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Harder Words: Learning Abstract Verbs with Opaque Syntax

Misha Becker [a] & Bruno Estigarribia [b]

[a] Linguistics Department , University of North Carolina

[b] Department of Romance Languages and Psychology Department ,
University of North Carolina
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Harder Words: Learning Abstract Verbs with Opaque Syntax

Misha Becker

Linguistics Department, University of North Carolina

Bruno Estigarribia

Department of Romance Languages and Psychology Department, University of North Carolina

Highly abstract predicates (e.g. *think*) present a number of difficulties for language learners (Gleitman et al., 2005). A partial solution to learning these verbs is that learners exploit regularities in the syntactic frames in which these verbs occur. While agreeing with this general approach to learning verbs, we caution that this strategy is not sufficient for learning another class of abstract verbs known as "raising" verbs (*seem*) since their argument structure frames cannot always be directly read off of the surface syntax. We conducted a novel verb learning study to test the role played by subject (in)animacy in determining the syntactic frame of novel verbs that could be categorized as raising verbs. Animacy is useful since raising but not control verbs admit inanimate subjects (*The rock seems/#claims to be heavy*). We outline a two-step process of probabilistic verb categorization that relies on subject animacy in addition to more traditional Syntactic Bootstrapping assumptions. We conclude by suggesting more general applications of this process to learning other kinds of opaque abstract predicates.

HARD WORDS AND HARDER WORDS

The well-known Syntactic Bootstrapping hypothesis was born in an attempt to explain how blind children are able to acquire verbs like *look* and *see*. As Landau and Gleitman (1985) showed, blind children are able to understand these verbs and to use them appropriately even though the action or state denoted by the verb is beyond the experiential realm of these children. They have never directly experienced "looking" or "seeing," yet they form accurate lexical entries for these verbs and make remarkably few errors in their use. As Gleitman (1990) explains, while the extralinguistic contextual support for verb meanings is irregular and unreliable, for both sighted and nonseeing learners, the *linguistic* context, as indexed by the argument structure frames that verbs occur in, is highly regular and systematic.

Moreover, the set of argument structure frames of verbs overlaps to a large degree with verb meanings. That is, verbs that have the same argument structure frames often have quite similar

Correspondence should be addressed to Misha Becker, Linguistics Department, CB#3155, University of North Carolina, Chapel Hill, NC 27599-3155. E-mail: mbecker@email.unc.edu

semantic properties (Fisher, Gleitman, & Gleitman, 1991). As one source puts it, "verbs of a feather flock together" (Lederer, Gleitman, & Gleitman, 1995). These authors proposed that, along with extra-linguistic cues in the form of observable events and states, children should exploit the syntactic "privileges" of verb occurrence in the learning process. This hypothesis has been supported by a great deal of experimental evidence (e.g., Naigles, Gleitman, & Gleitman, 1989; Fisher et al., 1991; Naigles & Kako, 1993; Lederer et al., 1995; Naigles & Hoff-Ginsberg, 1995; Lidz, Gleitman, & Gleitman, 2004). Crucially, language learners are assumed to use a combination of linguistic restrictions (the sentence frames a verb occurs in) and observation of the world (what is going on when "fall" is uttered) in developing the lexical entries of verbs.

Gleitman, Cassidy, Nappa, Papafragou, and Trueswell (2005) raise the stakes one notch by considering verbs for which there is *no* plausible extralinguistic support, namely, abstract verbs. Mental or credal verbs (*think, know, believe*) do not denote observable acts or states of being. Although these verbs (and verbs of communication, such as *say*) are extremely frequent in the ambient language and child-directed speech (Gleitman et al., 2005), they are acquired later than more concrete types of verbs, such as *eat* and *fall*. Given the paucity of observable support for these lexical meanings it may not be surprising that they are acquired relatively late; what remains to be explained, however, is how they are learned at all. Gleitman and colleagues propose that the syntactic frames these verbs occur in provide the key: what singles out mental verbs and verbs of communication is their occurrence with sentential complements.

(1)   a. John thinks/believes/knows [that [$_{IP}$ the moon is made of cheese]]
      b. *John fell/ate/gave [that [$_{IP}$ his brother is a fraud]]

The methodology typically used in studies that test this hypothesis is called the Human Simulation Paradigm (HSP; Gillette, Gleitman, Gleitman, & Lederer, 1999). Briefly, adult subjects are given some kind of pared down input (such as a video of a mother playing with her small child, but with the audio portion removed) and they are asked to guess which verb the mother is uttering when a beep is heard on the video. A variation is to provide adults with a list of nouns used in an actual sentence (taken from a conversation) and ask them to guess which verb was used in the sentence. Another variation is to give adults the full sentence, including function words, but with all content words turned into nonsense words (or, only the verb turned to nonsense). These linguistic cues can be provided together with the silenced video conversation or separately, allowing the researchers to isolate particular linguistic or nonlinguistic input cues available.

As experiments using HSP have shown repeatedly, sentence frame information is more helpful for correctly guessing verbs than observation of a scene, or knowing the actual nouns used in a conversation (Gillette et al., 1999, and others cited above). Moreover, it is particularly helpful for identification of mental verbs (Snedeker & Gleitman, 2004; Gleitman et al., 2005; Kako, 1998). It turns out that as lexical items "become more abstract, language-internal cues become most informative for their identification" (Gleitman et al., 2005, p. 35). For example, Snedeker and Gleitman (2004) showed that when adults are asked to guess which verb is being used in a conversation (minus the audio), visual cues alone lead adults to guess action verbs (*fall, play, push*), but syntactic cues such as a sentential complement (even if all the words are turned to nonsense) lead adults to guess a mental verb (*like, think, know*).

In an extension of this type of work, Papafragou, Cassidy, and Gleitman (2007) identified a possible extra-linguistic source of semantic information about mental verbs: false belief contexts.

The authors reasoned that in situations where an individual is obviously mistaken about something (e.g., the actor *thinks* there is a cup on the table but really it is a flower vase), a person might be likely to use a mental verb in describing the scene. Using a similar approach to that of Snedeker and Gleitman, Papafragou et al. found that, in fact, adults were more likely to use a belief verb if the scene they witnessed involved a case of mistaken belief. A second experiment revealed that both child and adult subjects were even more likely to guess that a mental verb was used in a conversation if the scene was described using a verb with a sentential complement (*Matt GORPS that his grandmother is under the covers*) than if provided with the false belief scenario alone. Thus, while extra-linguistic cues such as a false belief situation can be helpful in eliciting abstract mental verbs, sentence frame information is an even more powerful cue. The implication is that sentence frame information is what allows children to bootstrap onto the meanings of these abstract verbs.

With these results as background, let us consider another set of verbs, known as "raising" verbs. This class of verbs includes *seem, appear, tend, used (to)* (meaning 'happening regularly in the past'), *going to/gonna, happen* (meaning 'happenstance,' not 'occur'), *turn out* and the predicate adjectives *be likely, be certain* and *be about (to)* (in the sense of 'be about to do something'). Generally speaking, the meanings of predicates in this class have to do with evidentiality (*seem, appear*), tense/aspect (*going to, used to, tend, be about to*) or they qualify states of affairs (*happen, turn out, be likely)*. According to the literature just reviewed, learners should lean heavily on sentence frame information in discovering the semantic properties of these verbs.

We agree with this basic approach. However, raising verbs present an interesting case because not only are these verbs highly abstract, but the sentence frame they occur in most often (in both child-directed and adult-directed speech) is structurally opaque (Mitchener & Becker, 2011). That is, the surface string does not allow an argument structure representation of the sentence to be made straightforwardly. To see why this is so, and why this is problematic for Syntactic Bootstrapping, in the next section we explain (a) assumptions about the relationship between surface sentence structure and underlying argument structure that are crucial for Syntactic Bootstrapping, (b) why the sentence frame that raising verbs typically occur in is opaque, and (c) why apparently "nonopaque" sentence frames for raising verbs do not alone solve the learning problem. Following that, we lay out our hypothesis that subject (in)animacy plays a crucial role in identifying the class of raising verbs. We then present results from a novel verb-learning study we conducted with adults which support our hypothesis. Our goal is to further refine the Syntactic Bootstrapping hypothesis by illuminating further lexical learning mechanisms that can help expand its coverage.

LIMITATIONS OF SYNTACTIC BOOTSTRAPPING

Assumptions about Argument Structure: Adjacent NPs are (Semantic) Arguments of V

Syntactic Bootstrapping explains how children acquire verbs on the principle that children are able to construct a representation of argument structure and clausal boundaries (what Landau and Gleitman call a "surface parse") of a sentence based on its surface structure (Landau & Gleitman, 1985, p. 122). That is, if a child hears a string consisting of noun-verb-noun, the assumption is that the verb is transitive and not, for example, an intransitive verb with an extra noun occurring

after it (e.g., expressing a location), or a ditransitive verb with a missing argument, though these are logical, and linguistic, possibilities.[1]

More specifically, children are able to distinguish the meanings of pairs of verbs like *give* and *receive/get*, which can plausibly be used in narrating the same event, because children are able to make the first step of construing the actor in a scene as the syntactic subject of a sentence, and the entity affected by the verb's action as the syntactic object (Fisher, Hall, Rakowitz, & Gleitman, 1994). Thus, a scene in which an elephant is the source of a giving event and the rabbit is the recipient will evoke the meaning "give" if the sentence is *The elephant is gorping the ball to the rabbit*, but it will evoke the meaning of "get" if the sentence is *The rabbit is gorping the ball from the elephant*.

