

Semantic Scaffolding in L1A Syntax: Learning Raising-to-Object and Object Control

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1. Introduction

Verb learning is, by its very nature, an interface task: the language learner must integrate a lexical item with its semantics and subcategorization frame. Because this process is so complex, it has understandably fascinated researchers. But learning is further complicated in the case of raising-to-object (RO) and object control (OC) verbs, where a single string can map onto two underlying structures (1).

- (1) Suki gorp(ed) Dave...
 - a. RO: t_i to serve breakfast (e.g., *want*, *need*)
 - b. OC: PRO_i to serve breakfast (e.g., *ask*, *tell*)

In this paper, I propose that children's acquisition of RO/OC verbs is accomplished in part through "semantic scaffolding": a tactic of taking recourse to canonical semantics to support syntactic interpretation. In cases of high cognitive load, children may not parse a biclausal sentence in its entirety, instead attending to the semantics of the smallest contiguous proposition within such an utterance: the embedded clause. Semantic scaffolding reflects a basic, extralinguistic cognitive conceptualization of eventhood, and appears to lie at the root of a number of crosslinguistic and cross-developmental patterns.

2. Background

RO and OC verbs overlap in some of their allowable surface strings (e.g., (1)), but differ crucially in both semantic and syntactic requirements. While RO verbs may embed any clause which is itself semantically felicitous, OC verbs place extra demands on the embedded subject, often requiring animacy (2). Likewise, only RO verbs may grammatically embed expletive subjects (3).

- (2) Dave wanted/needed/#asked/#told the bacon to be crispy
- (3) Dave wanted/needed/*asked/*told there to be more bacon left

RO and OC are worthy of special interest not only for this strange "semi-complementary" distribution, but also because these verbs' meanings are (to a great extent) abstract or unobservable. Moreover, the relevant syntactic frame in each case is biclausal, containing silent syntactic and/or semantic dependencies; as a result, the underlying structure of these utterances is ambiguous, given the surface string. To date, the verb-learning literature has primarily focused on monoclausal structures, and so these phenomena have not been properly examined.

How are children able to assemble the lexical-semantic and syntactic information for these verbs? And what stages do they pass through on the way to achieving adultlike treatment of them? I hypothesized that before reaching adultlike competence and behavior with RO and OC, children may

capitalize on the syntax-semantics¹ interface, essentially relying on the semantics of the smallest *complete* proposition within a RO/OC utterance in their assessment of the sentence as a whole.

3. Experiment 1: Semantic Anomaly

I tested this hypothesis in two experiments with 32 monolingual English speaking children, ages 4-5, from the Chapel Hill, NC, area.² The first experiment, a semantic anomaly task (SA), probed children's restrictions on the animacy of the embedded subject in a RO/OC utterance (*The teacher needed the books to weigh less/#The girl told the soup to have carrots in it*). The second, a grammaticality judgment task (GJ), examined their restrictions on expletive subjects embedded under RO/OC verbs (*The girl wanted there to be cookies in the bag/*The boy asked it to be time for bed*).

3.1. Method

In Experiment 1, children were tested on their judgments of RO and OC utterances containing inanimate embedded subjects with a SA sentence judgment task (McDaniel and Cairns, 1996) modeled on the reward/punishment variant of the truth-value judgment task (Gordon, 1996). In this task, children saw pictures and heard short vignettes describing them. After each vignette, a puppet made a comment about the picture; the child's task was to reward the puppet for his semantically felicitous comments, and to punish him (i.e. provide him with a less attractive reward) for his anomalous comments. In the latter case, children were prompted to explain why the puppet's comment was "silly." Test items were separated by filler items to check for answer biases or inattention.

After a short training session, children provided judgments on a number of sentences. Each child was tested on one RO and one OC verb, receiving either "want/ask" or "need/tell" items. All test items contained animate matrix subjects, and inanimate embedded subjects. As a result, all RO test items had target "okay" answers, while all OC items had target "silly" answers. Example vignettes and test items appear in Appendix A.

