

An Experimental Study of Children's Comprehension of Null Subjects: Implications for Grammatical/Performance Accounts

Robyn Orfitelli and Nina Hyams
University of California, Los Angeles

1. Introduction

Until English-speaking children are approximately 3½ years old, close to 50% of their spontaneous productions lack a sentential subject (Hyams & Wexler 1993). This phenomenon is not limited to English (1), but also occurs in other languages (2)-(3), including Danish, Dutch, and French (Hamann & Plunkett 1998, Haegeman 1995, Rasetti 2003).

- (1) Tickles me.
- (2) Se, blomster har. (Danish, Hamann & Plunkett 1998)
look flowers have/has
'Look, has/have flowers.'
- (3) pleure pas. (French, Rasetti 2003)
cries.3sg not
'He/she is not crying.'

What is notable about these examples is that the null subject is not a grammatical option in the adult language. In English, for example, null subject sentences are only grammatical in specific situations, such as imperatives (4), and an occurrence known as diary drop (5), in which the author of a letter or a diary drops the subject, which is typically, although not exclusively, first or second person (Haegeman 1990).

- (4) Eat your dinner!
- (5) Talked to Mom yesterday. Don't know why she doesn't like telephones...

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1.1 Explaining the Null Subject Phenomenon: Grammatical and Performance Accounts

Attempts to explain the null subject (NS) phenomenon illustrate the long-running debate between the effects of competence and performance in language acquisition. Certain accounts appeal to the child's grammatical knowledge, and consider children's erroneous productions to be a manifestation of a difference between the child and adult grammars (e.g. Hyams 1986, 1992; Rizzi 1994, 2000). Other accounts assert that subject omission does not reflect different grammars, but instead reflects performance effects, such as limitations on memory and processing capacity (Bloom 1990, Valian 1991), or a preference for particular metrical structures that NS sentences satisfy (Gerken 1991).

Spontaneous speech data has not provided concrete evidence in favor of either class of explanation, as both predict that children will produce non-adult NS utterances. The theories, however, make very different predictions about how children will *comprehend* NS sentences. Grammatical accounts predict English-speaking children will understand and accept NS sentences as grammatical declarative sentences, as in Italian. Performance accounts, however, which hold that the child and adult grammars do not differ, predict that children should interpret NS utterances in an adult manner. Thus, for English-speaking children, only an imperative reading for NS sentences should be possible, not a declarative reading. The primary goal of the experiments presented here was to evaluate these competing predictions.

1.2 Null Subjects and the Root Infinitive Stage

During the same period as the NS stage, Wexler (1994) noted that children produce main clause declaratives with infinitival verb forms (6) alongside the finite forms that are grammatical in the adult language.

- | | |
|---|-----------------------|
| (6) Voir l'auto papa
see the car daddy
'Daddy sees the car' | (French, Wexler 1994) |
|---|-----------------------|

These 'root infinitives' (RIs) have since been documented in a wide variety of languages, such as Danish, Dutch, and French (Hamann & Plunkett 1998, Haegeman 1995, Wexler 1994); notably the same languages in which the NS stage has been documented. Similarly, in languages in which null subjects are grammatical for adults, such as Italian, RIs are extremely rare (Guasti 1994).

Children produce NS and RI sentences at similar ages, and exit the stages at the roughly the same time.¹ Based on this, certain theories predict a principled correspondence between the NS and RI stages (e.g. Rizzi 1994, 2000). To date,

1. It should be noted, however, that as a group, children exit the root infinitive stage before the null subject stage (Guasti 2002).

however, no experiments have been conducted to find evidence of this relationship. Such evidence could adjudicate between theories which do and do not predict a link. In an effort to provide this evidence, our second experiment was an RI task, and we compared each child's performance on it to their performance on the NS comprehension task.

