Chapter 1
Learning structures with displaced arguments

Misha Becker

1. Introduction

In typical, average, canonical sentences (sometimes called “basic” sentences), NPs bearing thematic roles are adjacent to their selecting predicate both in the underlying structure and on the surface. For example, in a basic active transitive sentence, the syntactic subject is also the “semantic subject” (usually an agent or experiencer) and is adjacent to the main predicate.

(1) John threw the ball.

\[ \langle \text{agent} \rangle \quad \langle \text{theme} \rangle \]

This paper looks at how children acquire two constructions which involve a more complex alignment of thematic relations; specifically, constructions in which the syntactic subject is not the agent/experiencer of the main (adjacent) predicate, but rather is semantically linked only to the embedded predicate. The two constructions to be investigated are raising-to-subject constructions, as in (3-a), and tough-constructions, as in (3-b).

(3) a. The climber\(_i\) seemed \(t_i\) to be stuck.
b. The girl\(_i\) is easy to see \(t_i\).

In derivational syntactic frameworks, the subject in both (3-a) and (3-b) is said to be derived from some lower part of the structure. Even in non-derivational frameworks (e.g. Lexical Functional Grammar), the subject in these construc-
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tions is not local with respect to the predicate that selects it. I will refer to
the subjects in these constructions as “displaced” subjects, and the predicates
that participate in these constructions as “displacing” predicates. Compared
to basic sentences like (1), these sentences are complex: they are biclausal
they contain two main predicates, seem/be easy and be stuck/see), and they
involve non-canonical semantic relations between the NP arguments and the
main predicate. In derivational syntactic frameworks, they involve an extra
derivational step of NP-movement from the lower clause to the higher one,
rendering their syntactic structure more complex.

The specific question I will address is how children figure out these com-
plex structures; more precisely, how children determine that the main clause
syntactic subject in just these structures is a displaced subject and is not se-
mantically selected by the (local) main clause predicate. One could recast
the question as a question about whether a predicate takes an agent (or ex-
periencer) subject. I take the view that this translates into a deeper question
about argument structure: non-agent/experiencer subjects are generally not
projected as external arguments, and so the external argument position is po-
tentially empty, underlyingly.1 The question I am investigating, at bottom, is
how children determine this kind of underlying representation.

This question is certainly not new. C. Chomsky (1969: 6) posed this very
question by asking how children acquire the structure of sentences in which
“the true grammatical relations which hold among the words in a sentence are
not expressed directly in its surface structure.” And N. Chomsky (1965: 22–
27) famously noted the same learnability conundrum. But the little research
that has been done on the acquisition of these constructions in children (in-
cluding C. Chomsky’s) has focused on the question of what children know
about these constructions in their target language, rather than how they come
to know it. Thus, the fundamental question of how these constructions are
acquired remains open.

The learnability problem results from a superficial overlap between the
displacing predicates just discussed and predicates that do select an external
argument (their subject is not displaced). This overlap is seen here:

(4) a. The climberi seemed [ti to be stuck.]
b. The climberi pretended [PROi to be stuck.]
(5) a. The girli is easy [(Op) PROarb to see ti.]
b. The girli is eager [PROi to see ei.]

1
The problem for the learner is that prior to knowing what the predicates *seem, pretend* and so forth mean, these sentences cannot be unequivocally parsed. Following work in the Syntactic Bootstrapping literature (Gleitman 1990, Gleitman et al. 2005, i.a.), I assume that although some cues to predicate meanings may be available from non-linguistic sources (i.e. observing events in the world), there is not sufficient sentence-external information to pin down the unusual argument structures of these kinds of abstract predicates. Rather, the child primarily infers the meaning and argument structure properties of the predicate based on the structure it occurs in. But this brings us back to our original question: how does the child figure out the structure?

To put the learning puzzle in perspective, consider the sentences in (6), which contain predicates with unknown lexical meanings.

(6) a. The climber gorped to be stuck.  
b. Max is daxy to see.

What is the semantic role of the subjects in these sentences, and what are the sentences’ underlying structures?

The learning strategy I propose is based on the semantic feature of animacy. Notice that the displacing predicates easily permit inanimate subjects, while the non-displacing predicates do not.

(7) a. The rock seemed to be stuck.  
b. #The rock pretended to be stuck.

(8) a. The house is easy to see.  
b. #The house is eager to see.

While displacing predicates permit both animate and inanimate subjects, if a reader/hearer encounters the novel predicates in (6) with inanimate subjects, the subjects are less likely to be construed as the agent/experiencer of the main predicate. That is, one is more likely to construe the subjects in (9) as being something that can be stuck or be seen (it is semantically related to those lower predicates) but not as a “gorper” or something that is “daxy”.

(9) a. The rock gorped to be stuck.  
b. The house is daxy to see.

Raising-to-subject and tough-constructions are not the only constructions that involve argument displacement. Passives likewise involve a derived subject
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(the syntactic subject is not an agent/experiencer and it undergoes NP-movement, as in The ball, was thrown to (by John)), and unaccusative verbs are verbs whose lone argument is a theme rather than an agent (Perlmutter 1978); in derivational frameworks, it is an underlying object which raises to subject position (The gifts, arrived at the wedding; Burzio 1986). While I will briefly discuss unaccusative constructions at the end of the paper, the main focus will be on raising-to-subject and tough-constructions (please see Becker (in press) for discussion of the passive).

Animacy is something children know about early in life. Within the first year of life, babies discriminate people from objects based on behavioral properties (Woodward, Phillips and Spelke 1993, Woodward 1998), and there is evidence that between about 6 and 18 months of age babies can categorize conceptually certain animals, like birds, as distinct from other apparently similar inanimate things like airplanes (Mandler and McDonough 1993). More importantly, by the second year of life they attribute intentional states to people but not machines (Meltzoff 1995). So by the time children start acquiring basic sentence structure, and certainly by the time they start acquiring these more complex sentences, the concept of animacy is available to them.

Moreover, animacy plays a significant role in grammatical hierarchical structure, and the ability of displacing predicates (but not non-displacing predicates) to take inanimate subjects is found cross-linguistically. Languages that require the subject to be more animate than the object in a transitive sentence (e.g. Japanese (Kuno 1973), Jacaltec (Craig 1976), Navajo (Comrie 1989) and Blackfoot (Ritter and Rosen 2010)) nevertheless allow an inanimate subject in certain constructions if it is derived.

This deep preference for subjects to be animate in human language was part of the rationale for Pinker’s Semantic Bootstrapping Hypothesis (Pinker 1984). Since subjects are often agents, and agents are (virtually) always animate, an animate NP is likely to be in the subject position; an inanimate NP is more likely to be in the object position. Indeed, there is good evidence that children preferentially associate agency with subjecthood (Fisher, et al. 1994, Naigles 1990) and can use that association to begin mastering the word order of their language (Hirsh-Pasek, et al. 1988). Part of the goal of my work is to extend the scope of Semantic Bootstrapping by considering what learners might do when the subject is in fact inanimate. Thus, my claim is that not only can an animate NP serve as a cue to canonical subjecthood, but an inanimate subject serves as a cue that the subject is displaced, and therefore that the structure is complex.
I will support my claim with two types of data: (1) naturalistic input data (child-directed speech from CHILDES) and (2) controlled experimental input data in simulated learning tasks with both children and adults. Both types of data show that even if inanimate subjects are highly infrequent, learners (adults and children) can use this information to make assumptions about the selectional properties of predicates, and therefore to learn complex, non-canonical sentence structures.