Also, given the pre-stimuli vignettes, all of the test items for both RO and OC verbs contained embedded clauses that were semantically infelicitous (either false or unverifiable). However, when considered as whole biclausal utterances, all RO items were semantically felicitous, while OC items were semantically infelicitous. Thus, if children were to parse only the embedded clause, they should reject *all* items. This would result in what appears to be adultlike behavior on OC, but not RO, items.

3.2. Results

In Experiment 1, both 4s and 5s performed as predicted: both were above chance in their judgments on the semantic restrictions of OC verbs, but neither group performed above chance on RO items. That is to say, both groups correctly rejected sentences like *#Elmo told the toys to be smaller*, but also incorrectly rejected sentences like *The boy wanted the cake to be chocolate*. The results appear in Table 1 (asterisks indicate $p < 0.01$).

¹ By "semantics" here, I mean both lexical semantics and extralinguistic conceptual semantics, although this dichotomy may prove to be less clear than some linguists believe. See, for instance, the literature on syntactic bootstrapping (e.g., Fisher, Gleitman, and Gleitman, 1991).

² The 4s group contained 8 boys and 8 girls and had a mean age of 4;6 (range: 4;1.15-4;11.12); the 5s group contained 7 boys and 9 girls, and had a mean age of 5;5 (range: 5;0.18-5;11.15). Participants had no known speech or hearing impairment or other cognitive or developmental delays.

Table 1: Percentages of OK/Silly Responses (Experiment 1)

Type	Item	adultlike		4s		5s	
		OK	silly	OK	silly	OK	silly
RO	...wanted [the coat to fit her]	100	0	56.3	43.7	58.3	41.7
OC	...asked [the trees to be tall]	0	100	22.9*	77.1*	20.8*	79.2*

The data was analyzed by age group and by verb type, and logistic regressions (with the standard error adjusted for multiple observations within subjects) were performed to compare the number of correct responses per age group to a chance level of performance (i.e., 50%). Both 4s' and 5s' judgments on OC utterances were significantly above chance (4: $z = 2.81$, $p = 0.0050$; 5: $z = 2.85$, $p = 0.0044$), but neither group performed above chance levels in their judgments of RO verbs (4: $z = 0.71$, $p = 0.4771$; 5: $z = 0.90$, $p = 0.3678$).

3.3. Discussion

In the SA task, both 4s and 5s correctly rejected OC utterances at an above-chance rate. However, both age groups also *incorrectly* rejected RO sentences to some extent, performing at chance levels on these items. These response patterns indicate that children may have parsed only the embedded clause in each item, leading them to reject *all* utterances. It is precisely this strategy which would result in what looks like adultlike behavior on OC, but not RO, items. Indeed, children's justifications for their negative answers also supported the analysis that they were judging the felicity of the embedded clause (for selected justifications, see Appendix B).

Children might make use of such an interpretation strategy as a result of limited processing resources (e.g., working memory), leading to a bottleneck on comprehension and assessment. In short, the requirements of a sentence judgment task on biclausal utterances—a task which demands abilities at the interface of linguistic and non-linguistic cognition, especially given the abstract semantic nature of these verbs—may require an amount of processing power which is not yet available, developmentally. As a result, 4s' and 5s' processors must winnow the elements advancing to the grammar's interpretive function.

However, if the results of Experiment 1 are indicative, what *does* make it through is not a random or haphazard collections of morphemes, but a semantically and syntactically independent proposition: the embedded clause. Thus, a picture emerges in which even the allotment of limited processing resources may be constrained and guided by UG.

Experiment 1 begs the question of how children fare when the task probes not semantic, but grammatical restrictions. Experiment 2 assessed children's performance in this second area.

4. Experiment 2: Grammaticality of Embedded Expletives

Experiment 2 tested children's knowledge of the adultlike distribution of expletive subjects embedded under RO and OC verbs.

4.1. Method

The participants and method were identical to those in Experiment 1, and children remained in either the "want/ask" or "need/tell" group.

All test items in Experiment 2 contained animate matrix subjects and expletive embedded subjects. As a result, all RO test items again had target "okay" answers, while all OC items had target "silly" answers. Example vignettes and test items appear in Appendix C.

