

# ***Tough-Adjectives are Easy to Learn***\*

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## **1. Introduction**

A long-standing puzzle in linguistic theory is how children come to figure out the structure of sentences in which the semantic relations among the words do not “line up” with their syntactic relations (N. Chomsky 1965, p. 22, C. Chomsky 1969, p. 6). For example, how does a child figure out that the syntactic subject of a sentence is not in fact its “semantic” subject? Such a situation arises in so-called *tough*-constructions, illustrated in (1).

- (1) a. The girl is easy/tough to see.  
b. [The girl<sub>i</sub> is easy/tough [Op [PRO<sub>arb</sub> to see t<sub>i</sub>]]

In this sentence, the subject *the girl* is interpreted as the semantic object of the lower predicate *see*. In previous studies of children's acquisition of *tough*-constructions the main reported finding is that children err in their interpretation of these constructions until quite late in development, around age 6 to 10 years (C. Chomsky 1969, Cromer 1970, i.a.). More recent investigations (Anderson 2005) have likewise found that children give at best inconsistent interpretations, and at worst consistently incorrect interpretations, until age 5 or 6 years. Mainly, children construe the subject of the sentence as the semantic subject of the lower predicate. Thus, (1) is interpreted to mean “it is easy/tough for the girl to see someone else.” The common supposition is that children arrive at this interpretation by misparsing the structure of (1) as a control structure, in which the main clause subject is the external argument of the main clause predicate, on analogy to (2).

- (2) a. The girl is eager to see.  
b. [The girl<sub>i</sub> is eager [PRO<sub>i</sub> to see e]]

While the exact syntactic analysis of (1) has long been disputed, the semantic role of the subject argument is clear. Here we adopt Hicks's (2009) analysis, which accounts for the fact that the matrix subject is interpreted as the semantic object of the lower verb.

In our research, we asked two questions: (a) Do children really have difficulty in parsing sentences like (1), or could the prior finding of errors be an artifact of the kinds of sentences used to investigate the construction? (b) More importantly, *how* do children come to distinguish these two syntactic structures, given their surface similarity? We answer these questions as follows: (a) children can in fact represent *tough*-constructions by age 4, and we explain the prior finding of late acquisition in terms of the wide use of

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animate (or animate-like) subjects in previous experiment stimuli; (b) children rely on the feature of subject *animacy* (or, more accurately, *inanimacy*) to acquire the structures of *tough*-constructions.

There are three reasons for homing in on animacy as the crucial feature. First, while both *tough* and control adjectives freely admit animate subjects, only *tough* adjectives admit inanimate subjects, as in (3).

- (3) a. The rock is easy/hard to lift.
- b. #The rock is eager/afraid to lift.

Thus, encountering an inanimate subject in this sort of sentence frame should serve as a strong cue that the matrix adjective is not a control adjective, and therefore likely a *tough* adjective.

Secondly, the concept of animacy develops very early in infancy. A vast literature documents babies' ability to discriminate animate from inanimate things on the basis of featural (e.g. having a face) and behavioral properties (e.g. self-propelled motion, causation) within the first several months of life (e.g. Fantz et al. 1975, Johnson et al. 1991, Leslie & Keeble 1987, Woodward et al. 1993). More pointedly, babies ascribe intentions and goal-directed movement to humans but not inanimate objects quite early, by some accounts as early as 5 months (e.g. Woodward 1998). Other studies put the attribution of intentional properties closer to 15-18 months (Meltzoff 1995, Onishi & Baillargeon 2005, i.a.), but still it is clearly in place by the time sentence structure is being acquired.

Thirdly, in child-directed speech parents uniformly use *tough*-adjectives with inanimate subjects, and control adjectives with animate subjects. In our search of four corpora within the CHILDES database (MacWhinney 2000) we found a stark asymmetry in subject use. Although the actual numbers of productions are extremely low for both adjective types, there is no overlap in their occurrence with animate or inanimate subjects. Table 1 shows the numbers (tokens) we found in our search of all Mothers' tiers in the Bloom (1970), Brown (1973), Sachs (1983) and Suppes (1974) corpora.