2. Comprehension of Null Subject Sentences: A TVJ Experiment

2.1 Methods

In order to evaluate the competing predictions made by production and grammatical accounts, we conducted a Truth-Value Judgment (TVJ) experiment (Crain & Fodor 1993) testing children's comprehension of NS sentences. This task involved the child viewing a scenario, and then listening to a comment made by an observing puppet. The child was then asked to decide if the puppet, a stuffed animal named Mr. Bear, commented truthfully or untruthfully. Subjects were asked to be Mr. Bear's teacher for the day, telling him if his statements were right or wrong, and why.

There were four unique scenarios in the task, each consisting of a story and an accompanying pair of pictures. The first of the pair was always a picture of two 'older' children named Mary and Billy, while the second picture was always of two 'younger' children named Emma and Ben.

In the pictures, the older children were always shown engaging in a particular activity, such as drawing a picture or playing with blocks, while the younger children were shown in close proximity to the relevant items (i.e. paper and crayons or blocks) but *not* interacting with them. Subjects were told that the older children are old enough that they may engage in these activities without being given permission, and, moreover, they do these activities every day. Conversely, the younger children must wait to be told to engage in the activity in question by their babysitter, who was Mr. Bear.

Before the experiment began, subjects were told that Mr. Bear's comments would either *describe* the actions of one pair of children, or would *command* them to do something. It was then established that it would be silly for Mr. Bear to tell the older children to do an activity they were already doing. It would, however, be appropriate for him to describe their actions. Conversely, it would be silly for Mr. Bear to describe the younger children performing an action they were not doing, but it would be appropriate for him to tell them to do the activity, because they were waiting for his permission.

For each item, subjects was shown both pictures. This was to remind them of the story, and to reinforce the distinction between the older and younger children. The child was then asked two background questions before Mr. Bear commented: 'Do Mary and Billy have to wait for permission to do X?' and 'Do Emma and Ben have to wait for permission to do X?' These questions established that the child understood the details of the scenario. If the child did not answer these questions correctly, the scenario was repeated. Once the child demonstrated that he understood the scenario, one of the pictures was removed,

and Mr. Bear commented, without being prompted, on the remaining picture, using one of three sentence structures: finite *declarative* clauses (7), *imperative* commands (8), or *null subject* sentences (9).

Table 1: Example items with adult judgments²

	Older children	Younger children
7. They always play with blocks ³	Correct	Silly
8. Please play with blocks	Silly	Correct
9. Play with blocks	Silly	Correct

The *declarative* and *imperative* conditions served as attentional controls. High performance on these conditions indicates that the child comprehended declarative and imperative clauses in an adult manner, and understood the scenario. Ensuring that the child had an adult interpretation of these conditions is a crucial control for the null subject items. If the child did not understand these conditions, then his results for the null subject condition would be unclear. For this reason, to ensure that performance on the *null subject* condition accurately reflected a child's level of grammatical comprehension, children scoring less than seven out of eight items correct on either the *declarative* or *imperative* condition were not included in any subsequent analyses. The *null subject* condition is the condition of interest, as it is for this condition that performance and grammatical accounts make different predictions.

Each condition was tested eight times, with four true and four false items, for a total of 24 test items. These items were pseudo-randomly balanced such that children were not tested on the same condition more than twice in a row. Sentences were read twice before the child responded. Before the experiment began, the child was instructed to tell Mr. Bear if he was right or wrong after each item without prompting from the experimenter. The child was therefore only prompted when a significant amount of time had passed without giving a response. The children's response justifications were noted before moving to the next test item. Due to the young age of the children tested, not all children were able or willing to provide response justifications in all cases, although the majority (26 of 30) provided justifications for at least some of the items.

2.2 Recordings

In addition to the predictions already discussed, grammatical theories make another prediction regarding the relationship between comprehension and performance. If children produce null subject sentences as a result of a non-adult

2. Playing with blocks was one of four scenarios. The other scenarios involved eating a cookie, drawing a picture, and putting on socks.

3. In English, the simple present tense has a habitual meaning. For this reason, 'Always' was included in *declarative* items, and the story about the older children indicated that they engaged in the relevant activity every day.

grammar, then we should see a high correspondence between an *individual child's* production of null subject sentences and that same child's non-adult assignment of a declarative reading to said sentences.

