Raising, Control and the Subset Principle

Misha Becker
University of North Carolina

1. The Subset Principle

One part of the answer to the Logical Problem of Language Acquisition is that children come to the task of language learning equipped with Universal Grammar: this allows them to entertain a limited set of hypotheses about what Language could possibly be like, so they don't have to consider all the possibilities in the universe. Another part of the answer, typically assumed, is that children use a learning strategy that follows the Subset Principle. The idea behind this principle is that the learner should assume the most restrictive grammar, and then change the grammar when faced with positive evidence in the input that the target grammar is different. If a learner assumed a grammar that was less restrictive, or larger than the actual target grammar, no evidence in the input would force the learner to change the grammar, due to the absence of negative evidence.

Although the subset principle has been challenged in the formal learnability theory literature (Angluin , 1980), it is still commonly assumed by researchers studying children's language development and is thought to play a dominant role in human language acquisition. There are good reasons for this. From a theoretical standpoint, we assume there is no negative evidence in the input that could help a learner to restrict a grammar that is too large. In other words, we cannot require the child to be explicitly corrected, in order to learn the target grammar (Chomsky , 1959). From an empirical standpoint, many of the patterns we find in children's early language suggest a highly restrictive grammatical system, and the subset principle has been invoked to explain particular phenomena in acquisition, for example in Manzini and Wexler (1987)'s account of the acquisition of the Binding Theory and Hyams (1986)'s account of setting the Null Subject parameter.

In this paper, I will look at a domain of language in which the subset principle falls short: namely, the acquisition of the distinction between raising verbs and control verbs. First I will review the syntactic properties of raising and control constructions and I will lay out what the subset principle would lead us to assume about how a language learner should distinguish these verb classes. Then I will show how the predictions of this kind of approach fail on both logical and empirical grounds. Finally, I will suggest an alternative learning strategy based on multiple cues.

2. Raising and Control

It is well known that both raising and control verbs can occur in the string environment in (1) in English.

(1) a. Janine tends [*t* to eat sushi] (raising)

  b. Janine likes [PRO to eat sushi] (control)

The structures of (1a) and (1b) differ accordingly: (1a) involves NP-movement of the subject from inside the infinitive, where it leaves a trace, while (1b) involves no NP-movement, and the subject of the

infinitive clause is PRO. Although both raising and control verbs occur in this type of sentence string, only raising verbs can occur with an expletive subject, as we see in (2).[1]

(2) a.   There tend to be storms at this time of year.

  b.   * There like to be storms at this time of year.

The subset principle leads us to hypothesize that children should assume that a novel verb, as in (3) is a control verb, not a raising verb. If the child has guessed incorrectly there will be input like (2a) that forces the learner to change her hypothesis. On the assumption that a verb cannot be a member of both verb classes, evidence that a verb can occur with an expletive subject implies that the verb does not assign an external theta role and therefore is a raising verb, not a control verb. If, on the other hand, the learner first assumes the novel verb in (3) is a raising verb, a wrong guess will not be met with counterevidence, since information that (2b) is ungrammatical is not present in the input.

(3)   Janine *gorps* to eat sushi

(4) assume *gorp* is control		assume *gorp* is raising	
gorp is really control	*gorp* is really raising	*gorp* is really control	*gorp* is really raising
↓	↓	↓	↓
correct	will hear (2a) and adjust	PROBLEM (no (2b))	correct

I take this to be the null hypothesis within generative syntax. It is consistent with Frank's (1998) claim that a raising structure is computationally more complex than a control structure, and a learner should therefore be inclined to suppose a control structure first for a sentence like (3). This position is in fact required on the view that raising (A-movement) is not acquired or does not mature until children are at least 5 years old (Borer and Wexler , 1987; Wexler , 2002; Hirsch and Wexler , to appear). I will refer to this learning strategy as the "expletive-driven" strategy, since it takes evidence of occurrence with an expletive subject as the triggering evidence that a verb is a raising verb.

What I argue here is that this learning strategy is insufficient on both logical and empirical grounds: a class of verbs that are ambiguous between being raising or control provide a problem for the logical soundness of the expletive-driven learning approach. Moreover, evidence from children's actual interpretations of raising and control sentences suggests that children do not assume that a verb in a sentence like (3) is a control verb.

3. The two verbs *begin*, again

As noted by Perlmutter (1979), there are verbs that are ambiguous between being raising and control verbs. Verbs like *begin*, *start*, *fail* and *continue,* can be raising verbs, as in (5):

(5)   It began to rain

but they can also function as control verbs, as in (6):

(6)   John began to eat a sandwich.