Also as in Experiment 1, given the pre-stimuli vignettes, all of the test items for both RO and OC verbs contained embedded clauses that were semantically infelicitous (false or unverifiable) and ungrammatical (since nonfinite). However, all biclausal RO items were felicitous and grammatical,

while OC items were felicitous but ungrammatical. Thus, if children parsed only the embedded clause, they should reject all items, which will again resemble adultlike behavior on OC, but not RO, items.

4.2. Results

In Experiment 2, only 4s performed as predicted, not 5s. While 4s correctly rejected OC sentences like **The girl asked it to snow*, they also incorrectly rejected sentences like *The farmer needed it to rain*. Performance by 5s was the opposite: they correctly accepted RO sentences, but incorrectly accepted OC sentences. The results are given in Table 2 (asterisks indicate $p < 0.01$).

Table 2: Percentages of OK/Silly Responses (Experiment 2)

Type	Item	adultlike		4s		5s	
		OK	silly	OK	silly	OK	silly
RO	...needed [it to rain]	100	0	62.5	37.5	77.1*	22.9*
OC	...asked [it to snow]	0	100	27.1*	72.9*	50	50

The data was analyzed as in Experiment 1. This analysis indicated that 4s performed above chance on OC items ($z = 2.91$, $p = 0.0037$) but not RO items ($z = 1.23$, $p = 0.2197$), while 5s were above chance on RO ($z = 2.62$, $p = 0.0089$) but not OC items ($z = 0.00$, $p = 1.0000$).

4.3. Discussion

In the GJ task, 4s correctly rejected OC utterances (**The girl told it to be warm*) at above-chance levels, but failed to correctly accept such RO utterances (*The woman needed it to be cooler in the car*). In contrast, 5s correctly accepted RO utterances but failed to correctly reject OC utterances. If we assume that children performed the grammaticality judgment task in an adultlike way, these response patterns are essentially incomprehensible.

However, these patterns may be explainable, on the assumption that children again attended to only the embedded clauses, and performed not a grammatical but a *semantic* assessment. Recall that given the pre-stimulus vignettes, none of the embedded clauses were semantically felicitous, while all full utterances—both RO and OC—were felicitous, as seen in (4)-(5).

- (4) a. *RO vignette*: The girl's mother gave her a bag with something tasty inside. The girl said, "I hope it's cookies!"
 b. *RO test item*: The girl wanted [there to be cookies in the bag]
- (5) a. *OC vignette*: The girl wanted to play it the snow, but it was a bright, sunny day. The girl said, "I wish it would snow! Why can't it snow?"
 b. *OC test item*: **The girl asked [it to snow]*

Syntactically, the entire RO, but not OC, utterances are grammatical, while the embedded clauses in both types are grammatical, at least with regards to the appearance of the expletive (although they are ungrammatical due to their nonfinite character). *Semantically*, however, the entire utterances are felicitous in both RO and OC, while the embedded clauses are infelicitous, given the vignettes. Given the response patterns here, 4s again appeared to be assessing the semantics, and not the grammaticality, of the embedded clauses alone. This strategy leads to apparently "adultlike" rejection of OC items and nonadultlike rejection of RO items.

However, the 5s' data *cannot* be explained with this analysis, as 5s responded in the opposite fashion. Instead, I propose that with their greater processing resources, 5s have more flexibility in what linguistic information proceeds through bottleneck to the parser. In short, 5s appear to prefer to parse the embedded verb with the next c-commanding *lexical* (not expletive) NP. In Experiment 1, this NP appeared in the embedded clause, but in Experiment 2, the only c-commanding lexical NP is the

matrix subject. By disregarding the embedded expletive, 5s construct “grammatical” semantically-driven parses for the stimuli. Thus, 5s may interpret test items like those in (6) as what appears in (7), allowing them to accept both RO and OC utterances.

- (6) a. The girl wanted there to be cookies in the bag
 b. *The boy asked it to be time for bed
 (7) a. The girl wanted... cookies in the bag
 b. The boy asked... for bed

The “choice” of matrix subject and lower predicate also makes sense in light of serial position effects of primacy and recency on memory (e.g., Deese and Kaufman, 1957). Studies indicate that when a number of items are presented in succession, the elements at the beginning (“primacy”) and at the end (“recency”) of the list will be disproportionately salient, and thus better recalled. In contrast, items in the middle of the list will be less easily recalled. These phenomena make exactly the prediction we see borne out in 5s’ patterns here: namely, that they would parse the matrix subject and the embedded predicate together, but would appear to disregard the “middle” of the utterance (i.e., the semantic subject of the embedded clause, and perhaps even the matrix verb).