This basic assumption holds for mental verbs, too. Mental verbs select a subject argument (that is, the verb *think* is semantically related to its subject—John is a "thinker" of something in (1a), repeated here as (2)), which surfaces adjacent to the verb, and they select a clausal complement (the thought), also adjacent to the verb.

(2)   John thinks [(that) the moon is made of cheese]

Selection or *subcategorization* refers to a lexical requirement of predicates that relates their meaning to the types of syntactic structures they can occur in.[2] In other words, a monadic predicate like *sleep* requires only a single NP argument in order to be satisfied, and it eschews an object NP (though it allows an optional locative or temporal modifier). A dyadic predicate like *hit* requires two NP arguments, and a mental verb would require both an animate (and sentient) NP subject and a sentential complement. Often, the arguments of a verb are also near it in the surface string and, conversely, adjacent phrases are normally arguments selected by the verb.

In the case of raising verbs, however, the subject of the sentence is *not* selected by the verb: there is no semantic relationship between them, but they are adjacent in the surface string all the same.

(3)   John seems [to like french fries]

Intuitively, *John* is the semantic subject of the infinitive predicate *to like french fries* but not of *seem*: it doesn't make sense to say that John is a "seemer." One way we can confirm that a verb like *seem* does not select a subject is that a meaningless subject (expletive *it* or *there*) can be used instead.

(4)   a. It seems [that John likes french fries]
       b. There seems [to be a mess in the kitchen]

To recap: syntactic bootstrapping works on the assumption that adjacent NPs are arguments of the main predicate, but when the main predicate is a raising verb, the adjacent NP is not in fact one of its arguments.

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[1]See Lee and Naigles (2005) for investigations of how syntactic bootstrapping works in null argument languages such as Mandarin.

[2]We do not distinguish between *selection* and *subcategorization* here, and we use these terms interchangeably. Another term sometimes used for this notion is *valence*. We do not intend to make any strong claims about this terminology.

Syntactic Opacity: Ambiguity on the Surface

If it were the case that all sentences of the form in (5) lacked a semantic relationship between the subject and main verb, there would be no learning problem.

(5)   NP verb [to Pred]

This sentence frame would then inform the learner that the main verb selected only the infinitive complement, and perhaps that the verb's meaning had something to do with aspect or happenstance (as opposed to actions, transfer or mental states), in the same way that the frame [NP verb [that S]] indicates that the verb denotes a mental state or communicative act rather than a motion. However, the sentence string in (5) admits a variety of underlying structures,[3] in some of which there is indeed a semantic relationship between the main verb and the subject. Consider sentence (6).

(6)   John claims [to like french fries]

In (6) we could say that John is a "claimer." Furthermore, expletive subjects are not allowed (*It/*There claims to be a mess in the kitchen), indicating that *claim* requires a semantically related subject. Formally, we say that the verb *claim* selects its subject (it assigns a theta-role to it) and also selects its infinitival complement. Verbs like *claim* are known as "control" or "equi" verbs (Rosenbaum, 1967; Chomsky, 1973, 1981). Knowing the meanings of these verbs allows us to make this distinction on the basis of sentences like (6). But the problem for language learners is precisely that the verb meanings are *not* known a priori. Does the verb in (7) select its subject?

(7)   John gorps [to like french fries]

We do not know. This is why such a sentence frame is opaque (see also Chomsky, 1965, pp. 22–27). We define opacity as follows:

(8)   A sentence is opaque if a surface parse of the underlying structure cannot be constructed without (at least partial) lexical semantic knowledge of the main predicate.

We employ the term "opacity" instead of "ambiguity" because these sentences are not ambiguous once the lexical meaning of the main verb is known (except in the case of a small class of verbs like *begin*; see discussion below).[4]

"Nonopaque" Frames Are Not Sufficient for Learning

As noted above, there are other sentence frames in which raising verbs occur, such as with an expletive subject (see (4)). Potentially, hearing a verb in one of these sentence frames could inform the learner that the verb in question is a raising verb. We know that children do make use of

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[3]We adopt here a syntactic representation in the spirit of derivational generative grammar. However, our account is equally compatible with nonderivational representations of raising that do not use empty categories or movement such as those employed in LFG (Bresnan, 2001) or HPSG (Sag, Wasow, & Bender, 2003).

[4]We do not intend any overlap between this term and its use in relation to referential opacity of NPs in sentential complements of belief verbs (Quine, 1961; Jackendoff, 1975; Leslie, 1987).

cross-sentential frame information in narrowing down the selectional properties of verbs (Naigles, 1996; Bunger & Lidz, 2004). But there are three reasons why we believe this cue to be insufficient.

First, languages such as Spanish do not have expletive subjects, and yet children acquiring Spanish come to learn the class of raising verbs. Secondly, even though English has expletive subjects (*it* or *there*), sentences containing them are far less frequent in child-directed speech than the corresponding sentence with a referential NP subject. Hirsch and Wexler (2007) reported that only 13% of sentences containing raising verbs in all of CHILDES had an expletive subject, leaving 87% of raising verbs occurring with referential subjects. Therefore, although the cue of hearing a verb with a semantically empty subject is highly informative (it has high cue validity in the sense of the Competition Model of Bates & MacWhinney, 1981), children are likely to hear many occurrences of raising verbs with referential subjects before they hear one with an expletive subject, potentially leading to incorrect categorization.

Third, nothing prevents a verb from being lexically ambiguous, so that it can occur with an expletive subject (thus behaving as a raising verb) but in other contexts behave as a control verb. In fact, there is a class of English verbs that have exactly this property. As discussed by Perlmutter (1970), verbs like *begin* can occur with existential *there* and weather-*it* subjects as in (9a), but when they occur with an animate subject, as in (9b), they bear a semantic relationship to that subject.

(9) a. It began to rain. / There began a riot in the streets. (raising)
     b. John began to write a novel. (control)

The verb *begin* bears a semantic relationship to its subject in (9b) because John volitionally instigated the writing event. But if a learner has encountered *begin* with an expletive subject like in (9a) this analysis should be impossible: (9a) should tell the learner that *begin* does not select a subject argument. Without knowing the lexical meaning of the verb, how does a child know to allow a semantic relationship to the subject in (9b) but not in (3) with *seem*? Therefore, we submit that, by itself, hearing a verb with an expletive subject in one construction (e.g. (9a)) does not necessarily imply that the same verb will function as a raising verb when it appears in the opaque context (9b).

We take this fact to suggest that there is no deterministic procedure children can follow to learn the class of raising verbs. Instead, we propose here a probabilistic procedure driven, we hypothesize, in large part by subject animacy.[5] While raising verbs easily permit inanimate subjects (since they have no semantic restriction on what goes in that position), verbs like *claim* disallow inanimate subjects.

(10) a. The rock seems to be heavy. (raising)
      b. #The rock claims to be heavy. (control)

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[5]We acknowledge that since verbs like *begin* and some control verbs (e.g., *want*) also occur in transitive sentences, but raising verbs do not, learners could use this additional sentence frame to further narrow down an individual verb's selectional properties. (Does the verb occur with expletive subjects? Yes: *seem* or *begin*. Does the verb occur with a direct object? Yes: *begin*, but not *seem*, and so forth.) However, we will not pursue this strategy for several reasons. First, not all control verbs allow a direct object (*John hopes the winner*), making this an unreliable cue. Second, certain raising verbs (e.g. *seem*) can be followed by a single NP, as in *John seems (like) a nice guy*, where that NP is not actually a direct object. Finally, there are homophonous uses of the verbs *used*, *tend*, and *happen* that do occur in (in)transitive frames. These issues further complicate the role that transitive structures could play in this learning problem.

Previous research with adults indicated that an inanimate subject was an extremely robust cue for analyzing an ambiguous string as a raising sentence. For example, Becker (2005) showed that when adults were asked to supply the main verb for a sentence that could potentially host either a raising or a control verb, participants were significantly more likely to provide a raising verb if the subject was inanimate (*The banner _____ to advertise an interesting new product*) than if it was animate (*The salesman _____ to advertise an interesting new product*).

In addition, according to Perlmutter (1970), lexically ambiguous verbs like *begin* function as raising verbs when they occur with an inanimate subject, and as control verbs when they occur with an animate subject. If the animate/inanimate distinction is useful for determining the structures of strings containing ambiguous verbs, we reason that it is probably useful more generally for verb categorization. In other words, if a verb occurs sometimes with an inanimate subject in a sentence frame like (5) (NP verb [to Pred]), the verb is *likely* to be a raising verb (or at the very least ambiguous). If the verb *only* occurs with animate subjects it is *unlikely* to be a raising verb.

EXPERIMENT

We conducted an experiment to test whether adult native English speakers would use information about the animacy of the subject of a sentence to categorize a novel verb as belonging to the raising verb class. While the experiment is in the spirit of previous work in the Human Simulation Paradigm (Gillette et al., 1999) the particular methodology we used is slightly different. Very briefly, participants were presented with a novel verb in a sentence frame like (11) and were asked to make a forced-choice grammaticality judgment about the same novel verb used in a different sentence.

(11)   The old man joops to be very tired.

Since we wanted to measure participants' categorization of novel verbs as raising vs. non-raising verbs, we thought it more straightforward to have them provide a grammaticality judgment rather than suggest a meaning for the novel verbs (as is typically done in HSP experiments).

