Grammatical Complexity and the Time Course of Syntactic Acquisition*

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Abstract

What is it about a child's linguistic competence that changes during syntactic development? Within the principles and parameters framework of Chomsky (1981), a child's grammar differ from an adult's in having different settings for certain parameters. The process of acquisition, under this view, consists of the sequence of parameter vectors which the child entertains as hypothesis grammars. If at some point in acquisition a parameter which is relevant for a particular construction is incorrectly set, the child will be unable to perform an adult-like analysis. While this view provides an answer to the "logical problem of language acquisition" it fails to explain why certain developmental stages exist. Beyond stipulated orderings of parameter settings, there is little that can be said in this framework to truly *explain* the time course of acquisition. In this paper, I argue that the stages of syntactic acquisition can be understood as deriving from an increase in the child's ability to handle grammatical complexity. I consider a number of well-attested acquisitional difficulties in a range of seemingly disparate aspects of syntax: relative clauses, control and verbal morphology. Using the formal system of Tree Adjoining Grammar (TAG), I show how the single hypothesis that children lack the ability to perform the TAG operation of *adjoining* relates these difficulties in a novel way, and provides us with a new type of explanation for the time course of syntactic development in terms of the complexity of formal grammatical devices.

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Introduction

There has been a great deal of debate about the process by which a child acquires her grammar. One view is that the acquisition of syntax involves some combination of lexical acquisition with parameter setting and/or rule acquisition. This view embodies what Pinker (1984) has dubbed the "continuity assumption": there is no fundamental change in form among the grammars in the child's sequence of hypotheses. They are all possible adult grammars. Changes in the child's grammatical competence are simply the result of the settings of various parameters. As more and more parameters become set to the values of the adult grammar, the child's competence becomes ever closer to the adult's.

Felix (1984) suggests that in addition to the changes allowed under continuity, the child's knowledge of universal grammar (UG) undergoes maturation. Thus, a child may misanalyze her input or produce ungrammatical strings not only because parameters are incorrectly set, but also because the child's "proto version" of UG differs from the one possessed by adults. As the child progresses, changes in grammatical competence can come about both as a result of the learning process and as a result of biologically induced alterations. This view of syntactic development is less constrained that one which embraces continuity, since a far greater number of explanations are possible to account for the child's developmental sequence.

Wexler (1990) proposes a more restricted version of the maturation view wherein certain representational constructs of UG may remain unavailable until a particular point in development. Such "UG constrained maturation" imposes limits on the range of possible explanations for the observed sequence in grammatical development: grammatical principles are, by hypothesis, fully formed from birth, but the system of grammatical representation

may grow richer. Borer and Wexler (1987) hypothesize late emergence of A-chains to account for the delayed appearance of passive sentences. Lebeaux (1988) and Radford (1990), among others, have argued that children do not start out with the functional categories in their representational inventory, so as to account for various properties of children's telegraphic speech such as the sparseness of verbal inflection and lack of complementizers. While UG constrained maturation certainly does constitute a restricted form of maturation, it is not clear what the empirical basis is for the restriction of maturation to representational vocabulary. Wexler (1990) argues that if we take seriously the idea that grammatical competence is biologically instantiated, it is natural to expect that it undergoes maturation, much like other biological systems. However, if we take Wexler's argument seriously, then it is quite obscure why the principles of UG should have a privileged status as being fully formed at birth, while the representational machinery alone should mature.

In this paper, I propose an alternative account of syntactic development. Instead of postulating maturationally induced changes in the child's substantive grammatical knowledge, I suggest that stages of syntactic development can be explained by positing changes in the child's competence of the formal, as opposed to substantive, universals of grammar. In particular, if we adopt the Tree Adjoining Grammar formalism as a meta-language in which substantive grammatical principles are expressed, then the acquisitional difficulties that children experience over a wide range of constructions can be reduced to the unavailability of the single formal operation of adjoining in the child's grammar.

The paper proceeds as follows: I first review a number of results from the acquisition literature concerning the acquisition of some complex (i.e. multi-clausal) constructions in English, in particular relative clauses and control. For each of these constructions, we see that children experience particular systematic difficulties, and I outline the different sorts of proposals that have been made to explain and characterize these difficulties. I next introduce TAG, and demonstrate how the TAG formal machinery allows for a unified explanation for the acquisitional problems discussed. Then, I consider the case of acquisition of verbal morphology and verb raising. I show how the child's inability to perform adjoining results in their inability to distinguish main and subordinate clauses. Untensed clauses, then, are produced by the child since they are well-formed subordinate structures.

