

## Do What You Know: “Semantic Scaffolding” in Biclausal Raising and Control

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### 0. Introduction

Verb learning requires action at the interface of 3 linguistic modules: syntax, semantics, and the lexicon. The child must associate a verb with its meaning, subcategorization requirements, and possible syntactic frames—a large task. But learning raising-to-object (RO) and object control (OC) verbs poses a special challenge, since a single string can be mapped onto two underlying structures.

- (1) Suki gorped Neil<sub>i</sub>...
- a. RO:  $t_i$  to drink espresso
  - b. OC: PRO<sub>i</sub> to drink espresso

In this paper, I examine the acquisition of RO/OC verbs, and propose that children learn them through “semantic scaffolding”: a non-adultlike tactic of taking recourse to the semantics of an utterance to support interpretation. In situations where the processing system is overtaxed, children rely on the semantics of the smallest complete proposition—the *embedded clause*—in their assessment of the sentence as a whole. Furthermore, the phenomenon of semantic scaffolding lies behind several other patterns in child and adult language.

### 1. Background

While they may share a surface string in terms of the overt syntactic frames in which they may occur, RO (e.g., *want*, *need*) and OC (*ask*, *tell*) verbs differ on a number of issues. In short, RO verbs are “laxer” than OC verbs in both semantic and syntactic requirements. First, RO verbs may embed any clause which is internally semantically felicitous, while OC verbs demand felicity with the embedded subject (2). In addition, RO (but not OC) verbs may grammatically embed expletive subjects (3).

- (2) Neil wanted/needed/#asked/#told the coffee to be strong

- (3) Neil wanted/needed/\*asked/\*told there to be more coffee left

To date, the verb-learning literature has focused on single clauses, and little is known about the acquisition of verbs that take multiclausal frames. Within the realm of verb learning, the case of RO and OC is of special interest since these verbs' meanings are abstract, and because unlike verbs that appear in single clauses, the underlying structure of these utterances is ambiguous, given the surface string. Moreover, the relevant syntax is biclausal, and contains silent elements, thus rendering it fairly complex.

In short, the RO/OC distinction is opaque to a child hoping to bootstrap into syntax. How, then, do children assemble the lexical-semantic and syntactic information for these verbs? The acquisition of RO has not been examined at all, nor has OC been examined with this learning challenge in mind. Because RO/OC syntax is so complex, it is possible that children with limited processing resources may capitalize on the syntax-semantics interface, using a non-syntactic strategy for interpretation. I hypothesized that on the way to adultlike knowledge, children may rely on the semantics of the smallest *complete* proposition within a RO/OC utterance in their assessment of the sentence as a whole.

## **2. Experiment 1: Semantic Anomaly**

I tested this hypothesis with 32 children (ages 4-5) using two judgment tasks: a semantic anomaly task (SA: *The teacher needed the books to weigh less/#The girl told the soup to have carrots in it*), which tested children's restrictions on the animacy of the embedded subject, and a grammaticality task (GJ: *The girl wanted there to be cookies in the bag/\*The boy asked it to be time for bed*), which tested children's restrictions on embedded expletive subjects.

### **2.1. Method**

In Experiment 1, children ages 4-5 were tested on their judgments of RO and OC utterances containing inanimate embedded subjects. 32 monolingual English speaking children (ages 4;1.15-5;11.15) were recruited from the Chapel Hill, NC, area to take part in the study.<sup>1</sup> Children received a small token gift for their participation.

Experiment 1 comprised a SA sentence judgment task (McDaniel and Cairns 1996) which was modeled on the reward/punishment variant of the truth-value judgment task (Gordon 1996). In this task, children saw pictures and heard short vignettes about them. After each vignette, the child listened to a puppet make a comment about the picture. The child was asked to reward the puppet for his semantically felicitous comments by "feeding" him a plastic orange, and to punish

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<sup>1</sup> 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 linguistic (speech or hearing) impairment or other cognitive or developmental delays.

him (i.e. provide him with a less attractive reward) for his semantically anomalous comments by “feeding” him a plastic piece of lettuce. In the latter case, children were also asked to explain why what the puppet said was “silly.” Test items were separated by filler items, included to check for answer biases or inattention.

