the dependency. Consider a syntactic dependency between X and Y, where the grammatical antecedent may be identified by some constraint (e.g. c-command and/or locality):

(22)




If the relevant constraint has not yet been acquired, then an alternative strategy is needed to resolve the dependency; for example, by retrieving an antecedent from the discourse:

(23)



Additionally, there must be evidence available in the input to (eventually) acquire the relevant syntactic constraint. Otherwise, without this evidence, some aspect of the dependency must be available in UG; this will make further predictions similar to adjunct control about factors like exceptions, experimental contexts, etc.

Languages vary in their inventories of syntactic dependencies, with some dependencies observed more universally than others. Positing a domain-specific feature in UG may account for more widely observed dependencies, while evidence is needed in the input in other cases. Arguments identifying which features are in UG often (reasonably) appeal to this universality, or lack thereof; this paper is concerned also with the transparency of a given feature in the input: for abstract properties which are not directly observable from the linear input, evidence for these properties may be more elusive, even when the relevant structures are available in the input. Attachment height and c-command are examples of such properties (with the same logic for locality in other frameworks).

### 6.3 *Role of the argument of the poverty of the stimulus*

This paper presents an argument from the poverty of the stimulus that the abstract components of adjunct control are innate. Evidence for these

components does not occur in the input, so they must be available from another source. If attachment height and the controller are part of UG, then common features of control across languages may be explained without requiring redundancy in the input.

More broadly, based on the type of evidence that is *not* available and because these features of control are *not* learned, the conclusions about evidence in the input are applicable to linguistic dependencies more generally: if the actual elements of a dependency are not reliable for inferring the properties of the dependency, then a different form of evidence is needed for these properties. This was the case for adjunct control, as children's non-adultlike interpretations of adjunct PRO were likely to provide incorrect evidence about the adult grammar. Similarly, non-adultlike interpretations have also been observed for other types of anaphora (Chien & Wexler, 1990; McKee, 1992; for a review see Conroy et al., 2009), as well as A movement (Manzini & Wexler, 1987; Orfitelli, 2012; Mateu, 2016, i.a.) and A-bar movement (Tavakolian, 1981; Friedmann et al., 2009; Adani et al., 2010, inter alia; but see Hamburger & Crain, 1982; Gagliardi et al., 2016).

For many of these general phenomena, innate components have been proposed, based on the poverty of the stimulus. Meanwhile, children's non-adultlike behavior is often accounted for by a non-adult grammar. These accounts may achieve descriptive adequacy for children's non-adultlike behavior; however, if evidence is not available in the input for the non-adult

grammar *and* for the transition to the adult grammar, then this casts doubt on the explanatory adequacy of the grammar. If both forms of evidence are not available, then either a different non-adult grammar or extragrammatical sources are needed to account for children's behavior.

## 6.4 *Conclusion*

This paper considered how adjunct control is acquired and compared different sources of evidence in the linguistic input. These options did not provide evidence for the key grammatical components of adjunct control, suggesting that these components are innate, with other more overt forms of evidence in the input. Future research will further investigate the predictions of this evidence, as well as the more general implications for the content of UG.

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