Some Problematic Constructions

Relative Clauses

Tavakolian (1981) discusses an interesting asymmetry in the children's interpretation of relative clause constructions. Tavakolian presented children between the ages of 3 and 5 years with sentences containing a transitive verb with a relative clause attached either to the subject or object NP as in (1).[1]

(1) a. The sheep$_1$ [that e tickled the rabbit$_2$] kissed the monkey$_3$
b. The sheep$_1$ kissed the monkey$_2$ [that e tickled the rabbit$_3$]

After hearing such a sentence, the child was asked to act out the events which were described, using a set of stuffed animals. The question of interest for this experiment was which NPs were interpreted as the arguments of which verbs.

In the case of relative clauses attached to the subject NP as in (1)a, the children performed quite well uniformly. Children in all of the age groups, spanning 3 to 5 years, responded correctly with an average rate of 78% correct.

In cases where the relative is attached to the object NP as in (1)b, however, the performance is rather degraded. At the age of 3 years, practically none of the children respond with an answer appropriate in the adult grammar, and even at the age of 5, they perform only at 37.5% correct. Extremely interesting, though, is the practical unanimity of the character of the incorrect responses. The children correctly interpret the subject NP as the subject of the matrix verb *kissed*, but incorrectly assign this NP the subject role of the verb embedded within the relative clause, i.e. *tickled*.

In order to explain these data, Tavakolian proposes that the grammar of young children analyzes relative clause configurations, and more generally multiple clause structures, as instances of conjoined clauses. Tavakolian suggests that such an analysis "facilitates language learning by providing the child with a predetermined hypothesis about the structure and interpretation of multiple clause strings." Under the conjoined clause analysis, a child finds the first NP-V-NP sequence of the input and assumes it to form a simplex sentence. The next sequence of V-NP is analyzed as another sentence, this time with an empty subject position, and this sentence is attached to the first by coordination, where the absence of an overt conjunction is ignored. Thus, whenever the child receives as input an NP-V-NP-V-NP his grammar will impose the analysis in (2) upon it.

[1] In my presentation of Tavakolian's results, I consider only cases of relative clauses with a gap in subject position in which her data is most clear. Tavakolian's children seem to generally experience more difficulty with object relatives, and this may be the result of some other interfering factor.

(2) [$_{IP}$ [$_{IP}$ NP$_i$ V NP] [$_{IP}$ e_i V NP]]

As is typical for such cases of VP coordination, the empty subject of the second clause is taken to be coreferential with the first.

Let's see how this conjoined clause analysis works on the two cases of relative clauses we have considered. For the relative clause attached to the subject NP, i.e. as in example (1)a, the child would assign the following structure:

(3) [$_{IP}$ [$_{IP}$ the sheep$_1$ that tickled the rabbit$_2$] [$_{IP}$ e_1 kissed the monkey$_3$]]

Though this structure is radically different from the structure assigned by the adult grammar, the thematic relations work out identically. Tavakolian suggests that since the act out task does not allow us to distinguish predications expressed in relative and conjoined clauses, children's performance appears identical to adults in this condition, despite gross grammatical differences.

When the relative clause is instead attached to the object NP by the adult grammar, as in example (1)b, the structure assigned is:

(4) [$_{IP}$ [$_{IP}$ the sheep$_1$ kissed the monkey$_2$] [$_{IP}$ that e_1 tickled the rabbit$_3$]]

This time, the radical differences between this structure and that assigned by the adult grammar do lead to differences in the assignment of thematic relations which are observable in the act out task. The child takes the matrix subject *the sheep* to be the subject of the relative clause verb *tickled* as a result of the rules for the interpretation of empty subjects in coordination.

Lebeaux (1988) presents a somewhat different analysis of Tavakolian's data. He assumes that UG includes two operations which may occur during the course of a derivation: move-α and adjoin-α. This latter operation is responsible for the introduction of adjuncts into the phrase structure in the transition between the D-structure and S-structure levels of representation. Lebeaux proposes that, as a result of the associated computational complexity, children are unable to employ the adjoin-α operation in parsing, and, as a result, they are unable to construct the adult analysis of relative clauses. Lebeaux suggests that when children are confronted with a parsing difficulty, they "fall back" to an analysis of the construction whose complexity they can handle and which is licensed by their grammar. In particular, they analyze English relative clauses as co-relatives which are attached to the root IP structure, since this requires only a conjunction operation which Lebeaux assumes to be less difficult for the child. Note that Lebeaux's proposal differs from Tavakolian's in distinguishing relative clauses and other adjuncts from simple embedded clauses, which do not require the use of the adjoin-α operation.

	Condition		
Age	Active Temporal	Active *tell*	Passive *tell*
4	45.0	5.0	86.7
5	60.8	2.5	91.7
6	67.5	17.5	90.0

Figure 1: Controller of PRO in different construction types (from Goodluck 1981)

Control

Goodluck (1981) examines the phenomenon of control in two types of sentences: ones in which PRO is contained within an adjunct as in (5), and others where it appears within a complement clause as in (6).