After a training period, children were asked to provide SA judgments on a number of sentences. Each child received either “want/ask” items, or “need/tell” items. All test items in Experiment 1 involved matrix clauses containing animate subjects, and embedded clauses containing inanimate subjects. Example stories appear in (4), and test items appear in (5) and (6). Note that all RO test items had target “okay” answers, while all OC items had target “silly” answers.

- (4) Example vignettes: Semantic anomaly
- 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*
  - 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*
- (5) Semantic anomaly judgment test items: “want/ask” group
- a. The boy wanted the cake to be chocolate
  - b. The girl wanted the coat to fit her
  - c. She wanted the key to open the door
  - d. #Ernie asked the music to stop playing
  - e. #The girl asked the trees to be tall
  - f. #The boy asked the ball to fall back down
- (6) Semantic anomaly judgment test items: “need/tell” group
- a. The teacher needed the books to weigh less
  - b. The cat needed the bed to be shorter
  - c. Big Bird needed the pen to write
  - d. #Elmo told the toys to be smaller
  - e. #The girl told the soup to have carrots in it
  - f. #Bert told the car to drive faster

Importantly, 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 biclausal utterances as a whole, all RO items were semantically felicitous, while OC items were semantically infelicitous. Thus, if children parse only the embedded clause, they should reject *all* items. This will resemble adultlike behavior on OC items, but not RO items.

**2.2. Results**

The outcome of Experiment 1 was that both 4s and 5s performed above chance in their judgments on the semantic restrictions of OC verbs, but that neither group performed in an adultlike way on RO items. This means that both groups correctly rejected sentences like #*Elmo told the toys to be smaller*, but that both groups also incorrectly rejected sentences like *The boy wanted the cake to be chocolate*. The results are given in Table 1 (grey cells indicate  $p < 0.01$ ).

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 were performed to compare the number of correct responses per age group to a chance level of performance. A test of the hypothesis that children’s performance was equal to chance levels on OC items was rejected; both 4s’ and 5s’ judgments on OC utterances were significantly above chance (4:  $z = 2.81$ ,  $p = 0.0050$ ; 5:  $z = 2.85$ ,  $p = 0.0044$ ). However, neither group performed above chance levels in their judgments of RO verbs (4:  $z = 0.71$ ,  $p = 0.4771$ ; 5:  $z = 0.90$ ,  $p = 0.3678$ ).

Thus, both 4s and 5s performed as predicted.

**2.3. Discussion**

In the SA task, children were asked to provide judgments on the felicity of RO and OC constructions containing embedded clauses with inanimate subjects. Both 4-year-olds (4s) and 5-year-olds (5s) performed in an adultlike way by correctly rejecting OC utterances. However, both age groups also *incorrectly* rejected RO sentences, performing at chance levels on these items. Thus, the response pattern evidenced by children in both age groups indicates that children may have been parsing only the embedded clause in each item, leading them to reject all items. This strategy would lead to what looks like adultlike behavior on OC, but not RO, items.

Children’s justifications for their negative answers supported the analysis that they were judging the felicity of the embedded clause, as shown in (7).

- (7) Children’s justifications for negative answers
  - a. *Elmo told [the toys to be smaller]*  
“Because they can’t turn into small” (JS, 5;0.27)
  - b. *The girl told [the soup to have carrots in it]*  
“Carrots don’t be in soup” (GH, 4;7.4)
  - c. *Bert told [the car to drive faster]*  
“Because the car can’t go faster” (SA, 4;4.1)

- d. *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)

Such an interpretation strategy might be caused by a bottleneck on utterance size with regard to parsing, as a result of limited processing resources (memory, syntax parser). That is, the requirements of a metalinguistic sentence judgment task on biclausal utterances—a task which furthermore demands abilities at the interface of linguistic and non-linguistic cognition, especially given the abstract nature of the semantics of these verbs—may simply require an amount of extra processing power which is not available at this age. As a result, 4s’ and 5s’ processors must “pick and choose” what makes it through to the interpretive function of the grammar. However, it should be noticed that—if the results of Experiment 1 are indicative—what *does* make it through is not a random or haphazard collections of morphemes. Instead, it is a semantically and syntactically independent proposition: the embedded clause. Thus, even the allotment of limited processing resources may be constrained and guided by UG.