Table 1. Number of Adjectives Used with (In)Animate Subjects in Maternal Speech

	Animate Subject	Inanimate Subject
<i>Tough-Adjective</i>	0	48
Control Adjective	10	0

Thus, we reason that animacy is a plausible cue for learning to distinguish these constructions. In what follows we describe an experiment we conducted with the aim of answering the two questions outlined above.

## 2. Experiment

We conducted a novel word learning task. Participants were 40 children ages 4 to 7 years (M = 6;0, range 4;3-7;10, 15 boys and 25 girls). All children were monolingual native speakers of English without any known language or other cognitive impairments.

Each child watched a series of videos in which they saw and heard Playmobil characters having conversations. The characters were held in the experimenters' hands, while the experimenters themselves were off screen (only their hands were visible). The experimenters produced the voices of the characters, and the character who was "speaking" was made to move up and down slightly (the way children move a toy to show it is talking). The videos were about 1 minute in duration. During the video conversation, the characters used a novel adjective five times, always in the following type of sentence frame:

(4) The NP is *Adjective* to VP

This frame is compatible with the adjective being either a *tough* adjective or a control adjective (cf. (1a)/(2a)). After each video the child was asked two yes/no questions by a puppet. We measured the child's response and, crucially, how long it took the child to respond (Response Time, RT).

We based our methodology on one used by Naigles, Fowler & Helm (1995), who gave children grammatical or ungrammatical sentences to act out. They measured how long it took children to begin acting out the sentence, and they found that children took significantly longer to begin acting out ungrammatical prompts than grammatical ones. We reasoned that the children in our task would likely also take longer to answer a question that sounded ungrammatical to them, than one that sounded grammatical.

We constructed our two yes/no questions such that one question would be grammatical if the novel adjective had been construed as a *tough* adjective, but ungrammatical if it had been construed as a control adjective, and the other question would be grammatical if the adjective were construed as a control adjective but ungrammatical if it were construed as a *tough* adjective. Examples are shown in (5-6) using real English adjectives. The order of the two questions, and expected yes/no answers, were counterbalanced across items.

- (5) a. Is it hard to move a piece of plastic?  
b. \*Is the nurse hard?
- (6) a. \*Is it afraid to fight the dinosaur? (N.B. *it* = expletive)  
b. Is the nurse afraid?

We constructed two novel *tough* adjectives and two novel control adjectives. We assigned them to a category based on the kind of contextual meaning used with each adjective in the video conversation. All children saw/heard videos with all adjectives, so adjective type was manipulated within participants. Between participants we manipulated the animacy of the subject the adjective was used with. For children in group 1 the novel *tough* adjectives were used only with inanimate subjects, and the novel control adjectives were used only with animate subjects. The adjectives in our stimuli for group 1 are given in Table 2.

Table 2: Group 1 Stimuli

Novel Adjective	Approx. Meaning	Used with Subject	Example
daxy	easy	inanimate	An apple is very <i>daxy</i> to draw.
stropy	easy	inanimate	A motorcycle is not at all <i>stropy</i> to hide.
greppy	excited/happy	animate	I'm sure Mr. Farmer would be <i>greppy</i> to help.
narpy	excited	animate	My teacher was not <i>narpy</i> to teach (she made us sit all day doing nothing).

Note that in the group 1 stimuli the contextual meaning of the adjective is confounded with the subject animacy cue. Therefore, in the group 2 stimuli we removed this confound by keeping the contextual meaning cues the same but using all adjectives with animate subjects. These stimuli are shown in Table 3.

Table 3: Group 2 Stimuli

Novel Adjective	Approx. Meaning	Used with Subject	Example
daxy	easy	animate	The policeman is not <i>daxy</i> to draw (his uniform is complicated).
stropy	easy	animate	I bet the nurse is <i>stropy</i> to hide (she's very quiet).
greppy	excited/happy	animate	same as group 1
narpy	excited	animate	same as group 1

Our prediction, then, was that children in group 1 would categorize the novel *tough* adjectives as *tough* adjectives after hearing them used 5 times with an inanimate subject. They should therefore take less time to answer the question of the form in (5a) (e.g. *Is it daxy to draw an apple?*) and longer to answer the question like that in (5b) (e.g. *Is a tree daxy?*). We surmised that the children would make the opposite categorization of the adjectives used only with animate subjects; i.e. they would categorize them as control adjectives. As for the group 2 children, we expected them to categorize all adjectives the same way that the novel control adjectives were categorized in group 1, since all adjectives were used only with animate subjects. In other words, we expected the group 2 children to uniformly categorize all adjectives as control adjectives.