Before proceeding, it is worth noting that although I adopt a derivational syntactic framework in this paper (because it is the framework I am most familiar with), this research question could be pursued via alternative approaches. Notably, Kirby (2012) takes a Construction Grammar approach (Goldberg, 2003, 2006) to the representation and acquisition of raising and control verbs. Such an account is worth exploring in the future, particularly in connection with tough-adjectives. However, Kirby’s particular analysis will not extend to the data covered here. Her account relies on the claim that the highly frequent verb want is the “prototype” verb that takes an infinitive complement, and so the constructions it participates in (subject control when it takes just a bare infinitive complement (NP want to VP), but a raising-to-object when it takes both an NP and an infinitive (NP want NP to VP)), will be acquired earlier than the other constructions (raising-to-subject and object control, respectively). However, as we will see below the raising verb going (to) is nearly 3 times more frequent than want in the corpora I have used, casting doubt upon the view that frequency of individual verbs alone underlies learning preferences.

An additional side note regards the structure of tough-constructions. There has been a significant debate in the literature over whether tough-constructions involve movement or not, and if so, what kind of movement (e.g. A- or A′-movement; see, for example, Bresnan 1971, Chomsky 1977, Lasnik and Fiengo 1974, Postal 1971). I will follow Hicks (2009)’s recent analysis according to which subjects of tough-constructions undergo a combination of A- and A′-movement from the underlying object position of the embedded clause.

2. Naturalistic Input

We must first establish whether children hear inanimate subjects in the input, and if so, whether they hear them disproportionately more often with dis-
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placing predicates than non-displacing predicates. It turns out that inanimate subjects are quite infrequent in naturalistic speech, but when they do occur, they occur overwhelmingly with displacing predicates.

First let us examine parental use of raising-to-subject and subject control verbs. Since (several of) the verbs themselves have quite high token frequencies, I will limit this search to maternal speech to three children, Adam, Eve, and Sarah (Brown 1973) found in the CHILDES database (MacWhinney 2000). The total number of maternal utterances is 60,240. As shown in Table 1, we find that mothers do sometimes use inanimate subjects, but they virtually only use them with raising verbs (seem, used-to, going-to/gonna) and almost never with control verbs (want, try, like, etc.).

Table 1. Mothers’ Use of Animate/Inanimate Subjects with Raising and Control Verbs

<table>
<thead>
<tr>
<th></th>
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<tbody>
<tr>
<td>seem</td>
<td>4</td>
<td>6</td>
<td>8</td>
</tr>
<tr>
<td>used (to)</td>
<td>45</td>
<td>5</td>
<td>0</td>
</tr>
<tr>
<td>going (to)</td>
<td>1197</td>
<td>58</td>
<td>3</td>
</tr>
<tr>
<td>appear</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>tend</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>happen (to)</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>total</td>
<td>1246 (94.0%)</td>
<td>69 (5.2%)</td>
<td>11 (0.8%)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th></th>
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<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>want</td>
<td>405</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>like</td>
<td>210</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>try</td>
<td>86</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>love</td>
<td>10</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>hate</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>total</td>
<td>712 (99.7%)</td>
<td>2 (0.3%)</td>
<td>0</td>
</tr>
</tbody>
</table>

Although the asymmetry between raising and control verbs does not appear at first glance to be particularly large, since both types of verbs occur overwhelmingly with animate subjects, the distribution is in fact significant by a Pearson’s chi-square test ($\chi^2(1) = 33.8, p \leq 0.001$). The important observation is that there are non-zero occurrences of inanimate subjects with
raising verbs, and effectively zero occurrences of inanimate subjects with control verbs. One way to look at the asymmetry is that out of sentences with an inanimate subject, nearly all of them contain raising verbs (69/71). The two counterexamples (uses of *want* with an inanimate subject) are the following, one from Adam’s mother and one from Sarah’s mother:

(10) a. “Well, no, it doesn’t want to ski.” (Adam file 23)
    b. “This one just doesn’t want to go right.” (Sarah file 135)

In many ways, *want* is the least problematic of these verbs, since for some speakers it displays hybrid behavior and may actually permit expletive subjects (a hallmark of raising verbs). That is, in informal queries I have found that some native speakers allow sentences like *It wants to rain*, or they at least find them marginal, compared to, for example, *It claims to rain*. Thus, *want* may display hybrid properties of raising and control verbs. Importantly, the other control verbs, which do not display this hybrid behavior, are never used with inanimate subjects.

We will return to a discussion of expletive subjects in section 4.1, but for now I note that raising verbs’ rate of occurrence with expletive subjects is extremely low, and even this number (11 tokens) is conservative: all but 3 of them involved a tensed complement rather than an infinitive complement (e.g. *It seems that...*) and so have a different surface syntax from the rest of the utterances represented in the table.

Looking at parental use of animate and inanimate subjects with *tough*-adjectives and control adjectives, we find a much starker asymmetry. These adjectives have considerably lower token frequencies than raising and control verbs in input to children. Because of this, in order to find sufficient occurrences of these predicates, I used a much larger set of corpora. The data in Table 2 come from not only the Brown (1973) corpus, but also the following corpora: Bloom (1970), Clark (1978), Kuczaj (1977), MacWhinney (2000), Sachs (1983), Suppes (1974) and Valian (1991). The total number of adult utterances out of which these exemplars were culled is 248,555 (these are largely maternal utterances, but in corpora where other adults contributed significantly to the conversations, such as the father and/or investigator, those speakers were included as well).

What is remarkable is that despite the low token frequencies of both *tough*-adjectives and control adjectives, when parents use *tough*-adjectives with referential subjects, they use them almost 100% of the time with an inanimate
subject (113/116 is 97.4%), even though these adjectives are perfectly acceptable with animate subjects (e.g. *John is easy to please*). The relatively higher proportion of expletive subjects with *tough*-adjectives than raising verbs makes the overall rate of inanimate subjects proportionally lower. As expected, control adjectives are used 100% of the time with animate subjects.

*Table 2. Adults’ Use of Animate and Inanimate Subjects with Tough/Control Adjectives*

<table>
<thead>
<tr>
<th></th>
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</tr>
</thead>
<tbody>
<tr>
<td>hard</td>
<td>2</td>
<td>95</td>
<td>67</td>
</tr>
<tr>
<td>difficult</td>
<td>0</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>easy</td>
<td>1</td>
<td>13</td>
<td>6</td>
</tr>
<tr>
<td>tough</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>total</td>
<td>3 (1.6%)</td>
<td>113 (59.2%)</td>
<td>75 (39.3%)</td>
</tr>
</tbody>
</table>

113/116 = 97.4% inanim. referential

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>happy</td>
<td>8</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>afraid</td>
<td>7</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>anxious</td>
<td>2</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>willing</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>glad</td>
<td>14</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>eager</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>total</td>
<td>32 (100%)</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

The three examples of *tough*-adjectives used with an animate subject are given in (11). The referent of the subject of example (11-b) is of course inanimate, but the subject itself is classified as animate because the pronoun *he* is grammatically animate. This use of the animate pronoun with an inanimate referent raises the very interesting question of exactly how animacy is marked and perceived by children with animated toys, and likenesses of animals. I address this issue more fully in Becker (in press).

(11) a. They’re [=chimpanzees] still hard to train . . . (Kuczaj file 129)
b. He’s [=deflated blow-up horse] awful hard to ride now. (Valian file 05a)
c. Well I’m a girl mommy and I’m easy to hold. (MacWhinney file 50b2)
3. Experimental Input

We have just seen that in child-directed speech parents almost never use inanimate subjects with non-displacing predicates (control verbs and adjectives). They do use inanimate subjects with displacing predicates (raising verbs and tough-adjectives), though the rate varies considerably between the two constructions.

The question is whether children will categorize a novel predicate as a displacing predicate based on encountering it with an inanimate subject as opposed to an animate subject. This is something we can investigate experimentally by presenting participants with novel predicates in sentences with animate or inanimate subjects. We can then measure their categorization of these predicates by testing to see whether the novel predicate is judged as grammatical in a further context that allows only displacing predicates.

In the following two subsections I will describe two experiments, one with adults that looked at categorization of novel verbs as either raising or control verbs, and a second one with children, which looked at categorization of novel adjectives as either tough or control adjectives. To preview the findings, both experiments revealed an influence of subject animacy on novel predicate categorization.