Experiment 1 still leaves open the question of how children fare when the judgment task is one of grammaticality, rather than semantic anomaly. Experiment 2 aimed to assess children’s performance in this area.

### **3. Experiment 2: Grammaticality of Embedded Expletives**

Experiment 2 tested children’s competence on the grammaticality of expletive subjects embedded under RO and OC verbs. Recall that RO (but not OC) verbs allow embedded expletives. This experiment tested whether children ages 4-5 respect this grammatical restriction.

#### **3.1. Method**

The participants and method were identical to those in Experiment 1.

Children were trained to provide judgments on grammaticality and were then asked to provide such judgments on a number of sentences. Each item accompanied a picture and each prompt sentence was preceded by a short vignette describing the picture.

Children again received either “want/ask” items, or “need/tell” items. All test items in Experiment 2 involved matrix clauses which contained animate subjects, and embedded clauses which contained expletive subjects. Example stories appear in (8), and test items appear in (9) and (10). Again, all RO test items had target “okay” answers, while all OC items had target “silly” answers.

(8) Example vignettes: Grammaticality judgment

- a. 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*

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- b. 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*

- (9) Grammaticality judgment test items: “want/ask” group
  - a. The girl wanted there to be cookies in the bag
  - b. Big Bird wanted there to be crayons in the box
  - c. Dora wanted it to be her friend Boots on the phone
  - d. *\*The girl asked it to snow*
  - e. *\*The boy asked it to be time for bed*
  - f. *\*The policeman asked there to be people on the sidewalk*
- (10) Grammaticality judgment test items: “need/tell” group
  - a. The woman needed it to be cooler in the car
  - b. The chef needed there to be more sandwiches
  - c. The farmer needed it to rain
  - d. *\*The girl told it to be warm*
  - e. *\*Sponge Bob told there to be a party at his house*
  - f. *\*The woman told there to be flowers on the table*

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 untensed). However, all biclausal RO items were felicitous and grammatical, while OC items were felicitous but ungrammatical. Thus, if children parse only the embedded clause, they should reject all items, which will again look like adultlike behavior on OC, but not RO, items.

### **3.2. Results**

The outcome of Experiment 2 was that development of the restrictions on embedded expletives appears to be non-monotonic. That is, while 4s judged expletives embedded under OC verbs in an adultlike way (i.e., they correctly rejected sentences like *\*The girl asked it to snow*), they did not perform above chance on expletives embedded under RO verbs (i.e., they failed to correctly accept sentences like *The farmer needed it to rain*). In contrast, however, 5s performed in an adultlike way on expletives embedded under RO sentences, but were at chance for judging expletives embedded under OC sentences. Thus, performance by 4s and 5s was diametrically opposed.

The results are given in Table 2 (grey cells 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 significantly above chance on the OC items ( $z = 2.91$ ,  $p = 0.0037$ ), but not the RO items ( $z = 1.23$ ,  $p = 0.2197$ ), while 5s showed the opposite pattern: they performed above chance on RO items ( $z = 2.62$ ,  $p = 0.0089$ ) but not OC items ( $z = 0.00$ ,  $p = 1.0000$ ).

Thus, 4s performed as predicted, but not 5s.

### 3.3. Discussion

In the grammaticality judgment task, children were asked to provide judgments on the acceptability of RO and OC constructions containing expletive subjects in the embedded clause. While 4s correctly rejected OC utterances (e.g., *\*The girl told [it to be warm]*) at above-chance levels, they failed to correctly accept similar 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 are indeed performing the grammaticality judgment task in an adultlike way, we cannot make sense of their response patterns.

However, these patterns may be explainable given the hypothesis that children are actually performing a semantic, rather than a grammatical, assessment of the test items in Experiment 2. Recall that given the pre-stimulus vignettes, none of the embedded clauses were semantically felicitous, while all of the full utterances—both RO and OC—were felicitous, as seen below.