### 3. Results

First we show that our methodology gives expected results in the case of real words and novel transitive or intransitive verbs. In these warm-ups and fillers children were uniformly and significantly faster in answering the grammatical question than the ungrammatical one. In these and all subsequent graphs, the y-axis shows the log<sub>10</sub> of the response duration as measured in milliseconds (msec).

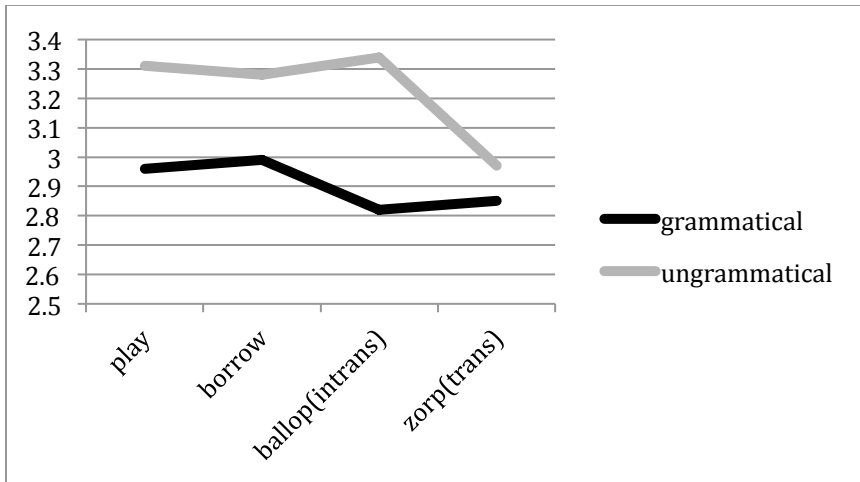


Figure 1: Log10 of RT (msec) to warm-ups and fillers, by grammaticality

The two filler items were novel verbs, one used as a transitive verb and one used as an intransitive verb. Ungrammatical questions in these cases, as well as the warm-ups (*play*, *borrow*), constituted argument structure violations.

In addition, we included two English adjectives, *hard* and *afraid*, and here again children were significantly faster in answering the grammatical question than the ungrammatical question ( $p = .04$ ). There was no interaction between the two adjectives ( $p = .47$ ). All analyses were done using a mixed linear regression model with condition, adjective type, age and grammaticality as fixed effects, and subject as the random effect.