Method

Participants were presented with a novel verb contained in a sentence. To assess speakers' categorization of the novel verb we asked them to make a forced-choice judgment about which of two further sentences containing the novel verb sounded "better" to them. In each case, the two further sentence frames were a *there*-construction (12a) and a pseudocleft (12b). The test sentences for a given verb were held constant across conditions.

(12)   a. There joops to be a computer on the desk. (raising-compatible)
       b. What the fairy joops is to be small. (not raising-compatible)

Only raising verbs can occur with an expletive *there* subject. On the other hand, raising verbs cannot occur in pseudoclefts (**What John tends is to paint landscapes*), but various non-raising verbs can (e.g., control and transitive verbs: *What John wants is to win the race; What John*

ate was a french fry). Therefore, if a speaker has categorized the novel verb as a raising verb, she should select the *there*-sentence as sounding better. If the novel verb is categorized as a nonraising verb, the pseudocleft should sound better.

We constructed three novel "raising" verbs and assigned each verb a pseudo-definition. In addition, we introduced two types of fillers, with three items of each type. One type of filler item contained verbs whose use and definitions resembled control verbs (e.g., *like, try, hate*). Because of the surface similarity in the distribution of raising and control verbs, we introduced control-like fillers to discourage participants from developing a strong bias toward raising verb interpretations. In addition, we employed three filler items that contained novel transitive or intransitive verbs. Each participant was exposed to each of these nine novel verbs, shown with their pseudo-definitions in Table 1.

In certain experimental conditions (to be explained below), participants were made aware of the novel verbs' pseudo-definitions, while in other conditions they were not. Regardless of whether the pseudo-definition was made available to participants, the verbs were always used with a contextual meaning compatible with their definition. Thus, we ensured maximum coherence and naturalness in our stimuli.

Sentence-level cues and word-level cues

Each participant was exposed to each of the three novel raising verbs and each of the six novel filler verbs, but between participants we manipulated two aspects of how these verbs were presented. Of primary interest was whether providing the novel raising verbs with an inanimate subject as opposed to an animate one would encourage speakers to categorize the verb as a raising verb and therefore to select the *there*-sentence as sounding better. We consider subject animacy to be a *sentence-level cue* because it involves a manipulation of words in the sentence adjacent to the target verb but does not give information about the verb itself. To illustrate this manipulation, some speakers were given the stimulus in (13) with an inanimate subject, while others were given the stimulus in (14) with an animate subject.

(13) The book joops to be very long. (inanimate subject)

(14) The old man joops to be very tired. (animate subject)

TABLE 1
Novel Verbs and their Definitions

Target		Filler			
Raising-like verb	Definition	Control-like verb	Definition	Trans/ Intrans.	Definition
joop	to look a certain way	rickle	to really dislike being someplace	ballop	to swing your arms in circles
meb	to probably be a certain way	sart	to make a big effort to be some way	flim	to breathe fire and be scary
trollick	to be some way most of the time	zid	to really enjoy being someplace	frell	to touch something very gently

The reader will notice that the exposure sentences in (13) and (14) differ not only in the animacy of the subject but also in the embedded predicates (*to be very long* vs. *to be very tired*). Sentences were constructed so as to be maximally natural, and certain predicates simply sound unnatural with either animate or inanimate subjects (#*The book joops to be very tired*/#*The old man joops to be very long*). While it would not have been difficult to find isolated predicates that tolerate both animate and inanimate subjects (e.g., *to be in the garden*), it would have been impossible to do this in one of the versions of our task discussed below, namely one in which participants read short stories containing our novel verbs without compromising the coherence of the stories and stimulus sentences. Our intention in creating these stimuli was for the animacy of the subject to be the only biasing factor, not the internal semantics of the infinitive predicate, but we acknowledge that using different embedded predicates might have unintended biasing consequences. Nevertheless, we chose to alter the embedded predicate in all versions of our task to maximize naturalness and coherence of the stimuli and to maintain continuity across the different versions of the task.

A relevant question about our sentence-level cue is whether it is a semantic feature or a syntactic one that we are manipulating. In fact, linguistic animacy bears both syntactic and semantic features. It is syntactic in the sense that it has (morpho-)syntactic reflexes in many languages. Some well-known examples are (a) differential object marking of animate NPs in Spanish (Aissen, 2003), (b) the requirement that the subject be more animate than the object in Navajo (Hale, 1972), and (c) the ban on transitive verbs having inanimate subjects in Jacaltec (Craig, 1977) and Japanese (Kuno, 1973).[6] On the other hand, animacy is clearly a semantic feature of nouns and has conceptual underpinnings. We believe that animacy represents a semantic feature that is tightly integrated into syntactic representations. Many semantic features related to animacy, such as sentience, agenthood, and so forth, are invoked in Keenan's prototypical characteristics of syntactic subjects (Keenan, 1976). Additionally, animacy is a concept available to humans in early infancy (Carey, 1985; Woodward, Phillips, & Spelke, 1993; Saxe, Tenenbaum, & Carey, 2005; see Gelman & Opfer, 2002, and Wagner & Lakusta, 2009, for good overviews). As such, we believe animacy is an important key in the puzzle of language bootstrapping, as it bridges conceptual, semantic and syntactic knowledge.

To approximate a baseline condition, we provided participants with novel verbs in sentences containing only animate subjects. But since a sentence such as (14) on its own is totally uninformative about either the meaning or the category of the main verb, we supplied participants in this condition with the pseudo-definitions in Table 1 with each verb. For example, a participant would receive the following stimulus:

(15)   JOOP: to look a certain way
       The old man joops to be very tired.

Although we consider this to be our baseline condition, we can also think of the pseudo-definition as providing a *word-level cue* about the category of the novel verb. That is, perhaps knowing that the verb means "to look a certain way" would lead speakers to infer that the verb has the syntactic properties of a raising verb since it also has a lexical semantic property of some raising verbs (i.e., relating to appearance). In fact, providing this word-level cue in our baseline

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[6]See Comrie (1989) and de Swart, Lamers, and Lestrade (2008) for additional examples.

condition stacks the deck against us by (potentially) improving participants' chances of correct categorization in that condition. If, as we expect, we find significantly better categorizations of novel raising verbs when provided with an inanimate subject compared with a definition, then the effect of the inanimate subject is that much more robust.

In constructing the pseudo-definitions we attempted to create meanings that would be compatible with the sorts of meanings real raising and control verbs can have, without using definitions of actual English verbs.[7] This turned out to be a surprisingly challenging task, and many of our "novel" definitions are quite close to definitions of existing verbs. We acknowledge that participants might have simply inserted the closest English verb into the stimuli and responded according to the English verb. We attempted to forestall such a strategy by making the definition slightly different, either semantically or by virtue of lexical category (e.g., *meb* is similar to *be likely*, but since *likely* is a raising adjective it cannot be directly inserted into the verb slot; *John likelies to be the winner*). Nevertheless, we cannot rule out with certainty the possibility that some participants used this strategy.

By manipulating the sentence-level cue of subject animacy and the word-level cue of the definition between participants, we will be able to evaluate the relative strengths of these two types of information. In addition, we employed a third condition in which participants received both types of cues together. Thus, our main between-participant manipulation is illustrated in Table 2.

We predicted that the sentence-level cue of an inanimate subject would be a stronger cue to raising verb categorizations than the word-level definition cue (i.e., relative to baseline) and that both cues together would be an even stronger cue than either cue alone, thus leading to the highest proportion of correct categorizations of raising verbs.

(16) Hypothesized relative cue strengths:
      Both >> Inanimate Subject >> Definition (baseline)
      strongest. . . . . .weakest

Testing Robustness: Additional Task Versions

While it is useful to find out how participants would categorize novel verbs based on a single, isolated exposure sentence, we also wanted to know whether the pattern of results would be robust across different manners of presenting the stimuli. Thus, we included additional (between-participant) conditions that altered our presentation of stimuli along two different dimensions:

TABLE 2
Examples of Stimuli in Definition (Baseline), Inanimate Subject and Both Conditions

Definition	Inanimate Subject	Both
JOOP: to look a certain way	JOOP:	JOOP: to look a certain way
The old man joops to be very tired.	The book joops to be very long.	The book joops to be very long.

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[7]A similar strategy was used to create novel verb meanings in Pinker, Lebeaux, and Frost (1987).

frequency of exposure (number of exemplars of each verb) and *mode of presentation* (list of isolated sentences vs. sentences in a story). In each of these further versions, the novel verbs themselves, their definitions, and the sentences participants had to choose between were kept the same. Thus, all participants, regardless of condition, saw one or more sentences containing the verb *joop* and had to choose between the sentences in (12) above.

To alter the frequency of exposure, some participants saw only a single exemplar of each novel verb, as illustrated above, some participants saw three different sentences each containing the novel verb, and other participants saw five different sentences for each novel verb. This manipulation is exemplified in Table 3. If a participant saw three sentences for *joop*, then he or she also saw three sentences for each of the other novel verbs, including fillers. The purpose of these versions of the task was to see (a) if the main effect found in the 1-exemplar condition is replicated with additional exemplars, and (b) if additional exposures strengthened participants' categorization of novel raising verbs. Following previous research demonstrating the effects of frequency of exposure on acquisition of words (e.g., Naigles & Hoff-Ginsberg, 1998), we expected more exemplars to lead to more correct categorizations of raising verbs.