5. Conclusion

In the experiments presented here, I tested children’s knowledge of the semantic and syntactic restrictions on subjects in clauses embedded under RO and OC verbs. The results supported the prediction that local semantics, and not global syntax, would guide children’s judgments in such tasks. This preferential attention to a contiguous clause in multiclausal utterances is a major component in the cluster of *semantic scaffolding* strategies (Kirby, 2009).

Although children *do* distinguish the verb classes syntactically under other circumstances (Kirby, 2009), they did not appear to do so in the experiments presented here. Rather, they scaffolded their judgments of biclausal RO/OC utterances by parsing the smallest *acceptable* semantically independent proposition in each utterance: the embedded clause alone (4s), or the embedded predicate plus the first c-commanding lexical NP (5s). Indeed, it should be noted that what may appear to be a conflation of the two verb types (by parsing them both in the *same* preferential way) may instead simply be a result of the matrix verb not making it through the full interpretive process (that is, a reflection of the fact that the parsing is, in fact, constrained by a bottleneck).

The semantic scaffolding analysis thus has the added appeal of defining the nature of interaction between UG and processing limitations. Semantic scaffolding, as an innate predisposition, guides precisely *what* makes it through a processing bottleneck: not a random set of lexemes, but rather *a clausal proposition as an independently functioning semantic “whole.”* As children’s processing power grows, so, too, does the preferred shape of this proposition, such that lexical/referential subjects are preferred to expletives.

Semantic scaffolding encompasses several strategies which guide children in their learning by dictating what both the *shape* of clauses and *relationships* among elements in clauses should be. Given the literature on child cognition in linguistic and extralinguistic realms, it appears that semantic scaffolding has a basis in domain-external structure, arising as the *linguistic* reflection of an *extralinguistic* cognitive default or primitive. Because of its source in nonlinguistic cognitive structure, it should not be surprising that semantic scaffolding has left marks not only in child language, but in adult language as well.

In general, the strategy of parsing of the embedded clause as a unit, to the exclusion of lexical elements in the matrix clause, may arise from the desire to keep units together *syntactically* which function together *semantically* (cf. “First Law,” Behaghel, 1932; “relatedness,” MacWhinney, 1982); at the clausal level, this reflects a basic notion of eventhood as including the actors taking part in the event.

The clausal proposition (more specifically, the verb and its external argument) is the basic semantically coherent unit. As a result, semantic scaffolding initially biases the child to expect this particular clausal shape: a well-formed clause contains a syntactically contiguous subject and predicate. Moreover, it appears that the grammar prefers that subjects be referential—a phenomenon reflected in crosslinguistic tendencies in subject lexicalization (Keenan, 1976; Dowty, 1991).

The “contiguity” effect in semantic scaffolding may lie behind other patterns in child language, including children’s interpretation of multiclausal control structures. C. Chomsky (1969) found that children were slower to acquire the syntax for the subject control (SC) verb *promise* (*Dave promised Suki to cook bacon*) than that for OC *tell* (*Dave told Suki to cook bacon*); young children interpret both sentences under the OC pattern, assuming that *Suki* is the bacon-chef in each. The acquisition of the *tell* and *promise* patterns may depend on whether each verb allows for the contiguous appearance of an embedded proposition. With *tell*, the semantic subject forms a contiguous unit with its predicate. With *promise*, though, this pattern does not obtain; the child must look past one c-commanding NP to find the semantic subject of the embedded predicate. As predicted by semantic scaffolding, children initially interpret *promise* sentences as having OC, like *tell*.³

Data from relative clause (RC) processing also support semantic scaffolding’s assumption that children prefer to produce and/or parse semantic (clausal) units as a whole. MacWhinney (1982) cites data from Limber (1976) and Menyuk (1969; both cited therein) indicating that object-modifying RCs (both object- and subject-extracted) emerge in spontaneous production before subject-modifying RCs. Note that where subject-modifying relative clauses would disturb the contiguity of the matrix subject and its verb, object-modifying RCs do not.