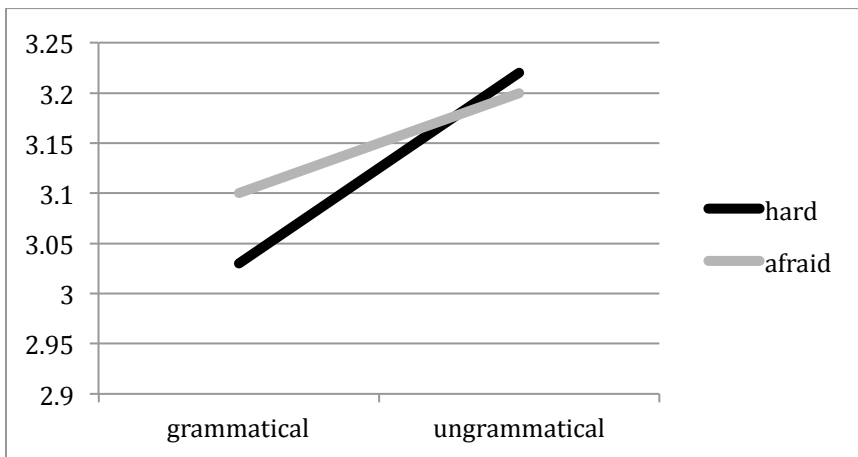


Figure 2: Log10 of RT (msec) to *hard/afraid*

Next we present the results of the group 1 data. As we expected, children were significantly faster in answering the grammatical question than the ungrammatical one for the novel *tough* adjectives. That is, they were faster in answering questions like *Is it daxy to draw an apple?* than *Is a tree daxy?* but only for the novel *tough* adjectives. For the novel control adjectives, no significant difference was found between the two types of questions. Here there is no main effect of grammaticality ( $p = .52$ ), but there is a main effect of adjective type ( $p < .01$ ) and a significant interaction between the two ( $p < .01$ ).

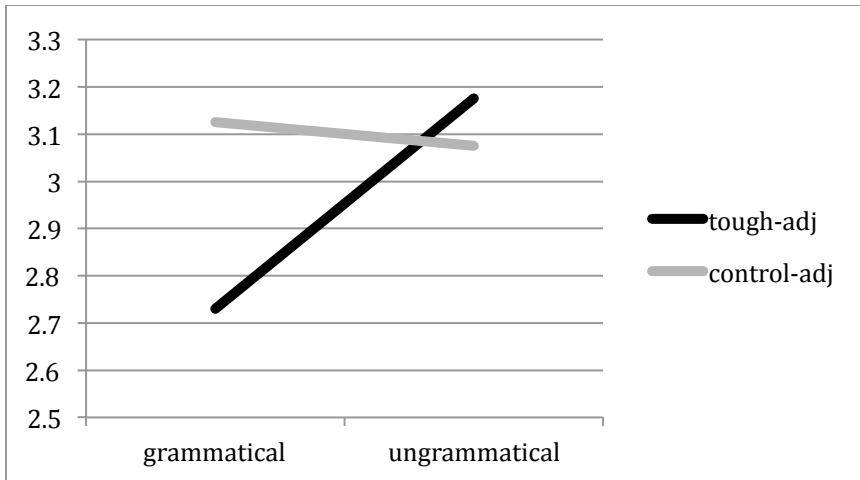


Figure 3: Results for Group 1, novel adjectives

Initially we were surprised by the lack of a difference in response time to the two questions for the novel control adjectives, since we had supposed that children would categorize these as control adjectives. So we expected children to take longer to answer question (6a) than (6b). We expected this for two reasons. First, the prior literature on children's *tough*-constructions reported that control was the preferred interpretation. Second, animate subjects are generally external arguments and are thematically related to their adjacent predicates. Our previous experimental work with adults had shown a strong bias for interpreting subjects, especially animate subjects, as external arguments (Becker & Estigarribia 2011). Thus, we expected children to show the same bias. Nevertheless, we believe that, since both *tough* and control adjectives equally admit animate subjects, an animate subject is in fact uninformative as to the adjective's category. Our child participants' responses showed that children had no basis for categorization when presented with animate subjects.

Now let us look at the group 2 data.

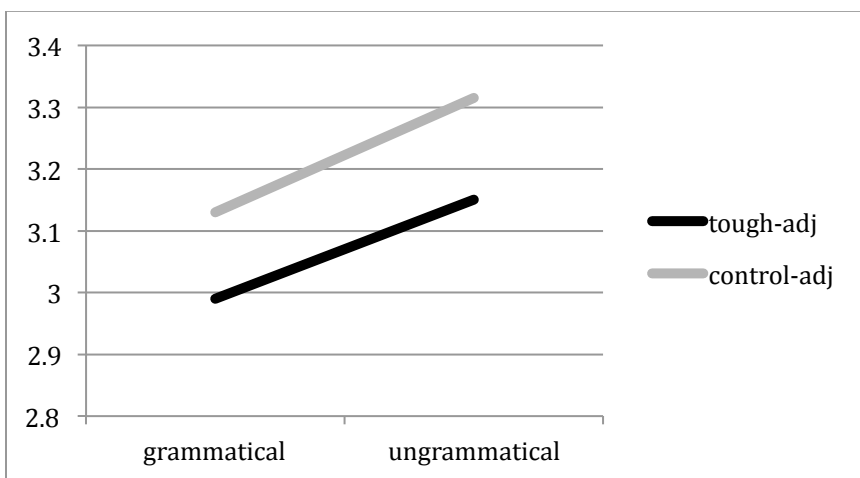


Figure 4. Results for Group 2, novel adjectives

Here there was a main effect of adjective type ( $p = .004$ ) and a main effect of grammaticality ( $p = .001$ ) but no interaction ( $p = .75$ ). Children were significantly faster in answering the grammatical questions for both types of adjectives, contrary to our predictions.