To alter the mode of presentation, some participants read their sentence(s) in a list of unrelated sentences, while other participants read their sentence(s) embedded in a short, fairytale-like story. The reason for this manipulation, beyond providing a further test of the robustness of our basic result, was to see whether the additional context provided by a story might enhance correct raising verb categorizations. We used fairytale-like stories because we considered using these stimuli in a future experiment with children. Out of necessity, the exact stimulus sentences used in the story presentations were different from those used in the list presentation: the list condition was meant to contain unrelated sentences (see (17)), but in a coherent story the sentences must be contextually related (see (18)). Nevertheless, as stated above, the sentences between which participants had to make their grammaticality choice were the same in both types of presentation

TABLE 3
Examples of Stimuli in 1-, 3- and 5-exemplar Conditions

	1-exemplar	*3-exemplars*	*5-exemplars*
Definition	The old man joops to be very tired.	The old man joops to be very tired.	The old man joops to be very tired.
		Skunks joop to have a white stripe on their backs.	Skunks joop to have a white stripe on their backs.
		The cat joops to have black fur and a long tail.	The cat joops to have black fur and a long tail.
			The teacher joops to be serious.
			Vanessa joops to be in a good mood.
Inanimate Subject	The book joops to be very long.	The old man joops to be very tired.	The old man joops to be very tired.
		The book joops to be very long.	The book joops to be very long.
		It joops to be sunny outside.	It joops to be sunny outside.
			That mountain joops to be too steep to climb.
			It joops to be about to rain.

(shown for these items in (19)). The following examples illustrate a list and story presentation of the 3-exemplar condition (baseline).[8]

(17)   List version

trollick: to be a certain way very often

1. My friend <u>trollicks</u> to be happy all the time.
2. My cat <u>trollicks</u> to have fleas.
3. The lifeguard at the pool <u>trollicks</u> to have a tan.

(18)   Story version

trollick: to be a certain way very often

Deep in the forest there lived a giant. The giant lived alone because every morning the giant sang a very loud song, and it woke up anyone who heard it. So the people who used to live near the giant had moved away.

One day, a girl came walking through the forest. She saw the giant sitting alone and said to him, "Mr. Giant, you look very sad. Why are you sad?" The giant replied, "All the people have moved away, and I am lonely. Will you ask them to come back?"

The girl went back to the village and asked the people, "Why did you move away from the giant in the forest?" The people said, "That giant <u>trollicks</u> to be loud every single morning. He wakes us up with his song!"

The girl went back to the giant and said, "The people said that you <u>trollick</u> to be loud every morning and you wake them up. Can you sing your song more quietly?"

The giant said, "I guess I do <u>trollick</u> to be loud. I will try to be more quiet!" The girl went back and told the people what the giant said. They missed the giant's company so they agreed to try living near him again.

(19)   a. What the giant trollicks is to be loud. (pseudo-cleft)
        b. There trollicks to be cold weather in winter. (*there*-construction)

Both of these manipulations (frequency and mode of presentation) were fully crossed with our sentence-level and word-level cues discussed above. Therefore, we can think of the frequency and mode manipulations as within-experiment replications of our original manipulation. In other words, novel verbs were presented with only a definition and no animacy cue (i.e., no inanimate subjects) one, three, or five times, and in list form or story form, to different participants. Likewise, novel verbs were presented without a definition but with inanimate subjects one, three, or five times, and in list form or story form, to different participants. Finally, raising verbs were presented with definitions and inanimate subjects one, three, or five times, and in list or story form, to different participants. This design yielded 18 different conditions (3

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[8]It will appear from the illustration in (17–18) that not only animacy but person of the subject was altered between the story and list conditions. In fact, not all subjects in all items in the list condition were third person, and not all stories had first and second person subjects. Person was not manipulated in a controlled way but was dictated in the story condition by naturalness. In the list condition we sought to have some variety of subject persons, but we did not control for this factor.

TABLE 4
Experiment Design

	Definition (baseline)			Inanimate subject			Both (definition + inan. subj.)		
N. ex.	1	3	5	1	3	5	1	3	5
List									
Story									

This table shows all cues manipulated between participants: the primary manipulation of definition vs. inanimate subject vs. both, plus the different versions of these manipulations (list vs. story presentation, number of exemplars). Each cell represents one of the 18 different conditions. Within each cell the exposure sentences included three novel raising verbs and six novel filler verbs, thre control-like verbs and three transitive/intransitive.

(definition/animacy/both) x 3 (1, 3 or 5 exemplars) × 2 (story/list)), to which participants were randomly assigned. This is illustrated in Table 4.

One caveat about the frequency manipulation, which will become important when we interpret our results, is that in the "inanimate subject" and "both" conditions when more than one exemplar was presented (i.e., 3- and 5-exemplar conditions), we gave participants *one* sentence with an animate subject (see bottom half of Table 3). The reason for this inclusion was two-fold. First, raising verbs actually occur the vast majority of the time with animate subjects in both child-directed and adult-directed speech (94.8% in child-directed speech and 75.5% in adult-directed speech; Mitchener & Becker, 2011), and thus we thought it most realistic to provide at least one animate subject sentence in those conditions where multiple exemplars were provided. Second, virtually all verbs occur in more than one sentence frame, and it is the *range* of frames that most informatively narrows down the range of likely lexical meanings a verb can have (Fisher et al., 1991; Lederer et al., 1995). Thus, we considered it possible that it is a verb's occurrence with *both* animate and inanimate subjects that signals its membership in the raising class.

A representative set of our stimuli is provided in the Appendices; the full set will be made available by the first author upon request.

Summary of Predictions

To summarize our predictions, we expected that presentation of a novel verb with an inanimate subject would lead to more categorizations of that verb as a raising verb compared with presentation of a novel verb with only an animate subject and a raising-compatible definition. Furthermore, we expected that the presentation of both of these cues together (inanimate subject *and* raising-compatible definition) would have an additive effect such that this condition would produce the highest rate of raising verb categorizations.

In addition, we expected that our main result would be robust across two further versions of the task, one which presented additional exemplars of the novel verbs, and one which presented the novel verb stimuli in a story format instead of in a list of unrelated sentences. Moreover, we expected more exemplars to lead to more correct categorizations of raising verbs.

Participants

Participants were 186 adult native speakers of English (52 males, 134 females; mean age 29, range 18–71). One subject was excluded because he was not correct on at least 80% of practice items, so the data we report below come from 185 participants.[9] Participants included students and employees of UNC Chapel Hill and members of the local community, and they were paid $5 each for their participation. Participants were assigned randomly to one of the 18 conditions.

Procedure

The experiment was coded into WebExp2 (Keller, Gunasekharan, Mayo, & Corley, 2009) by the second author. Participants were seated in front of a computer and told to follow the instructions on the screen. The instructions briefly explained the forced-choice sentence judgment task and then gave subjects ten practice trials with real English verbs used in grammatical or ungrammatical contexts (e.g., *The lady slept for a long time*/*The lady slept the baby*). All subjects (except one, who was then excluded) were correct on at least eight of the 10 practice items. Participants used the mouse to click on the submit button representing their choice, and they were automatically advanced to the next item.

After the practice items participants continued to the test items. Depending on the condition the participant was assigned to, the screen displayed one, three, or five sentences containing the same novel verb, organized either into a list of sentences or a story, and either a definition was displayed at the top of the screen or there was no definition at the top of the screen. The order of presentation of stimuli was random. Below the stimuli sentences two test sentences were displayed, one using the novel verb in a *there*-sentence and one using the novel verb in a pseudocleft. Each of these options had an associated submit button for participants to click on. (Participants were, in principle, able to go back and review the stimuli after reading the test sentences. We are not aware that participants in fact did this, and we do not believe it would change the results if they did.)

RESULTS

First, we present in Table 5 the percentage of "correct" responses in the 1-exemplar, list condition, where "correct" means selection of the *there*-construction for target novel verbs. (Although we will not analyze the responses to the control-like fillers here, for those items the pseudocleft was the correct choice, and for those items participants chose the pseudocleft on average 96.11% of the time. Thus, participants treated these items differently from the novel raising verbs and did not develop a bias to treat all novel verbs the same way.)

We can see in Table 5 that when presented with a raising-compatible definition but an animate subject, participants chose the *there*-construction as sounding better than the pseudocleft only about half of the time (53%). However, when presented with an inanimate subject rather than a

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[9]We aimed for 10 participants in each of 18 conditions. Due to external constraints, certain "filled" conditions were presented again, resulting in a few extra participants in those conditions.

TABLE 5
Observed Percentages of Correct Responses,
1-exemplar, list condition

Definition	Inanimate Subject	Both
53	93	73

definition, performance jumped to 93% correct. A logistic regression with subject random effects (to model the repeated-measures structure) revealed that this difference was highly significant ($\beta = 2.79$, $p = .005$). Interestingly, the effect of combining the definition and the animacy cue does not appear to be additive, as participants who received both cues together chose the *there*-construction only 73% of the time. Although performance is better with both cues (73%) than with the definition cue alone (53%), it is not significantly better ($\beta = 1.03$, $p = .14$).

Because of our between-subjects design, there are only 30 data points contributing to the data in Table 5 (three responses each from 10 participants). Little power may have been a contributing factor in not detecting a significant difference between the "definition" and the "both" conditions. We therefore added in next the data from participants who saw additional exemplars of the novel verbs to see whether the effect of subject animacy extends to these conditions and what effect, if any, the number of exemplars variable had on responses. Table 6 gives the mean correct responses according to word- and sentence-level cues and number of exemplars, and these results are depicted graphically in Figure 1.