Begin is a control verb in (6) in the sense that *John* is the agent of beginning the event; i.e. it is thematically related to *begin*.

Why are verbs like *begin* problematic? Imagine that a learner hears a sentence like (6) and assumes that *begin* is a control verb. Then the learner hears sentence (5). Now she changes her grammar and analyzes *begin* as a raising verb. *But this is the wrong grammar.* The learner must not prevent *begin* from

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[1]Although I assume a GB-style derivational approach, this assumption is rather irrelevant to the question I am addressing. Regardless of whether one assumes that (1a) and (1b) differ with respect to movement or not, in all frameworks I am aware of there is a difference between (1a) and (1b) in the semantic relationship between the matrix verb and the matrix subject. This is the issue of interest here.

being a control verb in appropriate contexts (such as (6)). Likewise, it would be incorrect for a learner to assume that all raising verbs, including *tend* and *seem*, are ambiguous because they can occur both with a referring NP subject and an expletive subject.

In a nutshell, we have the following question: how does a learner analyze pure raising verbs (*tend*) as only raising, pure control verbs (*like*) as only control, and ambiguous verbs (*begin*) as raising or control in the appropriate clauses?

One possible source of disambiguation can be ruled out. That is that because a verb's classification as raising or control is related to the verb's lexical meaning, children could use information about the meanings of these verbs to determine whether they are raising or control. But in order to use this information, you would have to infer the meaning of *tend* or *seem* on the basis of *nonsyntactic* information, such as observation of events and states in the world. However, it is not possible to directly observe "seeming" or "tending". Thus, it should not be possible to infer the meaning of a verb like *seem* or *tend* without having syntactic cues. The question remains, then, of how raising and control verbs are distinguished by learners.

The existence of ambiguous verbs shows that the premise of the expletive-driven learning strategy (that verbs can be raising or control but not both) is not true. Next, the strategy itself, namely that children should first assume a control structure, should be examined empirically. Let us turn to this now.

4. Children's Interpretations

If children do initially assume a control structure for a sentence like (3), we may identify a stage in development in which children misanalyze verbs like *seem* or *tend* as control verbs, but we would not expect to find a stage at which children misanalyze control verbs such as *like* or *want* as raising verbs.

4.1. Experiment 1

Recall that one of the primary differences between raising and control verbs is that control verbs stand in a thematic/selectional relationship with the matrix subject, but raising verbs do not. One way to see whether children are analyzing sentences as raising or control is to see whether they look for a semantic relationship between the matrix verb and matrix subject. To do this, 43 children ages 3–5 years participated in a (modified) Grammaticality Judgment task (McDaniel and Cairns , 1990). Children were asked to listen to a puppet's comment about a picture, and to report whether the puppet's comment was "OK" or "silly". There were 4 kinds of test sentences, illustrated in Table 1. All test sentences had an inanimate subject and either a raising or a control matrix verb. A second factor was manipulated, namely whether the lower predicate was semantically "compatible" or "incompatible" with the (inanimate) matrix subject. Children were asked to justify their negative responses, so if a child judged the sentence *The flower wants to fly away* as silly, we can see whether they did so because flowers cannot want or because flowers cannot fly away.

Table 1: Test Items in Experiment

Item	Matrix Verb	Lower Predicate
The flower wants to be pink	control	compatible
The flower wants to fly away	control	incompatible
The hay seems to be on the ground	raising	compatible
The hay seems to be excited	raising	incompatible

The prediction, shown in Table 2, is that if children are analyzing these sentences as control sentences (and if they assume that control verbs require an intentional/sentient subject), they should respond

that all sentences are "silly", since inanimate things lack intentionality.[2] If children are analyzing these sentences as raising sentences, then they should reject only those sentences with an "incompatible" lower predicate. Finally, if children have correctly classified both raising and control verbs, they should behave as adults.

Table 2: Predicted Responses Depending on Child's Assumptions

Item	all control		all raising		adult-like	
	OK	silly	OK	silly	OK	silly
The flower wants to be pink	☐	☐	☐			☐
The flower wants to fly away	☐			☐		☐
The hay seems to be on the ground	☐		☐		☐	
The hay seems to be excited	☐			☐		☐

The outcome of this experiment was that 5-year-olds behaved in an adult-like manner. They judged all of the control sentences to be "silly", but they judged the raising sentences to be silly only if the lower predicate was incompatible with the subject (e.g. *The hay seems to be excited*). However, 3- and 4-year-olds showed a different pattern. They behaved in an adult-like manner for the raising verbs, but not for some of the control verbs. The results are summarized in Tables 3 and 4 and are given as the proportion of OK or silly responses for each type of test item.