3.1. Adults’ categorization of raising and control verbs

Becker and Estigarribia (2013) conducted a novel verb learning task, in which novel verbs were used in sentences with either animate or inanimate subjects. We inferred participants’ implicit categorization of the novel verbs by using a forced-choice grammaticality judgment task.

3.1.1. Materials and Procedure

We presented adult speakers with nine novel verbs, one at a time, each in one or more sentences. Participants had to read these sentences on a computer screen, and then make a judgment about which of two further sentences containing the novel verb sounded better to them.

We labeled three of the novel verbs as “raising” verbs. These verbs were used in sentence frames compatible with English raising verbs (NP subject
and infinitive complement) and were assigned a made-up definition compatible with a raising type of meaning (see Table 3), though this definition was not made available to participants in every condition (see below). These were our target items of interest. The remaining six novel verbs were fillers and were of two types. One type of filler (three novel verbs) were similar to English control verbs: they were presented to participants in sentence frames compatible with English control verbs, and their made-up definition was semantically similar to control verb meanings. The remaining three filler verbs were novel transitive or intransitive verbs, so designated by their lexical meaning and sentence frames in the stimuli. When the verbs were presented in a sentence to participants, they were always used with the meaning shown in Table 3, even though participants may or may not have seen the definition.

Table 3. Novel Verbs and their Meanings (Becker & Estigarribia 2013)

<table>
<thead>
<tr>
<th>Verb Category</th>
<th>Experimental Type</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Raising target</td>
<td></td>
<td></td>
</tr>
<tr>
<td>joop</td>
<td></td>
<td>to look a certain way</td>
</tr>
<tr>
<td>meb</td>
<td></td>
<td>to probably be a certain way</td>
</tr>
<tr>
<td>trollick</td>
<td></td>
<td>to be some way most of the time</td>
</tr>
<tr>
<td>Control filler</td>
<td></td>
<td></td>
</tr>
<tr>
<td>rickle</td>
<td></td>
<td>to really dislike being someplace</td>
</tr>
<tr>
<td>sart</td>
<td></td>
<td>to make a big effort to be some way</td>
</tr>
<tr>
<td>zid</td>
<td></td>
<td>to really enjoy being someplace</td>
</tr>
<tr>
<td>Transitive/Intransitive filler</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ballop</td>
<td></td>
<td>to swing your arms in circles</td>
</tr>
<tr>
<td>flim</td>
<td></td>
<td>to breathe fire and be scary</td>
</tr>
<tr>
<td>frell</td>
<td></td>
<td>to touch something very gently</td>
</tr>
</tbody>
</table>

Each participant saw each of the nine verbs, so verb category was a within-participants factor. Between participants we manipulated a number of factors, explained in detail in Becker and Estigarribia (2013). Here I will focus on two manipulations and present the results relevant to them: whether participants were presented with the explicit definitions in Table 3 or not, and whether the novel “raising” verbs were used at least once with an inanimate subject, or
only with animate subjects. The subject animacy manipulation was done in the following way: participants in the 1-exemplar condition (see footnote 3) got one sentence (per verb) and for the target items (raising verbs) the subject was inanimate. Participants in the 3-exemplar condition saw each of their novel raising verbs in 3 sentences, one with an animate referential subject, one with an inanimate referential subject, and one with an expletive subject. Participants in the 5-exemplar condition got one animate subject, two inanimate referential subjects and two expletive subjects. In hindsight it might have been better to present participants with only inanimate subjects. Our reasoning in designing the study this way was that since raising verbs are used with animate subjects a large proportion of the time in natural speech (see Table 1), we thought that having these verbs occur sometimes with an animate subject would be more ecologically valid. In future work it would be good to rerun the experiment with only inanimate subjects.

To assess participants’ categorization of these novel verbs, we had them perform a forced-choice grammaticality judgment task. After reading the sentences for each verb, participants had to choose whether the novel verb sounded better in a there-construction (compatible with displacing verbs such as raising verbs but not with non-displacing verbs such as control or transitive verbs) or a pseudocleft (compatible with many non-displacing verbs such as some control verbs and all transitive verbs, but not raising verbs).

(12)  
   a. There joops to be a computer on the desk. (there-construction)  
   b. What the fairy joops is to be small. (pseudocleft)

Based on previous experimental work (Becker 2005), we predicted that participants’ default assumption would be that an animate subject was an agent or experiencer subject, and that a sentence like (13) would not involve displacement. That is, we predicted that participants would not categorize the novel verb in (13) as a raising verb and would therefore choose the pseudocleft as sounding better. On the other hand, if presented with an inanimate subject, as in (14), we predicted that participants would be led away from their default bias and instead categorize the novel verb as a raising verb, choosing the there-construction instead. In other words, we expected novel verbs seen at least once with an inanimate subject to be categorized as raising verbs more often than those seen only with animate subjects.

(13)  The old man joops to be very tired.
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(14) The book joops to be very long.

The animacy variable was partially crossed with the definition variable, so that some participants were given an explicit definition but the verbs were used only with animate subjects, some participants were not given a definition, but the novel raising verbs were used with at least one inanimate subject, and some participants were given both cues together: they received an explicit definition of each verb and the verb occurred with at least one inanimate subject. No participants were given only animate subjects and no explicit definition.5

Table 4. Manipulation of Between-Participants Factors

<table>
<thead>
<tr>
<th></th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Subject</td>
<td>Yes</td>
</tr>
<tr>
<td>Inanimate</td>
<td>√</td>
</tr>
<tr>
<td>Animate</td>
<td>√</td>
</tr>
</tbody>
</table>

An example of a raising verb item with a provided definition and used with an inanimate subject is given in (15). (A larger set of example stimuli is provided in Appendix A.)

(15) Joop: to look a certain way

a. The old man joops to be very tired.
b. The book joops to be very long.
c. It joops to be sunny outside.

3.1.2. Results

The results are shown in Figure 1. Here I average the results across the conditions containing different numbers of exemplars, and present data only from the list condition. The full study included 185 adult participants; the results below come from 91 of them (those participants in the list presentation condition). The figure shows the mean percentage of correct categorizations of novel raising verbs (i.e. selection of the there-sentence as sounding better). For comparison, I also show the mean percentage of correct responses for the control-like filler verbs. Recall that these are verbs with meanings and distributions similar to English control verbs and were presented only with animate
subjects. For these verbs, a correct response is selection of the pseudocleft, and as we can see in the graph these responses are essentially at ceiling.

Figure 1. Percentage Correct Categorizations of Novel Raising Verbs and Control-like Fillers

The main result for our target items was that when given only a lexical definition, even if it was one like “to look a certain way,” participants chose the there-construction only 51% of the time. However, when presented with the novel raising verbs with at least one inanimate subject, even with no definition, participants chose the there-construction 87% of the time. This difference is significant by a logistic regression ($\beta = 2.56, p < .0001$). When presented with both a lexical definition and inanimate subjects, participants chose the there-construction 72% of the time, significantly more than in the definition-only condition ($\beta = 1.23, p = .02$), but somewhat less than in the animacy-only condition. It is interesting to note that the definition and the subject animacy cue did not appear to have an additive effect: the percentage of correct responses in the “both” condition is not higher than in the animacy-only condition. In summary, when adults were given at least one inanimate subject they were very likely to pick the there-construction, indicating that they had categorized the verb as a raising verb.
3.2. Children’s categorization of tough- and control adjectives

The results of the study with adults suggest that adults can be led to categorize a novel verb as a raising (displacing) verb if they encounter that verb with an inanimate subject. The next question is whether children are similarly influenced by a predicate’s occurrence with an inanimate subject.

Becker, Estigarribia and Gylfadottir (2012) conducted an experiment with 40 children ages 4–7 years (mean age 6 years, 15 boys and 25 girls) (see also Becker, submitted). Children watched a series of videos in which Playmobil people had conversations using a novel adjective. The adjective was always used in a sentence frame of the form in (16).

(16) NP is Adjective to VP

This sentence frame is in principle compatible with the adjective being either a tough-adjective or a control adjective (cf. John is easy/eager to please). In each video conversation the adjective was used 5 times (see Appendix B).