We hypothesized that seeing more exemplars of a novel verb would increase the likelihood of "correct" categorizations. However, as we can see in Table 6 and Figure 1, there is no linear increment in the percentage of correct raising categorizations as the number of exemplars increases, and in some cases there is a slight decrement. A second logistic regression with subject random effect revealed the same significant effect of subject animacy ($\beta = 2.56$, $p < .0001$). We now find a significant effect of the combined (definition plus animacy) cue ($\beta = 1.23$, $p = .02$) compared to the baseline. This is perhaps due to the greater number of data points, since in a further logistic regression, the number of exemplars variable itself had no effect ($\beta_{linear} = -0.31$, $p = .44$; $\beta_{quadratic} = .14$, $p = .72$). We note, in addition, that although the "both" condition now yielded significantly more correct responses than the baseline condition, it did not yield more correct responses than the condition in which an inanimate subject was the only cue. That is, the "both" condition did not have an additive effect.

TABLE 6
Observed Percentages of Correct Responses

	Definition (baseline)			Inanimate Subject			Both		
N. ex.	1	3	5	1	3	5	1	3	5
List	53	60	40	93	77	91	73	70	73

This table shows the mean percentage of *there*-sentence selections for novel raising verbs, according to number of exemplars.
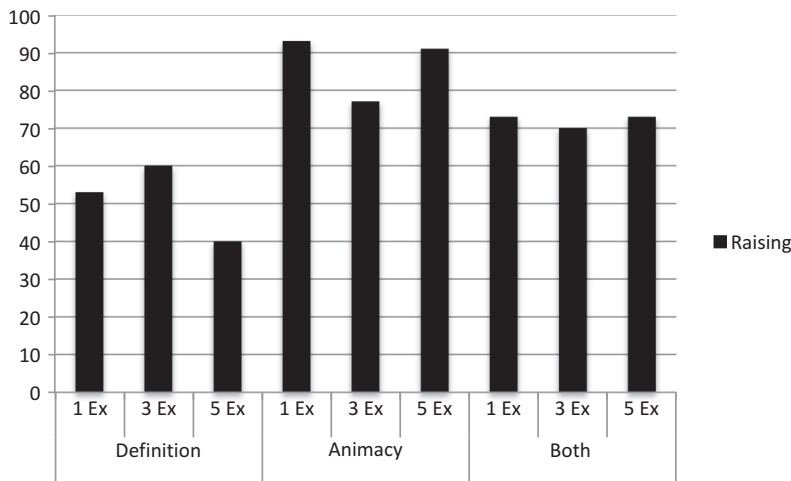
FIGURE 1   Mean percent correct responses to novel raising verbs according to number of exemplars.

TABLE 7
Observed Percentages of Correct Responses

	Definition (baseline)			Inanimate Subject			Both		
N. ex.	1	3	5	1	3	5	1	3	5
List	53	60	40	93	77	91	73	70	73
Story	70	70	67	82	60	71	80	87	70

This table shows the mean percentage of *there*-sentence selections for novel raising verbs, including all variables.

Finally, we tested whether presentation in the story format yielded a different pattern of responses from the list format. The full table of results in all conditions is found in Table 7 and graphically depicted in Figure 2.

The primary effect reported above, namely a significant effect of the subject animacy cue compared with the definition cue, is found here as well ($\beta = 2.36$, $p < .001$; see the logistic regression results in Table 8); the combined cues also led to significantly more correct categorizations than the definition cue alone ($\beta = 1.14$, $p = .02$) (but, again, not more than the animacy cue alone, except in the 3-exemplar, story condition). There was a small main effect of the mode of presentation ($\beta = .98$, $p = .03$) and a very strong interaction with the subject animacy cue. As before, the animacy cue was robust in the list condition ($\beta = 2.36$, $p < .001$), but the facilitative effects of the animacy cue were weakened in the story condition ($\beta = -2.21$, $p = .002$). In the "both" condition (definition plus inanimate subject) the interaction with mode of presentation was not significant. Thus, the powerful effect of seeing an inanimate subject is robust across different frequencies of exposure, but it is tempered by presentation of novel verbs in the context of a story.
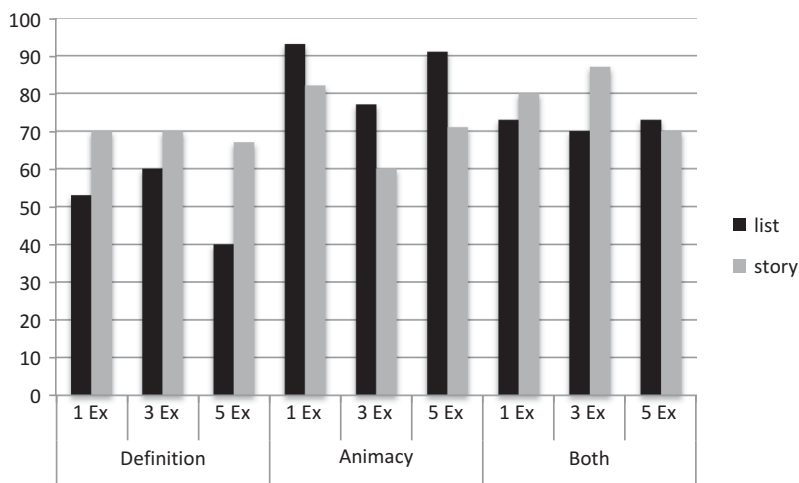
FIGURE 2 Mean correct responses to novel raising verbs according to
number of exemplars and mode of presentation.

TABLE 8
Fixed-effect estimates for the logistic regression model with an interaction between cue type
and mode of presentation

	Estimate	SE	z	p
Intercept (definition, list)	0.06	0.32	0.20	0.84
Animacy cue	2.36	0.53	4.46	<.001
Both cues	1.14	0.47	2.42	0.02
Story presentation	0.98	0.46	2.13	0.03
Animacy * Story	−2.21	0.70	−3.16	0.002
Both * Story	−0.49	0.68	−0.72	0.47

DISCUSSION

Our main hypothesis was strongly supported by our data. For novel verbs, the animacy cue (i.e., an inanimate subject) was highly informative, leading to much higher raising categorizations than the definition cue alone. This main result was replicated across different numbers of exemplars and different modes of stimuli presentation.

Two of our hypotheses were not supported, however. We had expected the sentence-level (animacy) cue and the word-level (definition) cue to have an additive (or quasi-additive) effect, such that when both cues were presented together participants would have the highest rate of correct raising categorizations. However, this was not the case. Rather, the combination of animacy and definition cues yielded significantly more correct categorizations of raising verbs than the definition cue alone, but generally somewhat fewer than the animacy cue alone. We do not know why these cues are nonadditive, but we can speculate that the presence of the lexical pseudo-definition may have taxed participants' cognitive load, either by forcing them to keep

this information in working memory while reading the sentences and making their judgment, or by distracting them by calling known verbs to mind which participants then had to either fit into the sentences or block out.

In any event, we argue that this weaker facilitation on the part of pseudo-definitions as compared to the sentence-level cue of subject animacy lends quite strong support for the Syntactic Bootstrapping hypothesis. That hypothesis holds that learners are unlikely to be able to glean lexical definitions from the situational context, so that verb learning should depend instead on argument structural cues (especially for abstract verbs, as discussed above), since it is more reliably available to learners. The pattern observed in our experiment is that even when lexical definitions are provided (thus, equally available), learners still rely less on them. Thus, the argument structure cues thought to play a primary role in verb learning on the basis of availability (according to Syntactic Bootstrapping) may in fact serve as better cues a priori.

Second, we had predicted that the beneficial effect of the animacy cue on raising categorizations would strengthen as more exemplars were encountered. However, it turned out that increasing the number of exemplars had a detrimental effect on raising categorizations. Why might this be? We believe it stems from the fact that in the 3- and 5-exemplar conditions, participants saw one occurrence of the novel raising verb with an *animate* subject among the inanimate-subject sentences. Recall that in the 1-exemplar, animacy condition, the single novel verb occurred with an inanimate subject (thus, 100% of the time). But in the 3-exemplar and 5-exemplar conditions there was one animate-subject sentence, making for only 66.7% of items in the 3-exemplar condition and 80% of items in the 5-exemplar condition, occurring with inanimate subjects. It is interesting to notice, in this connection, that there was a marked dip in performance in the 3-exemplar, animacy cue condition, compared with either the 1-exemplar or 5-exemplar condition (see Figures 1 and 2). Thus, it appears that while a single exposure to an inanimate subject (and nothing else) strongly favors a raising categorization, even a single exposure to an animate subject, in addition to inanimate subjects, detracts from the effect of inanimacy. Moreover, it is possible that the degree of detraction is linked to the relative frequency of animate subjects compared with inanimate subjects, so that as the presence of an animate subject becomes relatively more frequent in the exposure set (0% vs. 20% vs. 33.3%) it detracts more from the efficacy of the inanimate subject cue.

Finally, although we did not make a specific prediction about the effect of presenting stimuli in lists of sentences versus a story context, it is interesting that we found an interaction between the subject animacy cue and the mode of presentation. Although the main effect of the subject animacy cue remained significant when we included the story condition in our model, the animacy cue was less effective when novel verbs were presented as part of a story than when they were presented in isolated sentences. We do not know why this is, but we can speculate that in the story condition the definition cue was relatively more helpful because participants had more semantic context to rely on in interpreting the novel verbs. In the absence of this extra semantic context (i.e. in the list presentation) participants relied more heavily on sentence-level cues for interpreting the verbs.