To test this prediction, a 10-minute audio recording was made of all children who participated in the TVJ task. Each child was presented with a wide array of toys and encouraged to tell stories about them to an experimenter. The experimenter participated as little as possible in these sessions, speaking only to encourage the child to continue or begin a new story.

The recording sessions were transcribed, and for each session, 'obligatory subject contexts' (OSCs) were identified. OSCs were defined as clauses in which a subject must be present for a native English-speaking adult. Cases in which subjectless sentences are grammatical, such as imperative clauses, were not counted. Every child's recording session had at least 21 OSCs, and many recording sessions had over 30.

Two independent researchers scored all OSCs for the presence or absence of a subject. Then, for each child, the number of OSCs lacking a subject was divided by the total number of OSCs to get the proportion of NS sentences for each child. A proportion greater than 0.3 was taken to indicate that the child was in the NS stage. This proportion of NS utterances is roughly what has been observed in the natural production of English-speaking children in the NS stage.

2.3 Results

As mentioned in the previous section, children who did not correctly answer at least seven out of eight items on the *declarative* and *imperative* conditions were eliminated from further analyses. Despite this restriction, very few children had to be eliminated from the study, even in the youngest age group (2½-3 years). Only 5 children of the 35 tested were eliminated, leaving us with a total of 30 children for our analysis of NS comprehension. These 30 children (13 boys, 17 girls) consisted of 10 children in each six-month interval between 2½ and 4 years (2.54-3.97 years, mean age 3.25). These three age groups were chosen because they correspond to three different portions of the NS stage. In the youngest age group, we expected virtually all children to still be in the NS stage, while in the oldest age group, we expected virtually all children to be out of it. In the middle group, we expected to find some variation, with some children who in the NS stage, and some children who have passed out of it. Participant details are shown in Table 2.

Table 2: Participant Details

Group	Age Range	Mean Age	N
2;6-2;11	2.54-2.96	2.79	10
3;0-3;5	3.06-3.33	3.18	10
3;6-3;11	3.56-3.97	3.78	10
Total	2.54-3.97	3.25	30

In accordance with our stipulation, children performed well on *declarative* and *imperative* trials. This high accuracy indicates that these 30 children had no difficulty with the task and had a correct, adult interpretation of both declarative and imperative sentences. We have therefore ensured that children's comprehension of the *null subject* items is independent of these factors.

Children's performance on the *null subject* condition by age group is shown in Figure 1. Overall, the two younger groups of children perform extremely poorly on this condition, with the youngest age group scoring well below chance, at 14% correct.

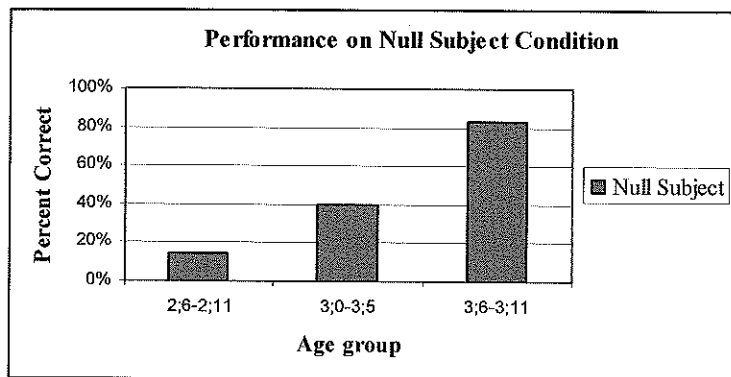


Figure 1

As a group, the middle age group performs at 40%, a marked increase from the youngest group. It is important to note, however, that this increase in overall group performance is not due to a marginal increase for each child in the age group. Instead, we find two distinct groups of children in the middle age group: one which has completely mastered the *null subject* condition and shows near perfect performance, and one which continues to show below chance performance (Table 3). Below chance performance was considered to be only zero to one items correct out of eight, meaning that the vast majority of children in the youngest age groups were answering correctly *at most* one item out of eight in the *null subject* condition.