3.2.1. Materials and Procedure

We created two novel tough-adjectives and two novel control adjectives. The tough-adjectives were used in conversational contexts where their meaning was roughly comparable to ‘easy’, and the control adjectives were used in contexts where their meaning was roughly ‘happy’ or ‘excited.’ Children were not told explicitly what the novel adjectives meant, but their consistent contextual usage means that one could substitute either easy or happy/excited for the novel adjective in each respective conversation and the conversation would be coherent.

<table>
<thead>
<tr>
<th>Tough Adj.</th>
<th>Contextual Meaning</th>
<th>Control Adj.</th>
<th>Contextual Meaning</th>
</tr>
</thead>
<tbody>
<tr>
<td>daxy</td>
<td>easy</td>
<td>greppy</td>
<td>happy/willing</td>
</tr>
<tr>
<td>stroppy</td>
<td>easy</td>
<td>narpy</td>
<td>happy/excited</td>
</tr>
</tbody>
</table>

An example conversation stimulus for each type of adjective is given below.

(17) daxy (novel tough-adjective)
Nurse: Hi Mrs. Farmer. I’d like to draw a picture, but I’m not good at drawing. Can you help me?

Mrs. Farmer: Sure, Nurse! First, you need to find something to draw. Look here: here’s a flower. A flower is daxy to draw. Let me see if I can draw it. <Nurse draws flower> There! I did it! Now you try.

Nurse: OK, let me see . . . <Nurse draws flower but messes up> Oh, I can’t do it! It didn’t come out right. Let me try drawing that tree over there. I bet a tree is daxy to draw.

Mrs. Farmer: Wait, trees are not very daxy to draw. They have so many little branches and leaves. Here, try drawing this apple instead. Apples are very daxy to draw.

Nurse: OK. <Nurse draws apple> Hey look, I did it! Here’s my drawing.

Mrs. Farmer: Good job!

Nurse: You were right: you have to find something that’s daxy to draw when you’re just learning.

(18) greppy (novel control adjective)

Policeman: Nurse, I have to move some furniture, but I can’t do it by myself. Can you help me?

Nurse: Well, I’m pretty busy right now. But let’s ask Mr. Farmer. He is always greppy to help. Oh look, there’s Mrs. Farmer.

Policeman: Hi Mrs. Farmer! Is Mr. Farmer around? Could he help me move some furniture? I asked the nurse, but she is not greppy to help.

Mrs. Farmer: I’ll ask him. I’m sure Mr. Farmer would be greppy to help. Mr. Farmer! Can you help the policeman?

Mr. Farmer: Sure, I can do it! What do you want me to do?

Policeman: Just help me move this furniture over there.

Mr. Farmer: OK! <Policeman and Mr. Farmer move furniture>

Policeman: Thanks! Oh, Mrs. Farmer, can you help me wash my car?

Mrs. Farmer: Let’s ask Mr. Farmer again, since I don’t like washing cars and he’s so greppy to help. Mr. Farmer, can you help the policeman again?
Learning structures with displaced arguments

Mr. Farmer: Sure, no problem! <washes car with policeman>
Policeman: Thanks, Mr. Farmer! It’s so nice to have a friend who is always greppy to help.

Each child saw videos for all adjectives, so like in the adult study, predicate category was a within-participants factor.

In addition, we manipulated subject animacy between participants in the following way. For 20 of the children (Group 1), the novel tough-adjectives were always used with an inanimate subject (as in (17)), while the novel control adjectives were always used with an animate subject (as in (18)). For the other 20 children (Group 2), all adjectives were used only with animate subjects. The reason for this manipulation was that in the first set of children, the contextual cues to the adjective’s meaning and the sentence frame cue (subject animacy) were confounded. In the second group of children we removed this confound by keeping the contextual information the same but removing the subject animacy cue.

The conversation for daxy with animate subjects (Group 2) is shown in (19), and the stimuli are summarized in Table 9.

(19) daxy (novel tough-adjective)

Nurse: Hi Mrs. Farmer. I’m taking an art class, and I need to practice drawing a person. Can I draw your portrait?
Mrs. Farmer: I’m pretty busy right now. Maybe you could draw the policeman.
Nurse: But I’m just starting, so I want to draw someone who is daxy to draw. The policeman is not daxy to draw. He has all those little buttons on his uniform, and his helmet is complicated.
Mrs. Farmer: I see. What about Mr. Farmer? I bet he is daxy to draw. He wears very simple clothes and doesn’t wear a hat.
Nurse: That’s a good idea! Mr. Farmer, can I draw your portrait?
Mr. Farmer: Sure!
Nurse: <draws Mr. Farmer> There, I did it! See, Mr. Farmer was daxy to draw. I made my very first portrait!
Mrs. Farmer: Good job! It’s good that you started out with Mr. Farmer. Now you can try drawing someone who is not daxy to draw, like the policeman.
**Table 9. Summary and Examples of Stimuli in Child Experiment**

<table>
<thead>
<tr>
<th>Group 1</th>
<th>Adjective</th>
<th>Example Sentence</th>
<th>Subject</th>
</tr>
</thead>
<tbody>
<tr>
<td>daxy</td>
<td>Apples are very <strong>daxy</strong> to draw.</td>
<td>inanimate</td>
<td></td>
</tr>
<tr>
<td>stroppy</td>
<td>This motorcycle is big and not at all <strong>stroppy</strong> to hide.</td>
<td>inanimate</td>
<td></td>
</tr>
<tr>
<td>greppy</td>
<td>I’m sure Mr. Farmer would be <strong>greppy</strong> to help.</td>
<td>animate</td>
<td></td>
</tr>
<tr>
<td>narpy</td>
<td>She was not <strong>narpy</strong> to teach</td>
<td>animate</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Group 2</th>
<th>Adjective</th>
<th>Example Sentence</th>
<th>Subject</th>
</tr>
</thead>
<tbody>
<tr>
<td>daxy</td>
<td>The policeman is not <strong>daxy</strong> to draw.</td>
<td>animate</td>
<td></td>
</tr>
<tr>
<td>stroppy</td>
<td>Yes, I bet the nurse is <strong>stroppy</strong> to hide.</td>
<td>animate</td>
<td></td>
</tr>
<tr>
<td>greppy</td>
<td>(same as Group 1)</td>
<td>animate</td>
<td></td>
</tr>
<tr>
<td>narpy</td>
<td>(same as Group 1)</td>
<td>animate</td>
<td></td>
</tr>
</tbody>
</table>

In order to evaluate children’s categorization of the novel adjectives, we developed a method of measuring children’s non-explicit (i.e. non-metalinguistic) grammaticality judgments. The reason we needed a new methodology was that while children can be trained to give explicit, metalinguistic grammaticality judgments for certain aspects of grammaticality, like word order, our past work has shown that it is extremely difficult to get children under the age of 7 to give consistent metalinguistic grammaticality judgments for these kinds of complex sentences. Moreover, other methodologies that would normally be appropriate for this age group, such as preferential looking or the truth-value judgment task, measure children’s semantic interpretations of sentences rather than their grammaticality judgment. Therefore we developed a new methodology that measured children’s reaction time in responding to Yes/No questions.

The premise of this methodology is that it will take children longer to answer ungrammatical questions than grammatical ones. We based this methodology on a very similar one used by Naigles, Fowler & Helm (1995), in which children took longer to respond in an act-out task to ungrammatical prompts than to grammatical prompts. In our target items, we asked each child two Yes/No questions following each video (order of questions was counterbalanced across participants), one of which would be grammatical if the adjec-
tive were construed as a *tough*-adjective (see (20)), and the other of which would be grammatical if the adjective were construed as a control adjective (see (21)).

(20) Is it Adjective to VP?
   a. Is it daxy to draw a tree?
   b. *Is it greppy to help the policeman?

(21) Is NP Adjective?
   a. Is the nurse greppy?
   b. *Is a tree daxy?