- (11) 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]
- (12) 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 the OC utterances, are grammatical, while the bracketed embedded clauses in both RO and OC utterances are grammatical (if untensed). *Semantically*, however, the entire utterances are felicitous in both RO and OC, while the bracketed embedded clauses are infelicitous, given the pre-stimulus vignettes: that is, each embedded clause corresponds to a state of affairs that was *not* described in the vignette.

Given the response pattern we see here, then, it appears that just as in Experiment 1, 4s are assessing the embedded clauses (not the full biclausal utterances) in

isolation, and are doing so for semantics, rather than syntactic grammaticality. This strategy of using local semantics in their judgments, and not global syntax, led to what appeared to be 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 5s, who must certainly have greater processing resources than 4s, have greater flexibility in what linguistic information they allow through the processing bottleneck to reach the parser; they appear to prefer to parse the embedded verb with the next c-commanding *lexical* (not expletive) NP, which in the test items in Experiment 2 can only be found in the matrix clause. By disregarding the embedded expletive, 5s are able to construct “grammatical” semantically-driven parses for both RO and OC utterances. Thus, test items like those in (13) may be interpreted by 5s as in (14), allowing these children to accept both RO and OC utterances.

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

Children's “choice” of matrix subject and lower predicate makes sense in the context of studies on serial position effects on memory, specifically the effects of primacy and recency (e.g., Deese and Kaufman 1957). Studies indicate that when a number of items (say, words) are presented in succession, the elements at the beginning (i.e., “primacy”) and at the end (i.e., “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. This phenomenon makes exactly the prediction we see borne out in 5s' interpretations of items in the GJ task: 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 the matrix verb as well).

Results in both tasks thus supported the prediction that children will focus on the embedded clause in their sentence judgments.

#### **4. Conclusion**

In the experiments presented here, I tested children's knowledge of the semantic and syntactic restrictions on clauses embedded under RO and OC verbs. In Experiment 1, both age groups correctly rejected OC sentences, but incorrectly rejected RO sentences, indicating that they parsed only the embedded clause, and not the entire utterance. In Experiment 2, children again appeared to parse only the embedded predicate in test items, and to do so with respect to semantics, rather than syntax. 4s again parsed the lower clause alone (they correctly rejected OC sentences, but incorrectly rejected RO sentences), but 5s' reversed pattern (they correctly accepted RO sentences, but incorrectly accepted OC sentences)

indicated that these older children, who likely have greater processing resources, were parsing the embedded VP with the next c-commanding lexical (not expletive) NP as a subject. By disregarding the expletive, 5s constructed semantically-driven parses which they judged as “grammatical.” Results in both tasks thus supported the prediction that local semantics, and not global syntax, guided children’s judgments. This process is one piece of a cluster of strategies I refer to as *semantic scaffolding* (for greater detail, see Kirby 2009).

In short, instead of distinguishing (and assessing) RO and OC verbs syntactically in these experiments, children appeared to “scaffold” their judgments of these biclausal utterances in both tasks by parsing the smallest *acceptable* semantically independent proposition in each utterance: either the embedded clause alone (for 4s), or the embedded predicate plus the first c-commanding lexical NP (5s). This analysis has the added appeal of explaining how UG may still constrain non-adultlike performance in the face of processing limitations.

In children’s performance on these tasks, we can see how semantic scaffolding constrains and directs interpretation in the absence of adultlike syntactic knowledge or processing power. Faced with a taxing metalinguistic judgment task on a syntactically complex biclausal utterance, along with the demands of integrating linguistic and non-linguistic (real-world) knowledge, children may encounter a processing bottleneck in terms of the linguistic components that make it through to the interpretive function. Here we see semantic scaffolding, as an innate predisposition, guiding precisely *what* makes it through: not a haphazard collection of morphemes, but rather *a clausal proposition as an independently functioning semantic “whole.”* The particular shape of the proposition that makes it through the bottleneck seems to change over time (in terms of whether it must include a lexical–not expletive–NP), but the thrust of the process is the same in either case.

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: either 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).