Table 3: Results of Experiment: Relative Proportion of OK/Silly Responses

Item	3-year-olds		4-year-olds		5-year-olds	
	OK	silly	OK	silly	OK	silly
The flower wants to be pink	☐		☐		☐	**
The flower wants to fly away	☐	*	☐	**	☐	**
The hay seems to be on the ground	☐	*	☐	**	☐	*
The hay seems to be excited	☐	*	☐	**	☐	**

$*p \leq 0.05$, $**p \leq 0.01$

Table 4: Results of Experiment: Percent OK/Silly Responses (%)

Item	3-year-olds		4-year-olds		5-year-olds	
	OK	silly	OK	silly	OK	silly
The flower wants to be pink	64	36	47	53	12	88
The flower wants to fly away	30	70	16	84	0	100
The hay seems to be on the ground	77	23	91	9	79	21
The hay seems to be excited	27	73	12	88	0	100

In brief, 3- and 4-year-olds incorrectly accepted sentences like *The flower wants to be pink* about half the time or more, while responding in a largely adult-like way to all other types of sentences. A possible explanation for this result is that the younger children are misanalyzing verbs like *want* as raising verbs. If the sentence had been *The flower seems to be pink*, the children would have been correct in judging

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[2] The idea behind this prediction is that if children are imposing a control analysis on raising verbs, they must be shifting the verbs' meanings to require a sentient subject (e.g. "seem intentionally"). Thus, in this case they would be expected to treat these sentences the same way as control sentences.

the sentence OK. (And if *The flower wants to fly away* was analyzed as *The flower seems to fly away*, it would still be "silly"). In fact, this is what I would like to argue children are doing: they initially permit control verbs to have a nonthematic, or raising-like interpretation. However, the children did not misanalyze raising verbs as if they were control verbs. Children's own justifications of their answers support this conclusion: children sometimes responded that "flowers aren't alive" or "doors can't try to do anything", but they never responded that "hay can't seem to do anything".

One might worry that the 3- and 4-year-olds in this experiment responded in the way they did not because they analyzed control verbs as raising, but because they were failing to parse the middle of the sentence (i.e. the matrix verb). Perhaps they were parsing only the matrix subject and lower predicate (e.g. *The flower...pink; The hay...on the ground*). To see whether children do in fact parse the matrix verb, a second experiment was run.

4.2. Experiment 2

The second experiment involved a Truth-Value Judgment Task (Crain and Nakayama , 1987). Twenty-one children ages 3–4 years were told a series of stories, and each story was followed by a comment from a puppet. The child's task was to judge the puppet's utterance as either true or false. Test sentences included raising and control sentences, e.g. *The pig wanted to eat the donut*, *The dog seemed to be purple*.

Table 5: Test Sentences in Experiment 2

Raising Verbs	Control Verbs
The dog seemed to be purple	The pig wanted to eat the donut
The horse used to be small	The horse hoped to be big
The horse tends to eat hay	The dog tried to catch the frisbee
The rhino happened to be under the tree	The rhino decided to lie in the shade

The stories were constructed so that in order to respond correctly to the sentence, the (raising or control) verb would have to be parsed. For example, one the stories was about a dog that was actually white but stood under a black light and so appeared to be purple. A child parsing only *the dog ... be purple* should respond "false", since the dog was not in fact purple; but a child parsing *the dog seemed to be purple* should respond "true" since the dog did seem to be purple when standing under the lamp. The control sentence stories were constructed similarly: in the story about the pig, the pig wanted to eat the donut but actually ate a banana, so a child parsing only *the pig... eat the donut* should respond "false" since the pig did not eat the donut, but a child parsing the verb *want* in the test sentence should respond "true", since the pig had wanted to eat the donut.

The results are given in Table 6.[3]

Table 6: Results of Follow-up Experiment: Percent Correct

age	raising	control
3	71.4	64.3
4	83.3*	78.9*

*$p < 0.01$

The results of the follow-up experiment show that 4-year-olds were significantly better than chance (50%) for both raising and control verbs. Three-year-olds were trending better than chance for raising

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[3]The percentages given in Table 6 omit the responses to the test item containing *tend*. Children at this stage of development do not have the verb *tend* in their lexicon and thus were consistently incorrect on this item. In fact, only one child answered correctly to *tend*, after asking the experimenter what *tend* meant.

verbs, and it is unclear whether they are at or above chance for the control verbs. It should be noted, though, that if the children were not parsing the verbs at all, their performance should have been at 0%, and all children are significantly better than 0% for both types of verbs.