#### 4. Discussion

The results from groups 1 and 2 look quite different. We had expected the two groups' data to differ, but actually the group 2 results were surprising in a couple of respects. First, we had expected the responses to the *tough* adjectives to resemble the responses to control adjectives given in the group 1 data, since both involved animate subjects. However, unlike the control adjectives in group 1, the *tough* adjectives in group 2 did show a significant effect of grammaticality (and in the right direction). That is, the children did manage to correctly categorize these adjectives as *tough* adjectives despite their occurrence with animate subjects.

The second thing that surprised us was that the responses for the control adjectives in group 2 should have looked identical to those for the control adjectives in group 1, since the stimuli were identical. However, the group 2 children managed to correctly categorize these adjectives as control adjectives while the group 1 children had not. Why might this be?

We believe these findings actually point to inanimate subjects being an extraordinarily powerful cue. In the absence of any sentence-level cues (such as inanimacy; i.e., group 2), but in the presence of a rich enough conversational context, children were able to extract enough situational cues to infer something about the likely meaning of the adjective. In fact, when children were asked after their post-video questions what they thought *daxy* etc. meant, some children correctly responded “easy” (this was particularly true for the novel *tough* adjectives; they never responded “excited” when asked what *greppy* or *narpy* meant). Thus, contrary to our assumptions children seem to have been able to infer some aspects of these predicates' lexical meanings on the basis of the conversational context. Although this finding appears to be at odds with the Syntactic Bootstrapping hypothesis, we note that Papafragou et al. (2007) found a similar ability of children to draw inferences about the meanings of mental verbs (e.g. *think*) upon witnessing particular kinds of contexts, such as false belief contexts. Importantly, however, this effect turns up only in the absence of the inanimacy cue in our experiment.

If these contextual cues were available to the group 2 children, why were they apparently unavailable to the children in group 1? We believe the group 1 children were hindered in their categorization of the novel control adjectives due to contamination effects from the inanimate subjects in the novel *tough* adjective stimuli. It is as if the presence of the cue of subject inanimacy anywhere in the linguistic context interferes with all other potential cues to the predicate's meaning. In fact, we found a similar kind of pattern in an adult experiment we ran (Becker & Estigarribia 2011). This was a novel word learning task in which adults had to categorize novel raising and control verbs as either raising or control. If adults were given a pseudodefinition of a verb (e.g. “to look a certain way” or “to really enjoy being someplace”) and the verb was only used with animate subjects (e.g. *The old man joops to be tired*, or *My cat zids to be in the sunshine*) participants were quite good at categorizing novel control verbs correctly, but they were

unable to categorize novel raising verbs. However, in the condition in which adults encountered a novel raising verb with an inanimate subject (e.g. *The book jumps to be very long*) and no pseudodefinition, not only were they significantly *better* at correctly categorizing novel raising verbs, but they were *worse* at categorizing novel control verbs, even though those verbs always appeared, as before, with animate subjects. In our ongoing work we employ a between-subjects design in order to avoid these contamination effects.

Furthermore, even though our group 2 children were able to categorize novel adjectives to some degree, when we compare group 1 and group 2 directly, we see that the group 1 children (those who heard novel *tough* adjectives with an inanimate subject) were significantly faster in answering the grammatical questions than the group 2 children ( $p = .006$ ). That is, although some contextual support seems to be available for the meanings of these adjectives, it is not as powerful a cue as hearing the adjective with an inanimate subject.