In contrast to the younger groups, the oldest children tested performed well above chance as a group. This sudden increase in comprehension at 3½ years mirrors the sudden decrease in production of NS sentences that occurs at this age. As with the middle age group, virtually no children show chance performance (Table 3). The abrupt increase we find is due to the fact that 7 of 10 children in the oldest age group perform above chance, as compared to only 3 of 20 children in the younger two age groups combined.

Table 3: Individual Performance on the Null Subject Condition

	2;6-2;11	3;0-3;5	3;6-3;11
AC (7-8 correct)	1	2	7
C (2-6 correct)	0	0	1
BC (0-1 correct)	9	8	2

The consistent below chance performance indicates that children in the youngest two age groups are not guessing. Instead, they are using a consistent strategy that leads them to an incorrect, non-adult answer; in this case, a declarative interpretation. This interpretation lasts until the age of 3½ years, and then abruptly becomes adult-like within six months. Importantly, this behavior is predicted by grammatical accounts, but not by performance accounts.

Younger children's justification responses for the *null subject* condition confirm that they are assigning a declarative, rather than imperative, interpretation to *null subject* test items, providing further support for grammatical accounts. Just as for the declarative test items, subjects would often explain that Mr. Bear was right or wrong because he had been describing what the children were doing (10). Due to our study design, this declarative interpretation yields the wrong answer on *null subject* items regardless of whether Mr. Bear was referring to the older (10a) or younger children (10b).

- (10) a. He know these kids play every day. -M., 2;7
 Child answers 'true' when the correct answer is 'false'.
- b. He [Mr. Bear] said they play with blocks, but they aren't. -K., 2;9
 Child answers 'false' when the correct answer is 'true'

Finally, recall that grammatical accounts predict that a child who performs poorly (chance or below chance) on the *null subject* condition of the TVJ task should also produce a substantial number of null subject sentences, while a child who performs well (above chance) on the *null subject* condition of the TVJ task should not produce many null subject sentences.

An individual subject analysis compared each child's performance on the *null subject* condition of the TVJ task to the proportion of null subject sentences he produced in the recording. A 100% correspondence was found between above chance performance on the TVJ task and a lack of NS sentence productions in the recording task, meaning that children who were classified as being in the null subject stage by the performance-based recording task were also classified as being in the null subject stage by the comprehension-based TVJ task. This perfect correspondence again suggests that NS production arises from children allowing a declarative underlying representation of NS sentences, as predicted by grammatical, but not performance, accounts.

3. An experimental link between the Null Subject and Root Infinitive Stages

In order to experimentally examine a possible link between the NS and RI stages, every child who participated in our NS TVJ task was also given the Rice/Wexler Test of Early Grammatical Impairment (TEGI, Rice & Wexler 2001). TEGI is most commonly used as a diagnostic of Specific Language Impairment (SLI). It is designed to identify children in the RI stage, which extends beyond the usual age of 3½ years in children with SLI. For the purposes of this experiment, however, TEGI was used to identify which typically developing children in our study were in the RI stage. All subjects took TEGI within 30 days of beginning the TVJ task, with an average span of 8.6 days between the two tests.

3.1 Methods

Three sections of TEGI were utilized. The first section is phonological, and tested each subject's ability to produce [s], [z], [t] and [d] word finally. These sounds are the ones that occur as the third person singular finite and regular past tense inflectional markers in English. Passing this subtest ensures that if a subject omits inflectional markers, it is not due to an inability to produce the sounds involved. Any child who could not produce the sounds would have been eliminated from further analyses; however, all subjects passed, producing at least four out of five items correctly for each sound.

For this subtest, the child was asked to name a series of 20 pictures, all of which ended in one of those four sounds. If the child was not able to name an object, or gives it a different name (e.g. mousey for mouse) the experimenter said the name of the item and asked the child to repeat it. Cases in which the child consistently produced an incorrect, but similar, sound (such as [] for [s]) were counted as correct.