As a criterion of inclusion, children had to respond correctly to at least 7 out of 10 grammatical questions in the experiment (4 warm-ups/fillers, 2 English adjectives (*hard* and *afraid*), and 4 novel adjectives). Of the children whose data was retained on the basis of this criterion (40; 3 additional children were excluded on this basis), the mean correct score was 9.0/10. Below I report only the RT data; I do not report response correctness because there were so few incorrect responses to grammatical questions, and I do not believe it makes sense to judge either answer “correct” or “incorrect” for an ungrammatical question.

### 3.2.2. Results

First, we demonstrate that our methodology provides a good measure of children’s implicit grammaticality judgments. In our warm-up and filler items, which involved real or novel transitive and intransitive verbs, children took longer to answer ungrammatical than grammatical questions, where ungrammatical questions involved an argument structure violation. For example, children took significantly longer to answer questions like “Did the farmer play the car to his friend?” or “Did the nurse borrow?” than “Did the farmer play with the car?” or “Did the nurse borrow a basket?” regardless of whether the target answer was “yes” or “no.” This is shown in Figure 2.6

In addition, we tested our child participants on two real adjectives, one real *tough*-adjective (*hard*) and one real control adjective (*afraid*). For these items, children were asked the following questions:

(22) a. Is it hard to talk to the nurse?/*Is the nurse hard?
Figure 2. Mean RT (log10) for Warm-ups and Fillers

b. Is the nurse afraid?/*Is it afraid to fight the dinosaur?

The results for hard and afraid are given in Figure 3. A mixed linear regression revealed that for both adjectives, children were significantly faster in answering the grammatical than the ungrammatical question (for hard, Wald’s $\chi^2 = 11.27, p < .001$; for afraid, Wald’s $\chi^2 = 9.47, p < .01$), and there was no significant interaction between the two adjectives ($p = .47$).

Now let us turn to our novel adjective items. I will present the two groups of children separately, and then compare them. We ran a mixed linear regression model with condition, adjective type, age and grammaticality as fixed effects (participant was the random effect). The children who got the subject animacy cue (Group 1) took significantly longer to answer ungrammatical questions (than grammatical questions) for novel tough-adjectives (Wald’s $\chi^2 = 40.66, p < .0001$), but not for the novel control adjectives (Wald’s $\chi^2 = 1.01, p = .3152$; see Figure 4).

Thus, children were significantly faster in responding to the grammatical question ("Is it daxy to draw an apple?") than the ungrammatical question ("Is a tree daxy?") for the novel tough-adjectives. This confirmed our hypothesis that an inanimate subject cue would support categorization of the adjective as a tough-adjective. Presented with animate subjects, children did not appear to categorize the novel adjectives one way or another.
However, recall that there was a confound in the Group 1 stimuli: these children received the inanimate subject cue together with contextual cues to the adjectives’ meanings. Let us now look at the Group 2 data, where we removed this confound by presenting all adjectives with animate subjects.
Here the data look different (see Figure 5).

Figure 5. Mean RT (log10) to novel *tough* and control adjectives, Group 2

Children appeared to take longer to answer the ungrammatical questions for both types of adjectives, counter to our predictions. However, in this case the log10 transformation is actually misleading. First of all, the difference in the log10 Response Time was not significant for novel *tough*-adjectives (Wald’s $\chi^2 = 2.85, p = .09$), though it was for the novel control adjectives (Wald’s $\chi^2 = 9.24, p < .01$). Secondly, when we look at the raw Response Time scores in milliseconds (see Table 10) we can see that children took about the same amount of time to answer the grammatical and ungrammatical questions for novel *tough*-adjective items, suggesting an inability to categorize these adjectives without the inanimate subject cue.

Table 10. Raw Response Times (msec) to Novel Adjectives, Group 2

<table>
<thead>
<tr>
<th>Adjective Type</th>
<th>Grammatical</th>
<th>Ungrammatical</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>tough</em></td>
<td>1964.5</td>
<td>1723.8</td>
</tr>
<tr>
<td>control</td>
<td>1732.5</td>
<td>2841.3</td>
</tr>
</tbody>
</table>

Two additional pieces of data are relevant in interpreting these results. One is that when we compare Groups 1 and 2 directly on their RT to grammatical...
and ungrammatical tough-adjective questions, we can see that Group 1 children (inanimate subjects) were significantly faster in their responses to the grammatical questions than Group 2 children (animate subjects) were (see Figure 6). Since the only difference between the two groups was whether the novel adjectives were presented with animate or inanimate subjects, this stark difference suggests a facilitatory effect of hearing an inanimate subject in speeding up responses to grammatical questions.

Figure 6. Mean RT (log10) to novel tough-adjectives, Group 1 vs. Group 2

Secondly, in a follow-up study with 3- and 4-year-olds I removed all contextual cues to the adjective meanings, presenting novel adjectives in a semantically pared-down dialogue as illustrated in (23), modeled after stimuli used by Yuan and Fisher (2009).

(23) No-context dialogue
   A: The baker/chair is stroppy to push!
   B: Really? The baker/chair is stroppy to push?
   A: Yeah, the baker/chair is stroppy to push.
   B: What about the bus driver/book? Is the bus driver/book stroppy to push?
   A: No, the bus driver/book is not stroppy to push.

I manipulated subject animacy between participants and found that 3-year-
olds were significantly faster in answering questions of the form “Is it stroppy to push the chair?” than “Is the chair stroppy?” but showed no reliable difference in RT when they had heard the novel adjectives only with animate subjects. These results are strongly reminiscent of the Group 1 results reported above. That is, they underscore the important influence of inanimate subjects in leading learners to categorize novel predicates as displacing predicates. Due to space limitations, I cannot provide full details of this study, but please see Becker (submitted).

3.2.3. Discussion

Let me offer what I see as the two main implications to be drawn from these two experiments. The first implication is that inanimate subjects provide a cue that the main predicate is a displacing predicate. Both adults and children are equivocal in categorizing a novel predicate that could be a displacing predicate if it is presented with an animate subject, but they strongly categorize the same predicate as a displacing predicate if it is encountered with an inanimate subject. This is seen in adults’ preference for the there-construction for novel verbs seen with at least one inanimate subject and in children’s faster response times to questions like Is it daxy to draw an apple? when the adjective daxy had been used with inanimate subjects. Though I did not provide the full results, I noted that a similar finding turned up in 3-year-olds who were presented with simple dialogues with novel adjectives, lacking situational context.

The second implication is that there are other cues besides subject animacy that learners (both adults and children) make use of in inferring the lexical (semantic and argument-structure) properties of novel predicates. In the adult study we saw that participants chose the pseudocleft nearly 100% of the time when they were given a novel filler verb whose meaning resembled that of an actual control verb, but they chose the there-construction and the pseudocleft each about half the time if they were given a novel verb whose meaning resembled that of an actual raising verb, if it was presented with an animate subject. So there is some other source of information that pushes people away from their default control assumption. It could be the provision of the lexical definition, or it could be some aspect of the lower predicate we did not control for. Regarding the latter possibility, I should point out that there is no selectional relationship between the lower predicate (e.g. to be
very tired) and the main predicate itself (e.g. seem, claim), and so any influence of the lower predicate on the higher one would be extremely interesting but not entirely clear in its nature. And crucially, whatever this influence is, it does not lead participants to correctly choose the there-construction nearly 90% of the time, the way encountering an inanimate subject does.

As for children, we saw that in certain conditions children are able to extract some semantic information from the scene context which helps them categorize novel abstract predicates. In particular, the children in Group 2 were significantly faster in answering the grammatical question for novel control adjectives (“Is the nurse greppy?”) than the ungrammatical question (“Is it greppy to help the policeman?”), though they were not reliably different in their RT to novel tough-adjectives if these were heard with animate subjects. Papafragou, et al. (2007) found that children were able to infer the meanings of some mental verbs (like think) given particular scene contexts, specifically false belief contexts. So there may have been something about our scenarios that made a control meaning salient. However, the identical story contexts did not appear to cue children in this way in Group 1. Thus, the nature of the influence of situational cues on predicate learning is not really clear.