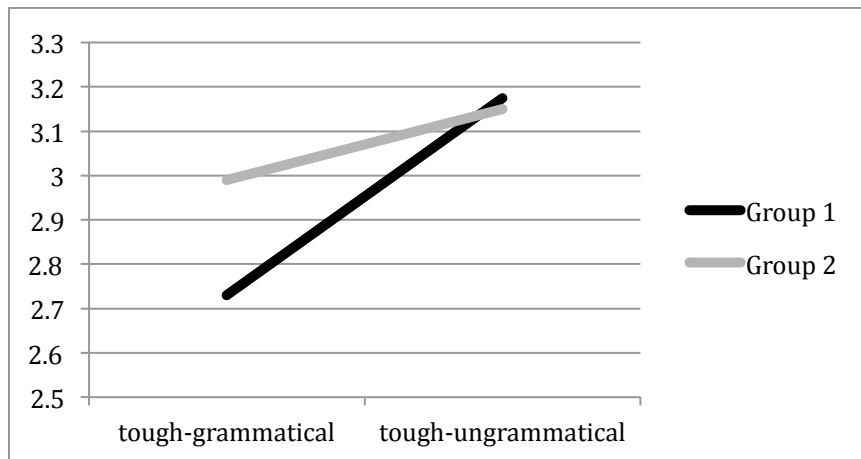


Figure 5: Group 1 vs. Group 2

A final important note about our data is that there were no age effects. That is, the 4-year-olds and the 7-year-olds behaved alike. As noted in the Introduction, previous work on children’s interpretation of *tough*-constructions has found that children misinterpret these sentences as control structures until at least age 5 or 6, if not later. However, our data show that children can correctly parse *tough*-constructions by age 4. What explains this discrepancy? We note that most, if not all, of the stimuli used to probe children’s comprehension of *tough*-constructions in past work has used animate NPs as subjects, or at least NPs that are “animized” in play such as *doll* and toy animals (as in Cromer’s work: *wolf, duck*). We showed that animate NPs can make it hard to categorize adjectives used in this sentence frame. We reason, therefore, that this accounts for children’s previous difficulty with this construction. The fact that our group 2 children did appear to categorize the adjectives correctly even in the absence of inanimate subjects might be explained by the richer context of the conversations used in our stimuli. We address the role of context below in section 5.



## 5. Conclusion and Future Directions

We set out to answer two questions: (a) Can children parse *tough*-constructions before age 5 or 6, and (b) *how* do children figure out that a sentence is a *tough*-construction as opposed to a control adjective construction? Our experiment revealed that children can indeed parse *tough*-constructions by age 4, and that hearing an adjective used with an inanimate subject provides a strong cue that the adjective is a *tough*-adjective, even if the overall frame of the sentence would be compatible with a control adjective parse.

We see (at least) two important questions stemming from this work, one theoretical and one empirical in nature. The empirical question is whether children even younger than 4 years can use the cue of subject inanimacy in the way we have demonstrated here. In the study reported here, two very young 4-year-olds had to be excluded from the study because their answers (to warm-ups, fillers and the English adjective items) were either random or showed a strong yes-bias. We suspect that these younger children found it challenging to keep track of all the events and characters in the videos. In our on-going work we have changed the experimental methodology slightly so as to remove contextual information completely. Instead, we adopt the kind of stimuli used in Yuan & Fisher (2009) and Arunachalam & Waxman (2010), in which (in our version) two puppets have a conversation using a particular novel word a number of times, but without any visual context paired with the conversation. In our case this amounts to a conversation like the following:

- (7) A: The chair is stropopy to push!  
B: Really? The chair is stropopy to push?  
A: Yeah! The chair is stropopy to push.  
B: Wow! What about the book? Is the book stropopy to push?  
A: No, the book is not stropopy to push.

We are now testing this procedure with 3- and 4-year-olds to find out if the cue of subject animacy can help with *tough* adjectives in even younger children. This manipulation will also allow us to look at the role of context in children's inference procedure. In particular, we wonder whether removing the contextual cues completely will lead children to rely exclusively on subject animacy for their categorizations.