The significance of this result is that children do not appear to ignore the main verb in the kind of sentences used in Experiment 1. The result of Experiment 1, then, is not explained by a failure of children to parse the main verb, but rather by children's willingness to assign these sentences a raising structure.

5. The Learning Strategy: Multiple Cues

The experiments with children show that children do not necessarily assume that a sentence like (3) has a control structure. If anything they are inclined to assume it has a raising structure. So how do children attain the correct adult grammar of distinguishing raising from control verbs?

I propose that learners will need to rely on clusters of cues, none of which is an absolute trigger. There are two families of cues relevant to learning this distinction: the first family relates to whether a given *sentence string* should be analyzed as having a raising or control *structure*; the second family relates to whether a given *verb* is likely to be a raising or a control *verb*.

5.1. Cues to Structure

Cues to whether a particular string has a raising or a control structure come from subject animacy and the eventivity of the lower predicate.

5.1.1. Subject Animacy

The results of a simulated learning experiment with adults (Becker , in press) showed that the animacy or inanimacy of the matrix subject played a large and significant role in adults' analysis of an ambiguous string as a control as opposed to a raising structure. Participants were asked to write a verb in the blank to complete the sentence. Participants were significantly more likely to write in a control verb in the blank given a sentence like (7) than a sentence like (8). Conversely, participants were significantly more likely to give a raising verb response in (8) than (7) ($p < 0.01$ by a logistic regression). Participants also gave ambiguous verbs as responses for both types of sentences in roughly equal proportions.

(7) The salesman _____ to advertise an interesting new product. (animate)

(8) The banner _____ to advertise an interesting new product. (inanimate)

Table 7: Responses in Subject Animacy Condition

Sentence	Control	Raising	Ambiguous
The saleseman _____ to advertise…	52.5%	18.8%	17.5%
The banner _____ to advertise…	17.5%	43.8%	23.8%

Control verbs typically require a sentient subject, while raising verbs place no semantic restriction on the subject of the sentence. Thus, a kind of "negative" selection could take place: given an inanimate subject, the learner should look for a verb that does not require its subject to be sentient, viz. a verb that does not select the subject. This is not an absolute trigger for two reasons: (1) raising verbs can occur with both animate and inanimate subjects, (2) there is no reason to suppose, a priori, that the learner might not assume a class of verbs that select *inanimate* subjects. Nevertheless, subject animacy seems to provide a robust cue in this context.[4]

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[4]In both Tables 7 and 8, rows total to near 100%. The reason they do not reach 100% exactly is that participants gave a small number of other responses (e.g. purpose constructions) that did not fit into any of these three categories.

5.1.2. Predicate Eventivity

One of the rather surprising results of the study with adults was that the eventivity of the lower predicate (infinitive clause) had *as strong an effect* on adults' responses as subject animacy. Participants were significantly more likely to write in a control verb in a sentence like (9) than in a sentence like (10), and their raising verb responses showed the opposite pattern.

(9) The boulder _____ to hit the car on the passenger's side. (eventive)

(10) These shapes _____ to belong to the group on the left. (stative)

Table 8: Responses in Predicate Eventivity Condition

Sentence	Control	Raising	Ambiguous
The boulder _____ to hit...	48.8%	11.3%	20%
These shapes _____ to belong...	21.3%	51.3%	21.3%

It is unclear what gives rise to this pattern, but it may relate to the fact that complements of control verbs often require an "unrealized future tense," (Bresnan , 1972), while complements of raising verbs do not. It may be easier to get an "unrealized future" interpretation of an eventive predicate than a stative predicate. In any event, adults consistently used these cues in the simulated learning study.

What this means, at minimum, is that raising verbs have "preferences" about the eventivity of the complement clause. Thus, learners might derive some information about whether the matrix verb is raising or control by noticing the aspect of the complement clause.

5.2. Cues to Verbs

Apart from determining whether a string of words is likely to have a raising or a control structure, there are additional cues from other sentence frames in which a particular verb appears. A verb that can appear with an expletive subject is likely to be a raising verb. A verb that can appear in a monoclausal transitive or intransitive sentence is likely to be a control verb.