GENERAL DISCUSSION

We began with the following conundrum: there is a set of verbs whose lexical meanings are highly abstract (and therefore not readily inferrable from observable events), and which occur frequently

in a sentence frame that is opaque—its underlying structure cannot be parsed unequivocally without knowing the verb's lexical meaning. We asked whether the presence of an inanimate subject in a verb's opaque syntactic context would lead adults to categorize a novel verb as a raising verb, and the answer to this question was "yes."

Our theoretical prediction was that since raising verbs cannot be unequivocally categorized on the basis of the opaque string, which happens to be the sentence context they are used in most frequently, children should employ a two-step process to categorize these verbs. Let us now spell out what this two-step process involves.

The first step is construction of the argument structure and clausal boundary representation (surface parse). It is at this step that subject animacy is informative. Our experiment showed that when presented with a sentence like (20a), adults in the simulated learning environment were significantly more likely to categorize the verb as a raising verb than in the case of (20b).

(20)   a. The book joops to be very long.
      b. The old man joops to be very tired.

Once the surface parse has been constructed, syntactic bootstrapping can proceed in the normal fashion, as described in what follows.

The different parses of (20a) and (20b) are those in (21a-b):[10]

(21)   a. NP_{inan} verb [t to VP] (raising)
      b. NP_{anim} verb [PRO to VP] (control)

(21a) is a raising structure and (21b) is a control structure. Control structures imply an agent or experiencer subject that is thematically related to the verb by having some volitional control over the predicate. This could imply that the verb has a meaning related to desire, perception, effort, etc. Raising structures have no implication about the thematic role of the subject except that it is *unrelated* thematically to the main verb. It is at this point that raising verbs' occurrence with expletive subjects in other contexts becomes informative. A verb that occurs in the structure in (21a) *and* occurs with expletive subjects is very unlikely to denote a state of emotion, perception, communication or action that would require a sentient individual as the emotor, perceiver, communicator, or actor. Since the sentence frame in (21a) is also incompatible with the sorts of meanings we find typically in transitive or intransitive verbs (motions, affecting actions), the range of plausible lexical meanings for a verb in (21a) is significantly restricted. We are left with auxiliary-like meanings having to do with aspect, probability and appearance, which are exactly the meanings we find among raising verbs. We do not know the exact source of these meanings, but we note that a similar mystery arises with the origins of other types of abstract semantics such as definiteness. One strong possibility is that these semantic categories are available to the child a priori; that is, the child expects these meanings to be encoded in language using nonthematic predicates. Cues such as subject inanimacy are instructive precisely because they relate to the learner's own hypotheses about language and how it will be structured. Several recent approaches to explaining language learning in terms of distributional evidence in the input underscore the importance of antecedent hypotheses in making

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[10]As we said before, our account is not contingent on the availability of empty categories or movement. For example, in LFG, the difference between (21a) ad (21b) is traditionally analyzed as functional control by an external argument of a raising predicate vs. anaphoric control by an internal argument of an equi predicate. Children still need to learn whether a verb lexically selects for a semantic argument bearing the SUBJ function (control) or not (raising).

efficient use of such distributional information (e.g., Lidz, 2010; Viau & Lidz, 2011; Yang, 2002).

This two-step probabilistic process for categorizing raising verbs is not unique to raising verbs—it is implicit in the syntactic bootstrapping of all verb types. But the first step (construction of a surface parse) is arguably (more) straightforward for other verbs, where observation of an event can indicate the relationship of all present arguments to the predicate (e.g., a running event requires a runner, a seeing event a seer and something seen, a giving event a giver, something given and a recipient). Since this is not available for raising verbs, learners have two options to construct the correct surface parse for a sentence such as [John seems [*t* to like french fries]]. One is to use cross-sentential information from sentences with expletive subjects. The second is to use cues within the opaque string itself. In this paper we described how the first option could work, and showed why it is problematic as a stand-alone strategy for raising verbs. We then focused on the second option, which we believe provides a more direct solution to the problem of parsing an opaque string. We showed that (in)animacy is relevant for this first step. Once the first step is taken, and the sentence is correctly parsed, then syntactic bootstrapping should proceed for raising verbs just as it does for all other verbs.

Importantly, this process is general enough that it can be used to learn other abstract predicates that occur in opaque sentences. In the examples below, is John the pleaser (i.e., *zady* is like "eager") or the one pleased (i.e., *zady* is like "tough")?

(22)   John is **zady** to please.

In fact, we predict that any abstract predicate (such as *tough*-adjectives, as in (22)) for which the argument mapping from string to underlying argument structure is opaque would require a similar learning process, combining sentence-internal cues such as animacy with classic syntactic bootstrapping. This hypothesis seems to be supported by results from our recent novel *tough*-adjective study with children (Becker, Estigarribia, & Gylfadottir, 2012). In this novel word-learning study, children categorize an adjective as a *tough*-adjective if it is used five times with an inanimate subject (*An apple is very daxy to draw*) but do not make this categorization for novel adjectives used five times with an animate subject (*Mr. Farmer is always greppy to help*). The learning strategy we propose here may extend to other constructions as well, such as the passive, where NP animacy is known to influence both children's and adults' interpretations of the structure (Lempert, 1989; Ferreira, 1994). Although we are not able to make concrete claims about these other constructions at present, we plan to extend our research program in these directions. This way, we hope to refine the Syntactic Bootstrapping hypothesis, expand its range of coverage, and provide further insights on mechanisms for lexical learning.

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APPENDICES

Since our experimental design included 18 distinct conditions, each with nine stimulus items (some of which contained short stories), we present here a representative subset of the stimuli, including the target items ("raising" verbs) and the control-like fillers. A complete list will be made available upon request.

Appendix A. One exemplar, definition only, story context

Target

1. **joop: to look a certain way**

Once there was a fairy who was very, very tiny. She was only about the size of a pea! And so regular people jooped to be very, very big. Other things were really big too. A flower blossom was about the right size for a bed. And one day the fairy found an open walnut shell, which was about the right size for a boat. The fairy used the walnut shell to sail across puddles and streams.

One afternoon it was raining. The fairy pulled a leaf over her head to stay dry, but it was raining more and more. There was so much water everywhere, the fairy might be in danger of drowning! Luckily she remembered her walnut shell boat. She got into her boat with the leaf still over her head and now she was safe.

Test:

    a. What the fairy joops is to be small.
    b. There joops to be a computer on the desk.

2. **meb: to probably be a certain way**

Once there was a fisherman who lived in a part of the world where the sea was often very stormy. When the fisherman was alone he didn't mind going out in the stormy weather, but if his son was with him he was very careful.

One day the fisherman and his son were out in their boat when the sky started to get dark and the wind got stronger. The fisherman said to his son, "We better head back to the shore. I bet a storm is heading our way." His son said, "Let's hurry! Otherwise we meb to be caught in the storm!"

The fisherman and his son made it back to land just in time.

Test:

    a. What the fisherman mebbed was to be careful.
    b. There mebbed to be a storm at sea.

3. **trollick: to be a certain way very often**

Deep in the forest there lived a giant. The giant lived alone because every morning the giant sang a very loud song, and it woke up anyone who heard it. So the people who used to live near the giant had moved away.

One day, a girl came walking through the forest. She saw the giant sitting alone and said to him, "Mr. Giant, you look very sad. Why are you sad?" The giant replied, "All the people have moved away, and I am lonely. Will you ask them to come back?"

The girl went back to the village and asked the people, "Why did you move away from the giant in the forest?" The people said, "That giant <u>trollicks</u> to be loud every single morning. He wakes us up with his song!"

Test:

    a. What the giant <u>trollicks</u> is to be loud.
    b. There <u>trollicks</u> to be cold weather in winter.

Control-like Filler

    1. **zid: to really enjoy being someplace**

Flora was a really mischievous cat. She lived in a house with a garden, a basement, and an attic, but she <u>zidded</u> to be in the laundry room. One day, while resting in her favorite place, she heard steps fast approaching! She didn't want to be bothered, so she jumped into a basket full of clothes. She hid at the very bottom of the basket and waited. The steps stopped. Suddenly, the basket was lifted by an invisible force! Flora tensed in terror . . . and then flew out through the air and into a metal box that closed itself with a big Bang! When the box started tumbling, she meowed loudly. Her owner heard her and took her out of the clothes dryer. She came out flustered . . . and fluffed!

Test:

    a. What Flora <u>zidded</u> was to be in the laundry room.
    b. There <u>zidded</u> to be laundry in the laundry basket.

    2. **sart: to make a big effort to be some way**

Once there was a very fearful dinosaur named Hugh. Hugh was afraid of everything! He was afraid of mammoths, saber-toothed tigers, volcanoes, lakes, and even of his own shadow. His classmates at the dino-school always made fun of him.

So when the new dino-student, Melissa, came to school, he <u>sarted</u> to be courageous and talk to her. She was so pretty with her long neck and spikey tail. When he finally mustered the courage to say hi, she looked away and blushed. Hugh realized she was shy but she liked him, so he invited her to have a glass of iced lava at the new dino-diner in town. They became friends and now Hugh is a very brave dinosaur.

Test:

    a. What Hugh <u>sarted</u> was to be brave.
    b. There <u>sarted</u> to be a new kid at school.