The theoretical question our work raises is whether the cue of inanimacy contributes to the formation of the (lexical/syntactic) category of *tough* adjectives or whether it serves to categorize newly encountered words into this already known category. The construction we investigated is one of several that have the exact same relevant property, namely that the syntactic subject is not an external argument but is derived from its theta-marked position. The other constructions are raising-to-subject (*The rock seems to be stuck*), unaccusative verbs (*The package arrived*), and passives (*The ball was thrown*). In all of these constructions the subject can easily be inanimate, while in the corresponding canonical constructions, i.e. those in which the subject *is* an external argument (subject control, unergative verbs and actives) the subject must be animate.<sup>1</sup> Thus, perhaps there is some general category of “displacing predicate”—

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<sup>1</sup> It is not completely true that the external argument of a transitive sentence must be animate. Certain languages, like English, permit sentences like *The rock broke the window*. We note, however, that these

predicates that fail to select an external subject, so that the surface subject has been displaced from lower in the structure. The question is whether such a general category exists in grammar, and if so what its origin is in the minds of speakers.

These are open questions, but let us consider how this category might be learned. One possibility is that it is given a priori, and new predicates are sorted into this category based on significantly greater than zero occurrence with inanimate subjects. Another possibility is that it emerges as a by-product of comparing individual pairs of constructions in which one member of the pair occurs with inanimate subjects in the input while the other does not (e.g. comparing raising vs. control verbs, or *tough* vs. control adjectives). However, we submit that a general category of “displacing predicate” could not be learned from the input without being built out of these pairwise comparisons. The reason is that although parents use inanimate subjects significantly more frequently with displacing than nondisplacing predicates, the actual relative proportions of use vary considerably across the types of constructions. Recall that the use of animate and inanimate subjects with *tough* and control adjectives is perfectly asymmetrical (100% use of inanimate subjects with *tough* adjectives and 100% use of animate subjects with control adjectives). But when we look at the use of animacy with unaccusatives and raising verbs in maternal speech we find very different rates. Unaccusative verbs are used with inanimate subjects about 38% of the time, while raising verbs are used with inanimate subjects only 5.2% of the time (Becker 2012, Mitchener & Becker 2011). For each pair of constructions (*tough*/control adjective, raising/control verb, unaccusative/unergative) the proportion of use of inanimate subjects with the nondisplacing predicate is low, between 0% and 5.5%, but the proportion of use of inanimate subjects with the displacing predicate ranges from 5.2% to 100%. With such a wide variation in use, we believe this cue would be ineffective for the construction of a general category (though it could be used to construct each specific category) of displacing predicates. If a high proportion of use of inanimate subjects were required, children might do well with *tough* adjectives, but probably less well with unaccusatives, and they should fail miserably with raising verbs. And yet, children do categorize these verbs correctly by age 4 (Becker 2006, Becker & Schaeffer, under review). On the other hand, if a low rate like 5.2% were sufficient to construct a category of displacing predicate, children might have difficulty distinguishing unaccusative verbs from unergative verbs, which occurred with inanimate subjects 5.5% of the time (Becker 2012).

Table 4: Use of Inanimate Subjects in Maternal Speech, by Predicate Type

Displacing Predicate	Inanimate Subj.	Nondisplacing Predicate	Inanimate Subj.
<i>tough</i> -adjective	100%	control adjective	0%
raising verb	5.2%	control verb	0.3%
unaccusative	37.8%	unergative	5.5%

On the other hand, if inanimacy serves merely to categorize novel predicates into a known category of displacing predicate, or if the specific types of displacing predicates

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constructions are highly marked: many languages disallow them completely (e.g. Japanese, Jacaltec; see de Swart et al. 2008), they are statistically very rare (Dahl 2000), and they require some additional external force to be attributed to the subject, such as a person throwing a rock which then broke the window.

are constructed, then inanimate subjects would only have to be significantly more frequent than in the parallel construction with a nondisplacing predicate. That is, the use of inanimate subjects with raising verbs (5.2%) would need to be significantly more frequent than with control verbs (0.3%), which in fact it is. Thus, the implication is that inanimate subjects serve as a cue for sorting novel predicates into the known category of displacing predicate, or for constructing the individual types of displacing predicates, but not for constructing a superordinate category. A finer fleshing out of this idea remains for future work.

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