This preferential attention to the embedded clause in multiclausal constructions should not be too surprising, as it appears to be a natural and expected result of tendencies observed in MacWhinney’s (1982) predisposition of “relatedness” or Behaghel’s (1932) First Law; the strategy of parsing of the embedded clause as a unit, to the exclusion of lexical elements in the matrix clause, appears to arise from the desire to keep units together *syntactically* which function together *semantically*. For all speakers, the clausal proposition is the basic semantically

coherent unit which should ideally be processed together syntactically. Semantic scaffolding biases the child to expect and prefer a particular clausal shape: a well-formed clause contains a syntactically contiguous subject and predicate. Moreover, given 5s' performance in contrast with that of 4s', it appears that the grammar actually prefers that the subject appearing in the contiguous clause be referential, not expletive. This makes sense, considering crosslinguistic adult tendencies in what is lexicalized as a "subject" (Keenan 1976, Dowty 1991).

The "contiguity" effect in semantic scaffolding may lie behind other patterns in child language, including children's interpretation of the multiclausal control structures. C. Chomsky (1969) found that children were slower to acquire the syntax for the subject control (SC) verb *promise* (*Neil promised Louise to make coffee*) than for object control (OC) *tell* (*Neil told Louise to make coffee*); young children interpret both sentences under the OC pattern, assuming that *Louise* is the coffee-maker in each utterance. I suggest that the staggered acquisition of the *tell* and *promise* patterns is in fact related to the alignment of thematic roles in the embedded clause and whether they allow for the contiguous appearance and processing of an embedded clausal proposition. In the *tell* utterances, the semantic subject, *Louise*, forms a contiguous unit with its predicate *cook dinner*. In contrast, in the *promise* utterance, the semantic subject of the cooking event, *Neil*, does not appear contiguously with its embedded predicate; instead, the child must look above the embedded predicate past one c-commanding NP to reach the semantic subject. As predicted by semantic scaffolding, the children in C. Chomsky's Stage 1 incorrectly interpret *promise* sentences as having object control, like *tell*.

Data from relative clause (RC) processing also support semantic scaffolding's assumption that children prefer to produce and/or parse entire semantic (clausal) units as a whole. MacWhinney (1982) cites data from Limber (1976) and Menyuk (1969; both cited therein) indicating that OO (object-modifying, object-extracted) and OS (object-modifying, subject-extracted) RCs emerge in spontaneous production before SO and SS types. I would argue that this acquisition pattern arises specifically from the desire to present clausal units as an uninterrupted whole: where subject-modifying relative clauses would disturb the contiguity of the matrix subject and its verb, object-modifying RCs do not.

The desire to match semantic with syntactic contiguity may also have left a mark in adult language. Children's interpretations of the contiguous embedded clauses here may be related to Specified Subject Condition (SSC; N. Chomsky 1973) effects seen in adult language; the SSC both limited NP movements (i.e., an NP may not raise over another NP that could have moved) and defined domains for anaphor binding, or more specifically "complete functional complexes." These CFCs are essentially clausal propositions of the type in which we are interested: "all grammatical functions compatible with its head are realized in it—the complements necessarily,... and the subject..." (N. Chomsky 1986:169). It seems that there is a preference, even in adult language, for producing and interpreting contiguous clausal propositions as independently functioning semantic units.

Semantic scaffolding may also lie behind “garden path” effects in sentence processing (e.g., Frazier 1978). Sentences like *The horse [raced past the barn] fell* are often initially misparsed as *The horse raced past the barn* (i.e., as not containing a reduced RC); it appears that in the absence of other information, the grammar defaults to an expectation of contiguous *subject + predicate* utterance shape.

Finally, we may see some effects of semantic scaffolding in second language relative clause processing. Research has indicated 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–like children–appear to get syntactic support from the basic semantic clause shape in its contiguous form.

In sum, the umbrella term “semantic scaffolding” encompasses several strategies which children turn to in the absence of adultlike syntactic knowledge and/or processing power, and which dictate what the canonical and expected overall shape of clauses and relationships among elements in clauses should be. These strategies can be seen not only in child language, but also in adult language as well. Given the literature on child cognition in both linguistic and extralinguistic realms, it appears that semantic scaffolding has a basis in domain-external structure (Kirby 2009). However, as we have seen, UG takes these extralinguistic notions and puts them through its own domain-specific filter, giving rise to the *linguistic* patterns we see here.

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