Alternatively, as in the adult study, there may have been sentence-internal cues other than subject animacy that we did not control for, such as the particular embedded predicates, which guided children’s (main clause) adjective categorization. We did control for the lexical aspect of the lower predicates (all were stative; none were eventive), but there may have been other distinguishing aspects of these predicates we did not consider. When attempting to create stimuli that are coherent and engaging, it is difficult to control for all possibilities. Nevertheless, the same caveat applies as before: there is no selectional relationship between the lower predicate itself and the main predicate, only between the lower predicate and the subject, so the nature of the influence of the lower predicate on the choice of the main clause predicate is not transparent from a syntactic standpoint.

One final point I would like to make about the tough adjective study with children is that there were no age effects among our participants: the 4-year-olds behaved the same as the 7-year-olds. But the conventional wisdom about tough-constructions is that they are hard for children—children consistently misinterpret them (as control constructions) until at least age 6, and in some cases as late as age 10. This raises the question of why the children in our study were able to categorize novel adjectives as tough-adjectives when they were presented with an inanimate subject. The answer I offer is precisely that
animacy holds the key: in previous work on children’s *tough*-constructions (e.g. Anderson 2005, Chomsky 1969, Cromer 1970), animate or animate-like subjects were used (e.g. *The doll is easy to see; The wolf is hard to bite*). What our data show is that when the subject is animate, these predicates can be hard to categorize, and my interpretation of the previous literature is that this is what made the task hard for children. In essence, I am suggesting that in previous experiments children were willing to miscategorize even known *tough*-adjectives as control adjectives if they were presented with an animate subject.

4. Conclusion and Open Questions

To summarize, I have argued that children acquire the complex structures of displacing predicates, in particular raising verbs and *tough*-adjectives, by hearing them used with inanimate subjects. In input to children these predicates are used more frequently with inanimate subjects than their non-displacing (control) counterparts. In two novel word-learning studies I found that both adults and children are more likely to infer that a novel predicate is a displacing predicate, and therefore that the structure is complex, if they hear it used with an inanimate subject than if they hear it with an animate subject.

A number of questions remain open, some of which I will address here. First I will discuss the cue of expletive subjects, followed by a discussion of unaccusatives. Finally, I want to raise a theoretical question about the origin of displacing predicates in the minds of language learners.

4.1. Expletives as a cue

Both raising and *tough*-predicates allow expletive subjects, while control predicates do not. Thus, expletive constructions would appear to be an obvious cue to learners that a predicate that occurs with them is a displacing predicate.

(24) a. There seems to be a problem here.
    b. *There claims to be a problem here.

(25) a. It is easy to please John.
    b. *It is eager to please John.
I exploited this asymmetry in my word learning experiments, using expletive constructions as a diagnostic for predicate categorization. I do assume that in real-life language learning, children will make use of this cue when it is present. However, there are a few reasons why I have focused on inanimate referential subjects instead. One is that expletives are not present in all languages, while inanimate NPs are. If we want to develop a learning strategy that all children can make use of, inanimate referential subjects are perhaps a better choice.

Another reason for emphasizing inanimate subjects is that expletives are even less frequent in input to children than inanimate subjects are. In my own search of the Brown (1973) corpus on CHILDES I found only 11 uses of a raising verb with an expletive subject, compared to 69 occurrences of raising verbs with an inanimate referential subject. In Table 1 there are 1315 raising verbs occurring with a referential subject, so if we include the occurrences with expletive subjects there are a total of 1326 relevant utterances, and 11/1326 is .8%. Based on a search of a much wider range of corpora in CHILDES, Hirsch and Waxler (2007) found a larger proportion (13%) of maternal uses of the raising verb *seem* with expletive subjects (the remaining uses of this verb have referential subjects), but their search was limited to the fairly infrequent verb *seem*. In the *tough*-adjective data there are proportionally more uses of *tough*-adjectives with expletive subjects, relative to those with raising verbs, but still fewer than the uses of *tough*-adjectives with inanimate referential subjects (75 occurrences with expletive subjects vs. 113 occurrences with inanimate referential subjects).

A further reason why expletives could actually be problematic for the learning procedure is that there are some predicates that take an expletive subject but do not allow raising of a referential NP into the subject position. For example, while the raising adjective *likely* allows expletive and raised referential subjects, the semantically similar *probable* allows only expletives. Similarly, the verb *to suck* (meaning to be bad, or unfortunate) can occur with an expletive but not a raised NP, in contrast to *seem*.

(26) a. It is likely that John will leave/John is likely to leave.
   b. It is probable that John will leave/*John is probable to leave.

(27) a. It seems that John left/John seems to have left.
   b. It sucks that John left/*John sucks to have left.
On the other hand, expletives could play a critical role in helping learners tease apart *tough*-constructions from other gapped constructions, such as complement object deletion (see (28); Lasnik and Fiengo 1974), degree constructions (see (29)) and constructions with *ready* (see (30)).

(28) The flowers are pretty to look at.
(29) The rock is too small to see.
(30) The sandwich is ready to eat.

All of these constructions permit inanimate subjects and involve an object gap in the embedded clause, but none of them permit expletive subjects.

(31) *It’s pretty to look at the flowers.
(32) *It’s too small to see the rock.
(33) *It’s ready to eat the sandwich.

These constructions, also, do not have the same underlying syntactic structure as *tough*-constructions (see Anderson 2005 for a good discussion). I do not know how often complement object deletion or degree constructions occur with inanimate subjects in child-directed speech, but in my search of the eight corpora reported above in section 2, I found 154 parental uses of *ready* with an infinitive complement, 16 of which had an inanimate subject (10.4%) (see Becker, in press). Interestingly, though, only 3 uses of *ready* involved an object gap in the lower clause; the remaining 151 had a subject gap.

Finally, I note that constructions with expletive subjects are not exactly complex in the way that constructions with referential NP subjects are: while it is true that the expletive is not an agent or experiencer of the main predicate, expletives are non-referential and so could not possibly bear any thematic role, in contrast to referential NPs. Thus, there is no surface ambiguity in these constructions. Additionally, expletives are not raised from a lower clause; hence, these constructions do not involve NP-movement. In brief, expletives can provide some important and useful cues about the lexical properties of displacing predicates, but they do not directly cue a complex underlying syntax, and, as we have seen, they are not without their problems. It may be that they play a more central role in acquiring displacing *adjectives* than displacing *verbs*. In the case of displacing verbs, inanimate subjects are at least as good a cue, are more prevalent in the input, and the experiments described above show that learners use them in the process of predicate cate-
Another open question is whether inanimacy indicates a displaced subject only in biclausal constructions such as raising-to-subject or tough-constructions, or whether it can be informative in monoclausal frames as well. I suspect that it is a somewhat more robust cue in biclausal structures. In monoclausal structures it is intuitively more likely that the NP or NPs in that clause are arguments of the verb. However, we find displaced subjects in monoclausal frames as well, for example in unaccusatives (34-a) and certain psych-verbs (34-b). In both cases the subject can easily be inanimate.

(34) a. [The relatives/gifts]i arrived t_i at the wedding.
   b. [John/the noise]i bothers t_i me.

Although I have not examined NP animacy in psych-verb constructions, I have looked at it in sentences with unaccusative vs. unergative verbs. In child-directed speech we see the same kind of asymmetry we saw with raising and tough-constructions (the data in Table 11 come from the Brown (1973) corpus on CHILDES).