5.2.1. Expletive Subjects

Although expletive subjects cannot distinguish ambiguous verbs from pure raising verbs, they can distinguish both of those classes from pure control verbs. In the experiment with adults, participants offered a raising verb response significantly more often than any other type of response in sentences with an expletive subject.

(11) It _____ to be too foggy to drive safely. (expletive *it*)

(12) There _____ to be no end to his complaints about the situation. (expletive *there*)

(13) It _____ to be much heavier than I expected. (referential *it*)

Table 9: Responses in Sentences with Expletive Subjects

Sentence	Control Response	Raising Response	Ambiguous Verb
It _____ to be too foggy	0%	82.5%	15%
There _____ to be no end	0%	86.3%	12.5%
It _____ to be much heavier	17.5%	47.5%	20%

Thus, expletive subjects can provide some useful information about the likely class of the matrix verb.

5.2.2. Monoclausal Frames

Finally, one of the properties of both control verbs and the ambiguous verbs is that many of them can also occur in a transitive or intransitive sentence, that is, in a monoclausal frame.

(14) a. Max wants a car.

    b. Sally likes math.

    c. Bush claimed victory.

(15) a. John started a novel.

    b. Mary failed the test.

    c. The argument continued.

This information might tell the learner that these verbs can assign an NP θ-role, and thus are not exclusively raising. I predict that this kind of evidence is probably very informative for the learner. Combined with the cue from expletive subjects, a learner could define all 3 classes of verbs: if a verb occurs with an expletive subject, it is not a pure control verb; if a verb occurs in a monoclausal frame it is not a pure raising verb. Thus, a verb that can occur in both contexts must be ambiguous. However, even this evidence does not serve as an unambiguous trigger: *seem* can occur with a simple NP complement, as in (16).

(16) John seems the best candidate.

The raising verbs *appear*, *happen* and *tend* have other uses as either intransitive or transitive verbs:

(17) a. Suddenly, a monster appeared.

    b. Good things happened.

    c. The shepherd tends his flock.

While these meanings are clearly different from the meanings of the raising verbs, many verbs are able to occur in multiple sentence frames, and children will need to figure out when a given verb occurring in multiple sentence frames is still the same verb, or different verbs.

Table 10: Summary of Probabilistic (Non-absolute) Cues

Structure Cues		Verb Cues	
Cue	Implication	Cue	Implication
Animate subject	control	Expletive subject	raising verb
Inanimate subject	raising	Monoclausal frame	control verb
Eventive predicate	control		
Stative predicate	raising		

6. Conclusion

In this paper, I have discussed some logical and empirical challenges for the expletive-driven learning strategy for distinguishing raising from control verbs. The logical challenge is that there are verbs like *begin* that can fit into both categories. If the proposed trigger for learning cannot truly disambiguate the classes it is supposed to, then the learning strategy fails. On the empirical front, the prediction that children first assume a control rather than a raising structure for sentences like (3) is not supported: children appear to permit control verbs to have a raising interpretation, a situation totally unexpected if children first assume a control interpretation only.

I have proposed two families of cues that could drive the learning of these verb classes. These cues are not absolute triggers, but could function in a probabilistic manner (Yang , 2002). For example, a verb occurring with an animate subject is likely to be a control verb; a verb occurring with a stative lower predicate is likely to be a raising verb. And unlike the expletive-driven strategy, these cues do not run into the problem of being derailed by the existence of verbs that are ambiguous between being raising or control.

The problems with single trigger approaches to learning the raising/control distinction have implications for the role that the subset principle might play in language acquisition. The idea behind the subset principle is that the learner should assume the smaller, more restrictive of two possible grammars, because only in that case will positive evidence lead the learner to change her mind. However, as Angluin (1980) showed, the existence of "intermediate" grammars would render this learning strategy unsound. In the same way, the existence of ambiguous verbs prevents the Subset Principle from working in this case. Recent work by Yang (2002) supports this trend of moving away from a single trigger type of approach, and toward a strategy that makes use of multiple sources of evidence in a probabilistic way. This multi-cue type of approach is also consistent with work in the verb learning literature (Gleitman , 1990) which admonishes that a learner will have to consider multiple sentence frames in which a verb appears in order to figure out the lexical meaning of the verb.

It is important to note that a multi-cue, probabilistic type of learning strategy in no way treads on the assumption of the poverty of the stimulus: in order to use these families of cues, learners must bring to the task certain restrictions on how grammar can be constructed. For instance, in order to use the types of cues I have described here to distinguish raising from control verbs, the learner must, at the very least, assume the Theta Criterion and the existence of different kinds of empty categories, notably NP-trace and PRO.

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