The remaining two subtests evaluated whether or not a subject consistently produced verbal inflection. The 3rd *person singular* subtest evaluated the child's ability to produce third person singular inflection. The child was shown a picture of a person, such as a pilot. The experimenter said "This is a pilot. Tell me what a pilot does." The child was instructed to give an answer using a subject, such as "A pilot flies the plane." If the child failed to use a subject, the experimenter modeled a sentence using an example picture of a teacher. If the child still did not produce the desired sentence, the experimenter would begin the sentence for the child by saying "A pilot..." and the child would finish it.

The *past tense* subtest evaluated the child's ability to produce regular and irregular past tense inflectional markings. For this task, the child was shown two pictures per item. The first picture showed an action in progress, such as a boy raking leaves. The second picture showed the completed action, such as the boy standing next to a pile of leaves. The experimenter pointed to the first picture and said "Here the boy is raking the leaves." The experimenter then pointed to

the second picture and said "But here he is done. Tell me what he did." This is designed to elicit a past tense response such as "The boy raked the leaves."

3.2 Results

In line with our requirements, all subjects passed the *phonological* subtest without difficulty. This established that the children had no problem producing third person singular and past tense inflection, and any cases in which the children did not produce this inflection must be attributed to other causes.

The number of children showing AC performance on the 3rd person singular and past tense subtests is shown in Figure 2. The two youngest groups of children performed poorly, with only four individuals behaving adult-like. As with our TVJ task, this behavior changed abruptly in the six month period between the middle and oldest group. Fully eight children in the oldest age group showed adult performance. In addition, within-subject performance was consistent. Those children who showed adult behavior on the 3rd singular subtest also showed adult performance on the past tense subtest, and visa versa.

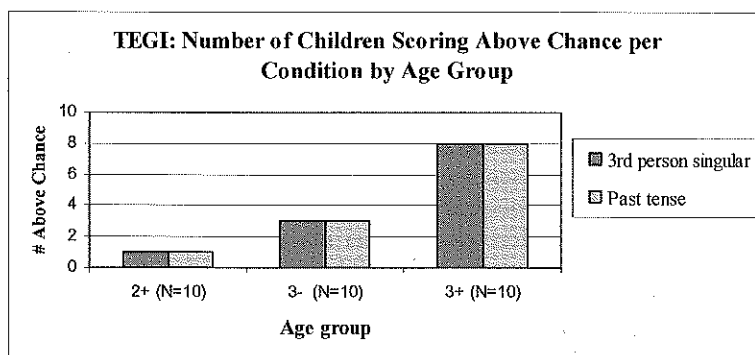


Figure 2

We found a near perfect correspondence between AC performance on TEGI and AC performance on the NS TVJ task, which constitutes the first evidence that the NS and RI stages are linked. As seen in Table 4, 28 out of 30 children tested showed either AC performance on both tasks, or had C or BC performance on both tasks.

Table 4: Correspondence Between TEGI and NS TVJ Performance

	BC or C, NS TVJ	AC, NS TVJ
BC or C, TEGI	18	0
AC, TEGI	2	10

Two children are exceptions to the correspondence between the NS and RI stages. Both of these children are in the middle age group (3;0-3;5), in which we

see the most variation in both of the tasks. Importantly, both children pattern in the same direction: They each perform BC on the NS TVJ task, while performing like adults on TEGI. It appears that they have exited the RI stage, but not the NS stage. This pattern mirrors a discrepancy that has been noted in production, that children exit the root infinitive stage slightly before exiting the null subject stage (cf. footnote 2, page 2). Twenty more children are currently being tested in the middle age range (3;0-3;5) in an effort to find more cases of this dissociation, and to ascertain if it is always in this same direction.

4. Discussion

The experiments discussed here address an issue of competence versus performance: Do children have a fundamentally different grammar from adults which allows them to produce and interpret null subject sentences as grammatical declarative sentences, or are there performance limitations which cause children to produce sentences that their grammar rejects? While these two theories do not differ with regard to their predictions about production, they differ greatly in their predictions regarding comprehension.