Semantic scaffolding’s effects may also be observed in the nonlinguistic realm: consider young children’s tendency to group objects thematically, rather than taxonomically (e.g., Markman and Hutchinson, 1984). This phenomenon may reflect children’s cognitive biases about how their world works: events are crucial, and each event involves key players.

As mentioned above, semantic scaffolding appears to have left its marks in adult language. Specified Subject Condition (SSC; Chomsky, 1973) effects in adult language limit NP movements and define domains for anaphor binding, or “complete functional complexes.” These CFCs are clausal propositions of just the type in which we are interested: “all grammatical functions compatible with its head are realized in it—the complements necessarily... and the subject” (Chomsky, 1986:169). Semantic scaffolding may also lie behind “garden path” effects in sentence processing (e.g., Frazier, 1978), in which sentences like *The horse [raced past the barn] fell* are initially misparsed as *The horse raced past the barn*. Here, the grammar defaults to an expectation of contiguous *subject + predicate*. Finally, research indicates that L2 speakers of both Turkish, an SOV language (Özcelik, 2006), and English, which is SVO (Izumi, 2003), perform better in comprehension and production on RCs which do not disturb the continuity of the matrix clause. Thus, when the adult processing system is stressed, adults, just like children, may get syntactic support from the basic semantic clause shape in its contiguous form.

In short, both child and adult language suggest a preference for producing and interpreting contiguous clausal propositions as independently functioning semantic units. Semantic scaffolding may in fact constitute a *syntactic* emergence of the unmarked (McCarthy and Prince, 1994).

Appendix A: Semantic Anomaly Task

Example vignettes

- a. *RO*: The boy’s mother was making a cake, but he didn’t know what kind. He really wanted a chocolate cake, though.
Puppet: The boy wanted the cake to be chocolate

³ Some might argue that this issue is confounded in English with the infrequency of the *promise* SC pattern. To those readers, I ask, *Why, then, is that pattern infrequent?* See also the adult phenomena mentioned here.

- b. *OC*: Bert and Ernie were listening to music together, but Ernie didn't like the music. He said to Bert, "Can you turn that music off?"

Puppet: #Ernie asked the music to stop playing

Test items: "want/ask" group

- The boy wanted the cake to be chocolate
- The girl wanted the coat to fit her
- She wanted the key to open the door
- #Ernie asked the music to stop playing
- #The girl asked the trees to be tall
- #The boy asked the ball to fall back down

Test items: "need/tell" group

- The teacher needed the books to weigh less
- The cat needed the bed to be shorter
- Big Bird needed the pen to write
- #Elmo told the toys to be smaller
- #The girl told the soup to have carrots in it
- #Bert told the car to drive faster

Appendix B: Children's justifications for negative answers (SA task)

- Elmo told [the toys to be smaller]*
"Because they can't turn into small" (JS, 5;0.27)
- The girl told [the soup to have carrots in it]*
"Carrots don't be in soup" (GH, 4;7.4)
- Bert told [the car to drive faster]*
"Because the car can't go faster" (SA, 4;4.1)
- The boy told [the ball to fall back down]*
"Cause it couldn't come back down, but if they got a ladder they could get it" (KO, 5;11.15)

Appendix C: Grammaticality Judgment Task

Example vignettes

- RO*: The woman bought some ice cream at the grocery store. When she got in the car, she realized she needed to turn on the air conditioning so the ice cream wouldn't melt.
Puppet: The woman needed it to be cooler in the car
- OC*: The girl was walking around outside and got really cold. She said, "I sure wish it was warm outside today!"
Puppet: *The girl told it to be warm

Test items: "want/ask" group

- The girl wanted there to be cookies in the bag
- Big Bird wanted there to be crayons in the box
- Dora wanted it to be her friend Boots on the phone
- *The girl asked it to snow
- *The boy asked it to be time for bed
- *The policeman asked there to be people on the sidewalk

Test items: "need/tell" group

- The woman needed it to be cooler in the car
- The chef needed there to be more sandwiches
- The farmer needed it to rain
- *The girl told it to be warm
- *Sponge Bob told there to be a party at his house
- *The woman told there to be flowers on the table

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