<table>
<thead>
<tr>
<th></th>
<th>Animate Subject</th>
<th>Inanimate Subject</th>
<th>% Inanimate Subject</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Mothers</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Unaccusatives</td>
<td>552</td>
<td>335</td>
<td>37.8%</td>
</tr>
<tr>
<td>Unergatives</td>
<td>207</td>
<td>12</td>
<td>5.5%</td>
</tr>
<tr>
<td><strong>Children</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Unaccusatives</td>
<td>1656</td>
<td>1166</td>
<td>41.3%</td>
</tr>
<tr>
<td>Unergatives</td>
<td>384</td>
<td>29</td>
<td>7.0%</td>
</tr>
</tbody>
</table>

The data in Table 11 show that while parents only rarely use inanimate subjects with unergative verbs, they do so quite often with unaccusatives, and the mothers’ distribution is significant ($\chi^2(1) = 85.0, p \leq .001$).

I have not tested children’s categorization of novel intransitive verbs on the basis of subject animacy, but we can observe a very similar asymmetry in children’s spontaneous productions of unaccusative and unergative verbs.
Conclusion and Open Questions

(see Table 11, where the distribution for children is also significant: $\chi^2(1) = 182.0, p \leq .001$; similar data are reported in Becker and Schaeffer 2013). Experimental evidence from Bunger and Lidz (2004, 2008) strongly suggests that children take intransitive novel verbs heard with animate subjects to be unergative, and those heard with inanimate subjects to be unaccusative.

Furthermore, formal learning algorithms that simulate the learning of unaccusative and unergative verbs have found subject animacy to be an essential cue for acquiring the distinction between these verbs (Merlo and Stevenson 2001, Scott and Fisher 2009).

Thus, it may be the case that inanimate subjects cue displaced subjects even beyond multiclusal structures. On the other hand, we should exercise caution here; we probably do not want to predict that no transitive verbs will select a theme as external argument. For example, there are locative predicates like *occupy* which seem to take a theme subject, which can be animate or inanimate, and a location object (*John occupies that desk at the moment; The sofa occupies the whole side of the living room*). I must leave further considerations of this question to future work.8

4.3. Are complex constructions known *a priori*?

Finally, an interesting theoretical question that my work raises is whether children innately expect language to allow the type of complex sentence structures discussed here, or whether this fact about language must be learned based on the input. One way to think about this question is to ask whether there is a general linguistic category of “displacing predicate” (see discussion about what this might mean in Becker, in press), such that children slot novel predicates into this category based on hearing them used with an inanimate subject, or whether this category is not known innately but rather is constructed based on language input (again, inanimate subjects providing the crucial cue). Let us explore the former possibility: that a hypothesized “displacing predicate” category is innately known.

One way to think about the predicate categorization problem faced by learners is that in order to construct a general category of “displacing predicate,” we would need to be able to identify some threshold of inanimate subject use, such that rates of use at or above that threshold would create the displacing category. But recall that the displacing predicates we have looked at have widely disparate rates of inanimate subject use. While *tough*-adjectives
Learning structures with displaced arguments

are used with inanimate subjects almost 100% of the time (considering only referential subjects), unaccusatives are used with inanimate subjects only a little under 40% of the time, and raising verbs only 5%.

Table 12. Relative Rates of Subject Inanimacy in Adult Speech, by Predicate Type

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Tough-adj.</td>
<td>97.4/59.2%*</td>
<td>Control adj.</td>
<td>0%</td>
</tr>
<tr>
<td>Unaccusative V</td>
<td>37.8%</td>
<td>Unergative V</td>
<td>5.5%</td>
</tr>
<tr>
<td>Raising V</td>
<td>5.2%</td>
<td>Control V</td>
<td>0.3%</td>
</tr>
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*Out of referential subjects/out of all (including expletive) subjects

If the threshold were very high, tough-adjectives would be unproblematic (i.e. 97% is high enough that the category can be constructed; perhaps 59% would also be high enough), but raising verbs, with only 5.2% use with inanimate subjects, might not contribute to the construction of this category and might be miscategorized as non-displacing predicates. Given the extremely low token frequency (not to mention low type frequency) of tough-adjectives (roughly, 1 in every 2,000 utterances), this exposure might not be sufficient for the construction of a general category of displacing predicates.

If the threshold were very low, so that a low rate like 5% were sufficient to construct this category, then both raising verbs and tough-adjectives could contribute to the formation of this category and would be correctly categorized, but we might run into problems with intransitive verbs. This is because unergative verbs are used with inanimate subjects over 5% of the time in maternal speech, and learners might categorize all intransitive verbs as displacing predicates.

On the other hand, if the learner merely needs to sort new predicates into a known category of displacing predicates, rather than create this category anew, the proportions of inanimate subject use can be helpful. That is, if the learner expects certain predicates to be of the displacing sort, and other predicates to be of the non-displacing sort, it is only the comparison of rates across each row in Table 12 that is needed. For example, the learner must compare 5.2% to 0.3%, which is highly significant given the high token frequencies of both raising and control verbs, or 37.8% to 5.5% (for unaccusatives vs. unergatives), which is also significant. Thus, in each case the pairwise comparison is significant. What I am proposing is that an inanimate subject is
a useful cue that the underlying syntax is complex *if* learners expect language to allow this type of complexity, but it may not be sufficient to lead learners to figure out that language permits complex structures with non-adjacent thematic relations *if* the possibility for such structures is not assumed a priori. But I leave further consideration of this question to future work.

5. Appendix A

The following lists examples of stimuli from the adult verb-learning experiment in the 5-exemplar condition, list presentation, first with the animacy manipulation (novel raising verbs are presented with at least one inanimate subject), then without that manipulation (novel raising verbs are presented only with animate subjects). A fuller set of stimuli is provided in Becker & Estigarribia (2013).

At least one inanimate subject:

1. **joop**
   - (a) The old man *joops* to be very tired.
   - (b) The book *joops* to be very long.
   - (c) It *joops* to be sunny outside.
   - (d) That mountain *joops* to be too steep to climb.
   - (e) It *joops* to be about to rain.

   Test sentences:
   - What the fairy *joops* is to be small.
   - There *joops* to be a computer on the desk.

2. **meb**
   - (a) That tree is tall and its branches are really high up, so it *mebs* to be hard to climb.
   - (b) It *mebs* to be hot every day when it’s summer.
   - (c) The president *mebs* to be a very organized person.
   - (d) That old house *mebs* to be haunted.
   - (e) It *mebs* to be foggy along the coast.

   Test sentences:
   - What the fisherman *mebed* was to be careful.
   - There *mebed* to be a storm at sea.
3. trollick

(a) It trollicks to be humid right before it rains.
(b) The kitchen sink trollicks to be full of dirty dishes!
(c) The lifeguard at the pool trollicks to have a tan.
(d) The floor in the basement trollicks to be dirty.
(e) It trollicks to be cold in the middle of winter.

Test sentences:
What the giant trollicks is to be loud.
There trollicks to be cold weather in winter.

Only animate subjects:

1. joop

(a) The old man joops to be very tired.
(b) Skunks joop to have a white stripe on their backs.
(c) The cat joops to have black fur and a long tail.
(d) The teacher joops to be serious.
(e) Vanessa joops to be in a good mood.

Test sentences:
What the fairy joops is to be small.
There joops to be a computer on the desk.

2. meb

(a) My sister is really tall, so she mebs to be a good basketball player.
(b) My friend saw a scary movie, so she mebs to be afraid of the dark.
(c) The president mebs to be a very organized person.
(d) Bill mebs to be sick because he didn’t come to school today.
(e) The cat mebs to be good at chasing mice.

Test sentences:
What the fisherman mebed was to be careful.
There mebed to be a storm at sea.

3. trollick
(a) My friend trollicks to be happy all the time.
(b) My cat trollicks to have fleas.
(c) The lifeguard at the pool trollicks to have a tan.
(d) The photographer trollicks to be very charming.
(e) Ogres trollick to be mean.

Test sentences:
What the giant trollicks is to be loud.
There trollicks to be cold weather in winter.

6. Appendix B

Here I provide the stimuli for the two versions of the child study on tough-adjectives.