The data presented here strongly supports the first conclusion, that children and adults possess different grammars. Below the age of 3½ years, children perform poorly on the *null subject* condition of our TVJ experiment, although they perform virtually perfectly on the *declarative* and *imperative* conditions, indicating that a lack of understanding of either the experiment or the proper use of declarative and imperative sentences is not the cause of their problems interpreting null subject sentences. Furthermore, we do not find children performing at chance level; children have either mastered this condition, or do not comprehend it at all. It appears that children are not guessing, but are assigning a consistently non-adult declarative interpretation.

If we have found evidence that children have a different grammar from adults, what form does this grammar take? Although we will not attempt an answer at this point, several pieces of data speak to this question. First, we find strong experimental evidence that the null subject and root infinitive stages are linked. This observation lends credence to those theories that assign a common cause to the null subject and root infinitive stages.

The two children who show 'anomalous' data also provide support for a particular class of accounts. These children appear to have exited the RI stage, as evidenced by high performance on TEGI, while remaining in the NS stage, as evidenced by below chance performance on the NS TVJ task. This data matches patterns that have been noted in natural production data, and support a theory that posits two types of null subject: one that is compatible with a root infinitive, and one that is not. Certain theories predict this explicitly (Rizzi 1994, 2000). Importantly, if this is the case, we predict that none of the 20 additional children in the middle age group who are being tested will show the reverse dissociation, of having exited the null subject stage, but not the root infinitive stage.

4.1 Prosody

One potential concern with the results of the NS TVJ task is that intonation was playing a role in the children's responses. If the null subject sentences were uttered with declarative intonation, the children could have been responding based on intonation rather than on their grammar. To assess the intonational cues in the test stimuli, an informal survey was conducted of 10 English-speaking adults. These adults listened to recordings of modified experimental stimuli, in which the beginning portion of the declarative and imperative sentences ('*They always*' and '*Please*', respectively) had removed, leaving behind the string of words identical to the null subject sentence (e.g. '*play with blocks*'). The adults were told that the strings had been altered by removing the beginning portions, and were instructed to identify whether each string had originally been a declarative sentence or an imperative sentence. For each experimental item, all 10 adults identified the declarative and imperative items correctly. In addition, all 10 adults correctly identified the null subject strings as being commands. Clearly, children were not exclusively using prosody in their analysis of the null subject sentences. If they were, they would have identified the items as being commands. Furthermore, despite the prosodic cues, children consistently identified the strings as declaratives, suggesting that in this case, (non-adult) grammatical knowledge was more salient than prosodic information.

4.2 Null Subject Comprehension: A Puzzle

A puzzling question remains about the results of the NS TVJ task. Young children, including those in the NS stage, correctly interpret and use commands, including null subject commands, in everyday speech. Based on our results, we expect that children should allow the sentence '*Play with blocks*' to be ambiguous between a declarative and an imperative reading. Instead, we find that the youngest subjects consistently assign a declarative meaning and reject an imperative meaning for the *null subject* condition.

One possible explanation for this behavior is that when faced with this sort of 'Mood ambiguity' (declarative versus imperative), the youngest children resolve the ambiguity in favor of a lesser marked or more economical declarative structure. As imperatives project to CP (or MoodP), while declaratives can be IP projections, the declaratives are more economical, and will be chosen. This idea is consistent with a truncation-type analysis.

5. Conclusions

The data presented in this paper suggests that the null subject stage is not merely a performance phenomenon, but also a comprehension one. English-speaking children are shown to assign a declarative interpretation to null subject sentences, rather than the correct adult imperative interpretation. This non-adult behavior disappears around the age of 3½ years. Of the two classes of theories

examined, grammatical and performance, only grammatical theories can account for these findings, as they predict parallel production and comprehension results, due to the child having a different grammar from the adult. Finally, we present data that experimentally links the null subject and root infinitive stages, and potentially provides support for grammatical accounts that posit two types of null subject.

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