    3. **rickle: to really dislike being someplace**

This is a story about a boy named Dan. All of Dan's friends really liked to go ice skating, and whenever they went to the ice rink they invited Dan to come along. But Dan <u>rickled</u> to be in the

ice rink because it was so cold. He much preferred to be someplace warm, like a bowling alley, or a pizzeria. So the next time his friends asked Dan if he wanted to go skating with them, he suggested that they all go bowling instead.

Test:

    a. What Dan <u>rickled</u> was to be in a cold place.
    b. There <u>rickled</u> to be several people at the bowling alley.

Appendix B. One exemplar, inanimate subject and definition cues ("both"), list context

Target

  1. **joop: to look a certain way**

  1. The book <u>joops</u> to be very long.

Test:

    a. What the fairy <u>joops</u> is to be small.
    b. There <u>joops</u> to be a computer on the desk.

  2. **meb: to probably be a certain way**
    1. That tree is tall and its branches are really high up, so it <u>mebs</u> to be hard to climb.

    Test:

    a. What the fisherman <u>mebbed</u> was to be careful.
    b. There <u>mebbed</u> to be a storm at sea.

  3. **trollick: to be a certain way very often**
    1. The kitchen sink trollicks to be full of dirty dishes!

    Test:

    a. What the giant <u>trollicks</u> is to be loud.
    b. There <u>trollicks</u> to be cold weather in winter.

  Control-like Filler

  1. **zid: to really enjoy being someplace**
    1. My sister <u>zids</u> to be at the beach.

    Test:

    a. What Flora <u>zidded</u> was to be in the laundry room.
    b. There <u>zidded</u> to be laundry in the laundry basket.

  2. **sart: to make a big effort to be some way**

    1. My brother <u>sarted</u> to be a really good student in school.

Test:

    a. What Hugh <u>sarted</u> was to be brave.
    b. There <u>sarted</u> to a new kid at school.

3. **rickle: to really dislike being someplace**

    1. I <u>rickle</u> to be sitting in a traffic jam.

Test:

    a. What Dan <u>rickled</u> was to be in a cold place.
    b. There <u>rickled</u> to be several people at the bowling alley.

Appendix C. Three Exemplars, inanimate subject cue only, list context

Target

1. **joop:**
    1. The old man <u>joops</u> to be very tired.
    2. The book <u>joops</u> to be very long.
    3. It joops to be sunny outside.

    Test:

    a. What the fairy <u>joops</u> is to be small.
    b. There <u>joops</u> to be a computer on the desk.

2. **meb:**

    1. That tree is tall and its branches are really high up, so it <u>mebs</u> to be hard to climb.
    2. It <u>mebs</u> to be hot every day when it's summer.
    3. The president <u>mebs</u> to be a very organized person.

    Test:

    a. What the fisherman <u>mebbed</u> was to be careful.
    b. There <u>mebbed</u> to be a storm at sea.

3. **trollick:**

    1. It <u>trollicks</u> to be humid right before it rains.
    2. The kitchen sink <u>trollicks</u> to be full of dirty dishes!
    3. The lifeguard at the pool <u>trollicks</u> to have a tan.

    Test:

    a. What the giant <u>trollicks</u> is to be loud.
    b. There <u>trollicks</u> to be cold weather in winter.

Control-like Filler

1. **zid:**
    1. My sister <u>zids</u> to be at the beach.

2. Cats <u>zid</u> the sunshine.
3. I <u>zid</u> to be in my warm bed on a cold day.

Test:

  a. What Flora <u>zidded</u> was to be in the laundry room.
  b. There <u>zidded</u> to be laundry in the laundry basket.

2. **sart:**

1. My brother <u>sarted</u> the leader of the group.
2. The soccer player <u>sarted</u> to be the fastest runner on the team.
3. The farmer <u>sarted</u> to be good to all his animals.

Test:

  a. What Hugh <u>sarted</u> was to be brave.
  b. There <u>sarted</u> to be a new kid at school.

3. **rickle:**

1. I <u>rickle</u> to be sitting in a traffic jam.
2. My friend <u>rickles</u> rainstorms.
3. My dad <u>rickles</u> to be at work when it's nice outside

Test:

  a. What Dan <u>rickled</u> was to be in a cold place.
  b. There <u>rickled</u> to be several people at the bowling alley.

Appendix D. Three exemplars, definition only, story context

Target

1. **joop: to look a certain way**

Once there was a fairy who was very, very tiny. She was only about the size of a pea! And so regular people <u>jooped</u> to be very, very big. Other things were really big too. A kitten <u>jooped</u> to be as big as a tiger. One day the fairy found an open walnut shell, which was about the right size for a boat. The fairy used the walnut shell to sail across puddles and streams.

One afternoon it was raining. The fairy pulled a leaf over her head to stay dry, but it was raining more and more. There was so much water everywhere, the fairy <u>jooped</u> to be in danger of drowning! Luckily she remembered her walnut shell boat. She got into her boat with the leaf still over her head and now she was safe.

Test:

  a. What the fairy <u>joops</u> is to be small.
  b. There <u>joops</u> to be a computer on the desk.

2. **meb: to probably be a certain way**

Once there was a fisherman who lived in a part of the world where the sea was often very stormy. The fisherman was brave, though, so when he was alone he didn't mind going out in the stormy weather.

One day the fisherman and his son were out in their boat when the sky started to get dark and the wind got stronger. The fisherman said to his son, "We better head back to the shore. I bet a storm is heading our way. Let's hurry! Otherwise we <u>meb</u> to be caught in the storm!"

His son said, "But dad, you are so brave and have been in so many storms. We <u>meb</u> to be hungry tonight if we don't catch some fish before we go back." But his father replied, "This storm is too dangerous. We <u>meb</u> to be stranded if we don't head back soon. We'll find something to eat tonight, don't worry."

The fisherman and his son made it back to land just in time.

Test:

   a. What the fisherman <u>mebbed</u> was to be brave.
   b. There <u>mebbed</u> to be a storm at sea.

3. **trollick: to be a certain way very often**

Deep in the forest there lived a giant. The giant lived alone because every morning the giant sang a very loud song, and it woke up anyone who heard it. So the people who used to live near the giant had moved away.

One day, a girl came walking through the forest. She saw the giant sitting alone and said to him, "Mr. Giant, you look very sad. Why are you sad?" The giant replied, "All the people have moved away, and I am lonely. Will you ask them to come back?"

The girl went back to the village and asked the people, "Why did you move away from the giant in the forest?" The people said, "That giant <u>trollicks</u> to be loud every single morning. He wakes us up with his song!"

The girl went back to the giant and said, "The people said that you <u>trollick</u> to be loud every morning and you wake them up. Can you sing your song more quietly?"

The giant said, "I guess I do <u>trollick</u> to be loud. I will try to be more quiet!" The girl went back and told the people what the giant said. They missed the giant's company so they agreed to try living near him again.

Test:

   a. What the giant <u>trollicks</u> is to be loud.
   b. There <u>trollicks</u> to be cold weather in winter.

Control-like Filler

1. **zid: to really enjoy being someplace**

Flora was a really mischievous cat. She lived in a house with a garden, a basement, and an attic, but she <u>zidded</u> to be in the laundry room. One day, while resting in her favorite place, she heard steps fast approaching! She didn't want to be bothered, so she jumped into a basket full of clothes. She hid at the very bottom of the basket and waited. The clothes were soft and comfy, and she <u>zidded</u> to lie there. The steps stopped. Suddenly, the basket was lifted by an invisible force! Flora tensed in terror . . . and then flew out through the air and into a metal box that closed

itself with a big Bang! When the box started tumbling, she meowed loudly. Her owner heard her and took her out of the clothes dryer. She came out flustered . . . and fluffed!

Her owner picked up Flora and held her gently. She was glad to be out of the scary dryer, and she zidded to be in her owner's arms.

Test:

    a. What Flora zidded was to be in the laundry room.
    b. There zidded to be laundry in the laundry basket.

2. **zid: to really enjoy being someplace**

Flora was a really mischievous cat. She lived in a house with a garden, a basement, and an attic, but she zidded to be in the laundry room. One day, while resting in her favorite place, she heard steps fast approaching! She didn't want to be bothered, so she jumped into a basket full of clothes. She hid at the very bottom of the basket and waited. The clothes were soft and comfy, and she zidded to lie there. The steps stopped. Suddenly, the basket was lifted by an invisible force! Flora tensed in terror . . . and then flew out through the air and into a metal box that closed itself with a big Bang! When the box started tumbling, she meowed loudly. Her owner heard her and took her out of the clothes dryer. She came out flustered . . . and fluffed!

Her owner picked up Flora and held her gently. She was glad to be out of the scary dryer, and she zidded to be in her owner's arms.

Test:

    a. What Flora zidded was to be in the laundry room.
    b. There zidded to be laundry in the laundry basket.

3. **rickle: to really dislike being someplace**

This is a story about a boy named Dan. All of Dan's friends really liked to go ice skating, and whenever they went to the ice rink they invited Dan to come along. But Dan rickled to be in the ice rink because it was so cold. He much preferred to be someplace warm, like a bowling alley, or a pizzeria. So the next time his friends asked Dan if he wanted to go skating with them, he suggested that they all go bowling instead.

But Dan's friend Martha said, "I rickle to be in the bowling alley, where it's so noisy and crowded. Maybe we could go get pizza." But Joe said, "I rickle to be in the pizzeria, it's too hot in there." It seemed like they couldn't agree. Then Dan suggested, "Let's play a game of soccer in the park!" Everyone liked that idea.