Group 1: Novel tough-adjectives:

1. daxy

Nurse: Hi Mrs. Farmer. I’d like to draw a picture, but I’m not good at drawing. Can you help me?
Mrs. Farmer: Sure, Nurse! First, you need to find something to draw. Look here: here’s a flower. A flower is daxy to draw. Let me see if I can draw it. <Nurse draws flower> There! I did it! Now you try.
Nurse: OK, let me see . . . <Nurse draws flower but messes up> Oh, I can’t do it! It didn’t come out right. Let me try drawing that tree over there. I bet a tree is daxy to draw.
Mrs. Farmer: Wait, trees are not very daxy to draw. They have so many little branches and leaves. Here, try drawing this apple instead. Apples are very daxy to draw.
Nurse: OK. <Nurse draws apple> Hey look, I did it! Here’s my drawing.
Mrs. Farmer: Good job!
Nurse: You were right: you have to find something that’s daxy to draw when you’re just learning.
2. stroppy

Mrs. Farmer: I want to buy Mr. Farmer a surprise birthday present. I will hide the present from him in this box until his birthday. So it needs to be something that is stroppy to hide.
Nurse: Hi Mrs. Farmer!
Mrs. Farmer: Hi Nurse! Will you help me think of a good present for Mr. Farmer? It has to be stroppy to hide, because it is a surprise.
Nurse: What about a motorcycle?
Mrs. Farmer: Let me see . . . . No, this motorcycle is bit and not at all stroppy to hide! See? It doesn’t fit in this box. I was thinking maybe a ladder.
Nurse: But the ladder isn’t stroppy to hide either! See? It sticks out.
Mrs. Farmer: You’re right, Nurse. Maybe I will get Mr. Farmer a nice watch.
Nurse: I think that’s a good idea! A watch is small and very stroppy to hide. < Mrs. F places watch inside box and closes>

Novel control adjectives:
1. greppy

Policeman: Nurse, I have to move some furniture, but I can’t do it by myself. Can you help me?
Nurse: Well, I’m pretty busy right now. But let’s ask Mr. Farmer. He is always greppy to help. Oh look, there’s Mrs. Farmer.
Policeman: Hi Mrs. Farmer! Is Mr. Farmer around? Could he help me move some furniture? I asked the nurse, but she is not greppy to help.
Mrs. Farmer: I’ll ask him. I’m sure Mr. Farmer would be greppy to help.
Mr. Farmer: Sure, I can do it! What do you want me to do?
Policeman: Just help me move this furniture over there.
Mr. Farmer: OK! <Policeman and Mr. Farmer move furniture>
Policeman: Thanks! Oh, Mrs. Farmer, can you help me wash my car?
Mrs. Farmer: Let’s ask Mr. Farmer again, since I don’t like washing cars and he’s so greppy to help. Mr. Farmer, can you help the policeman again?
Mr. Farmer: Sure, no problem! <washes car with policeman>
Policeman: Thanks, Mr. Farmer! It’s so nice to have a friend who is always greppy to help.

2. narpy

Mother: Hi, kids!
Children: Hi Mom!
Mother: Today was the first day of school. Did you like your teachers?
Child 1: Yes, I really liked my teacher. She was narpy to teach! She was very excited and gave us fun projects to do.
Mother: That’s great!
Child 2: I did not like my teacher. She was not narpy to teach. She made the class sit quietly and do nothing all day. We were all very bored.
Mother: Oh no, that sounds awful. It’s not good to have a teacher who isn’t narpy to teach!
Child 2: Yeah. If my teacher isn’t narpy to teach, I won’t learn anything!
Mother: Maybe your teacher was feeling sick, and that’s why she wasn’t narpy to teach. She will probably feel better tomorrow, and then you will learn a lot!

Group 2: Novel tough-adjectives

1. daxy

Nurse: Hi Mrs. Farmer. I’m taking an art class, and I need to practice drawing a person. Can I draw your portrait?
Mrs. Farmer: I’m pretty busy right now. Maybe you could draw the policeman.
Learning structures with displaced arguments

Nurse: But I’m just starting, so I want to draw someone who is daxy to draw. The policeman is not daxy to draw. He has all those little buttons on his uniform, and his helmet is complicated.

Mrs. Farmer: I see. What about Mr. Farmer? I bet he is daxy to draw. He wears very simple clothes and doesn’t wear a hat.

Nurse: That’s a good idea! Mr. Farmer, can I draw your portrait?

Mr. Farmer: Sure!

Nurse: <draws Mr. Farmer> There, I did it! See, Mr. Farmer was daxy to draw. I made my very first portrait!

Mrs. Farmer: Good job! It’s good that you started out with Mr. Farmer. Now you can try drawing someone who is not daxy to draw, like the policeman.

2. stroppy

Mrs. Farmer: Hi Policeman! Would you help me throw a surprise birthday party for Mr. Farmer? You’ll have to hide behind this fence until he gets home. Then, we’ll surprise him! I’m also going to invite the nurse. She is stroppy to hide because she is very quiet.

Policeman: Sure! This sounds like fun. Yes, I bet the nurse is stroppy to hide.

Mrs. Farmer: Hey Nurse, will you help me throw a surprise party for Mr. Farmer? You have to hide behind this fence with the policeman. I’ll put a blanket over you.

Nurse: Sure, I can do it.

Policeman: <starts snoring>

Nurse: Oh no! The policeman fell asleep! Mrs. Farmer! The policeman is not stroppy to hide, he’s making a lot of noise with his snoring!

Mrs. Farmer: Policeman, be quiet! Oh, the policeman is not stroppy to hide. Maybe I should have invited a different friend who is stroppy to hide. Oh look, here comes Mr. Farmer! Shhhhh!

Nurse & Mrs. F: SURPRISE!!

Mr. Farmer: Oh, you really surprised me!
Mrs. Farmer: Well, I guess it worked even though the policeman made some noise.

Novel Control adjectives: same as for Group 1.
Chapter 2
Notes

1. Here I abstract away from copular constructions (*John is a man*), in which the subject, to the extent it can be considered an external argument, is a theme.
2. The data shown here are adapted from Mitchener and Becker (2011: 175–176); here I collapse across each verb’s occurrences with stative and eventive lower predicates. The verb *happen (to)* was used but only the sense of “What happened to you?”. We will return to a discussion of expletive subjects in section 4.1.
3. We also manipulated, across (between-participant) conditions, the frequency of exposure to each novel verb (some participants saw only one exemplar, some saw three and some saw five exemplars of each novel verb) and whether the mode of presentation of the novel verbs consisted of a list of unrelated sentences (as shown in example (15) below) or as part of a very short story. The reason for including these manipulations was that we were curious about what other factors besides subject animacy might influence novel predicate categorization. Since the frequency manipulation did not result in any significant main effects, I will collapse across those conditions in presenting the results of our experiment here. There was a small but significant effect of the mode of presentation: the subject animacy cue was stronger when novel verbs were presented in the list rather than the story format. For a fuller discussion of those variables please see Becker and Estigarribia (2013).
4. The two test sentences were semantically unrelated to each other, as were the stimulus sentences. A reviewer suggests that the forced-choice task might benefit from having the two test sentences as similar as possible. It would be interesting to see whether this made a difference in the results. Our reason for making the test sentences dissimilar was to avoid possible contamination between the two sentences.
5. While it would be interesting to test this condition, the large number of between-participant conditions we already had (18) made testing additional manipulations infeasible.
6. In this and all subsequent graphs, the y-axis shows the log10 of the reaction time (RT) in milliseconds.
7. It is true that if the pronoun *it* is construed as referential, the second question in (22-a) would not be ungrammatical. We sought to make such a construal as unlikely as possible by having only animate characters referred to in the dialogue, but we cannot rule out with certainty the possibility that some children understood the expletive *it* as referential.
8. Children may also derive some cues to verb category from the lexical meanings of these verbs (Jackendoff 1990). However, following Gleitman et al. 2005 and others in the Syntactic Bootstrapping literature, I am adopting the view that verb meanings are acquired largely from structural constraints, rather than the lexical meanings being learned first via alternative means and then giving rise to structural knowledge.
# Chapter 3

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<th>Year</th>
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