Test:

    a. What Dan rickled was to be in a cold place.
    b. There rickled to be several people at the bowling alley.

Appendix E. Five exemplars, inanimate subject and definition cues, story context

Target

1. **joop: to look a certain way**

Once there was a fairy who was very, very tiny. She was only about the size of a pea! And so regular people jooped to be very, very big. Other things were really big too. A flower jooped to be about the right size for a bed. One day the fairy found an open walnut shell, which jooped to be about the right size for a boat. The fairy used the walnut shell to sail across puddles and streams.

One afternoon it was raining. The fairy pulled a leaf over her head to stay dry, but it jooped to be raining more and more. There was so much water everywhere, the fairy might be in danger of drowning! Luckily she remembered her walnut shell boat. She got into her boat with the leaf still over her head and now it jooped that she was safe.

Test:

  a. What the fairy joops is to be small.
  b. There joops to be a computer on the desk.

2. **meb: to probably be a certain way**

Once there was a fisherman who lived in a part of the world where the sea was often very stormy. The fisherman was brave, though, so when he was alone he didn't mind going out in the stormy weather.

One day the fisherman and his son were out in their boat when the sky started to get dark and the wind got stronger. The fisherman said to his son, "We better head back to the shore. A storm mebs to be heading our way. Let's hurry! Otherwise we meb to be caught in the storm!"

His son said, "But dad, you are so brave and have been in so many storms. We'll be hungry tonight if we don't catch some fish before we go back." But his father replied, "This storm mebs to be too dangerous. It's so dark in the sky, it mebs to be a stronger storm than you expect. We'll be stranded if we don't head back soon. We'll find something to eat tonight, don't worry."

The boy helped his father collect their empty nets and steer the boat towards home. He said, "Mom might be worried about us. It mebs that the storm is moving pretty fast."

The fisherman and his son made it back to land just in time.

Test:

  a. What the fisherman mebbed was to be brave.
  b. There mebbed to be a storm at sea.

3. **trollick: to be a certain way very often**

Deep in the forest there lived a giant. The giant lived alone because every morning the giant rang a very loud bell, and it woke up anyone who heard it. So the people who used to live near the giant had moved away.

One day, a girl came walking through the forest. She saw the giant sitting alone and said to him, "Mr. Giant, you look very sad. Why are you sad?" The giant replied, "All the people have moved away, and I am lonely. Will you ask them to come back?"

The girl went back to the village and asked the people, "Why did you move away from the giant in the forest?" The people said, "He trollicks to be loud every single morning. He wakes us up with that bell!"

The girl went back to the giant and said, "The people said that your bell trollicks to be loud every morning and you wake them up. Can you ring your bell more quietly?"

The giant said, "I guess my bell does trollick to be pretty loud. But it sure trollicks to be lonely out here with no one around. I will try to ring it more quietly if they'll come back!" The girl went back and told the people what the giant said. They missed the giant's company so they agreed to try living near him again.

The giant was so happy to have neighbors again, he kept his promise. From that point on it trollicked to be very quiet in the forest.

Test:

   a. What the giant trollicks is to be loud.
   b. There trollicks to be cold weather in winter.

Control-like Filler

1. **zid: to really enjoy being someplace**

Flora was a really mischievous cat. She lived in a house with a garden, a basement, an attic and a laundry room. When it was sunny she zidded to be in the garden, where it was nice and warm. But if it was rainy she zidded to be in the laundry room. One rainy day, while resting in her favorite place, she heard steps fast approaching! She didn't want to be bothered, so she jumped into a basket full of clothes. She hid at the very bottom of the basket and waited. The clothes were soft and comfy, and she zidded their warmth all around her. The steps stopped. Suddenly, the basket was lifted by an invisible force! Flora tensed in terror . . . and then flew out through the air and into a metal box that closed itself with a big Bang! When the box started tumbling, she meowed loudly. She didn't zid this scary place! Her owner heard her and took her out of the clothes dryer. She came out flustered . . . and fluffed!

Her owner picked up Flora and held her gently. She was glad to be out of the scary dryer, and she zidded to be in her owner's arms.

Test:

   a. What Flora zidded was to be in the laundry room.
   b. There zidded to be laundry in the laundry basket.

2. **sart: to make a big effort to be some way**

Once there was a very fearful dinosaur named Hugh. Hugh was afraid of everything! He was afraid of mammoths, saber-toothed tigers, volcanoes, lakes, and even of his own shadow. His classmates at the dino-school always made fun of him.

So when the new dino-student, Melissa, came to school, he <u>sarted</u> to be courageous and talk to her. She was so pretty with her long neck and spikey tail. When he finally <u>sarted</u> a brave attitude and said hi, she looked away and blushed. Hugh realized she was shy but she liked him, so he invited her to have a glass of iced lava at the new dino-diner in town. The next time he saw her he still felt shy, but he <u>sarted</u> to be more outgoing and talk to her again. They became friends and now Hugh is a very brave dinosaur.

One day when Hugh and Melissa were out munching leaves together, Hugh saw a big Tyrranosaurus Rex coming towards them. He got really scared! But he <u>sarted</u> courage because he wanted to protect Melissa. When the Tyrranosaurus Rex came up to them, Hugh puffed up his chest and said, "Leave us alone, mean dinosaur!" The T-Rex was so startled that someone had stood up to him, he just shrugged and went on his way.

News of the encounter with the T-Rex spread among Hugh's classmates, and soon everyone was saying that Hugh didn't even have to <u>sart</u> to be brave anymore.

Test:

  a. What Hugh <u>sarted</u> was to be brave.
  b. There <u>sarted</u> to be a new kid at school.

3. **rickle: to really dislike being someplace**

This is a story about a boy named Dan. All of Dan's friends really liked to go ice skating, and whenever they went to the ice rink they invited Dan to come along. But Dan <u>rickled</u> the ice rink because it was so cold. He much preferred to be someplace warm, like a bowling alley, or a pizzeria. So the next time his friends asked Dan if he wanted to go skating with them, he suggested that they all go bowling instead.

But Dan's friend Martha said, "I <u>rickle</u> to be in the bowling alley, where it's so noisy and crowded. Maybe we could go get pizza." But Joe said, "I <u>rickle</u> to be in the pizzeria, it's too hot in there." It seemed like they couldn't agree. Then Dan suggested, "Let's play a game of soccer in the park!" Everyone liked that idea.

The following week, the weather got really cold and it started to snow. Dan's friends called him up and suggested they have a snowball fight. But Dan <u>rickled</u> to be out in the snow. He wanted to stay home and drink hot chocolate. He said to his friends, "You guys go ahead without me. I <u>rickle</u> snowball fights, because I get covered in freezing snow! But you're welcome to come over for hot chocolate afterwards."

Test:

  a. What Dan <u>rickled</u> was to be in a cold place.
  b. There <u>rickled</u> to be several people at the bowling alley.

Appendix F. Five exemplars, inanimate subject cue only, list context

Target

1. **joop:**

   1. The old man joops to be very tired.
   2. The book joops to be very long.
   3. It joops to be sunny outside.
   4. That mountain joops to be too steep to climb.
   5. It joops to be about to rain.

   Test:

   a. What the fairy joops is to be small.
   b. There joops to be a computer on the desk.

2. **meb:**

   1. That tree is tall and its branches are really high up, so it mebs to be hard to climb.
   2. It mebs to be hot every day when it's summer.
   3. The president mebs to be a very organized person.
   4. That old house mebs to be haunted.
   5. It mebs to be foggy along the coast.

   Test:

   a. What the fisherman mebbed was to be careful.
   b. There mebbed to be a storm at sea.

3. **trollick:**

   1. It trollicks to be humid right before it rains.
   2. The kitchen sink trollicks to be full of dirty dishes!
   3. The lifeguard at the pool trollicks to have a tan.
   4. The floor in the basement trollicks to be dirty.
   5. It trollicks to be cold in the middle of winter.

   Test:

   a. What the giant trollicks is to be loud.
   b. There trollicks to be cold weather in winter.

Control-like Filler

1. **zid:**
   1. My sister zids to be at the beach.
   2. Cats zid the sunshine.
   3. I zid to be in my warm bed on a cold day.
   4. My dog zids to be at the dog park.
   5. John zids the circus.

Test:

  a. What Flora <u>zidded</u> was to be in the laundry room.
  b. There <u>zidded</u> to be laundry in the laundry basket.

2. **sart:**

  1. My brother <u>sarted</u> the leader of the group.
  2. The soccer player <u>sarted</u> to be the fastest runner on the team.
  3. The farmer <u>sarted</u> to be good to all his animals.
  4. Mary-Ann <u>sarted</u> courage in front of her friends.
  5. The ambassador <u>sarted</u> to be polite to his hosts.

Test:

  a. What Hugh <u>sarted</u> was to be brave.
  b. There <u>sarted</u> to be a new kid at school.

3. **rickle:**

  1. I <u>rickle</u> to be sitting in a traffic jam.
  2. My friend <u>rickles</u> rainstorms.
  3. My dad <u>rickles</u> to be at work when it's nice outside
  4. Samantha <u>rickles</u> to be out in the cold.
  5. Peter <u>rickles</u> stuffy classrooms.

Test:

  a. What Dan <u>rickled</u> was to be in a cold place.
  b. There <u>rickled</u> to be several people at the bowling alley.