(5) Cookie Monster$_i$ touches Grover [after PRO$_i$ jumping over the fence]

(6) a. Cookie Monster tells Grover$_i$ [PRO$_i$ to jump over the fence]

b. Grover$_i$ was told by Cookie Monster [PRO$_i$ to jump over the fence]

For adult speakers of English, the controller in cases of adjunct control must be the subject of the clause to which the adjunct is attached as indicated by the coindexation in (5). When PRO appears within the embedded infinitival complement of a verb like *tell* in its active form as in (6)a, it is obligatorily controlled by the object of the higher verb. When the verb is passivized, however, PRO is controlled by the derived subject as in (6)b, perhaps via the trace in object position.

In Goodluck's experiments, children between the ages of 4 and 6 are presented with examples similar to these and are asked to perform an act out task. In the case of adjunct control, the examples involve adjuncts headed by temporal prepositions like *before* and *after*, as these are likely to be acted out along with the predication expressed in the main clause. The percentage of cases in which children employ subject control for each of the three cases in (5) and (6) is given in figure 1. In cases of complement control, even the youngest group of children, 4 years in age, performs nearly perfectly. When the matrix verb is active, they overwhelmingly employ object control, yet when the matrix verb is passive, they correctly control PRO by the derived subject. However, in the cases of adjunct control, the performance is quite degraded. There is no decisive pattern in their responses demonstrating either uniform application of subject or

object control, though there is some sign of a tendency toward the adult pattern of subject control by age 6.

Goodluck takes these results as evidence for the claim that children are sensitive to c-command relations in even the early stages of their grammatical development. She argues that the fact that PRO must be controlled by a c-commanding NP explains why children do not have difficulty in the passive case in (6)b: the NP within the *by*-phrase does not c-command the object clause and hence cannot control it. In order to explain the asymmetry between adjunct and complement control, she suggests that children allow temporal adjuncts to be attached to VP or to IP, instead of only to IP as in the adult grammar. In such a position, an adjunct would be c-commanded by an NP object which may then serve as a controller to a PRO within the adjunct. Goodluck leaves open, however, the questions of why the child would initially make the assumption that both VP and IP attachments are possible for such adjuncts, as well as how a child would come to realize that the VP attachment was not possible despite the lack of negative evidence.

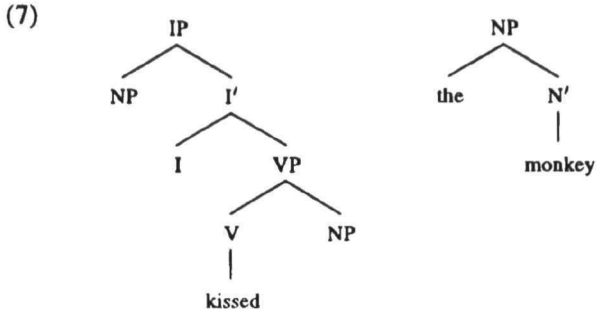
Wexler (to appear) suggests an alternative account of why children appear to lack adjunct control. Wexler proposes that adjunct control is delayed since temporal adjuncts like those in (5) require an empty operator for their interpretation, following Larson (1987), and the appearance of such empty operators in the child's grammatical representations are maturationally delayed.

The Basics of TAG

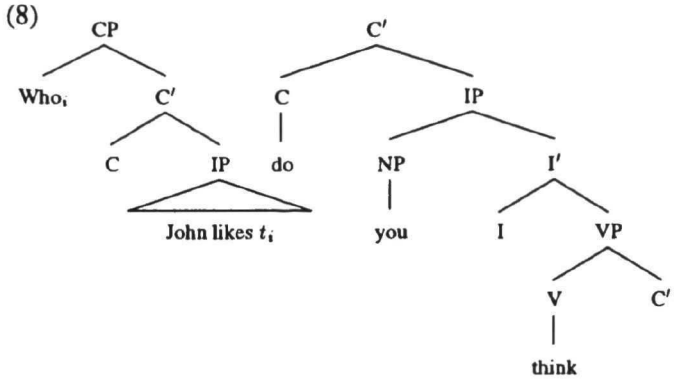
Before proceeding further, it will be helpful to introduce the TAG formalism. Tree Adjoining Grammar is a constrained grammatical formalism which accomplishes its grammatical description by factoring out recursion from the statement of local co-occurrence restrictions (Joshi 1985). The role of TAG in a linguistic theory is as a mechanism which specifies how phrase structure is composed. I emphatically point out that TAG does not replace or reduce the need for substantive principles of grammar. On the contrary, it provides a setting in which such principles can be expressed precisely. Thus, in the context of a modular principles and parameters theory of grammar, TAG forms part of the phrase structure module. Principles of other modules must then be expressed in terms which TAG allows.[2]

There are two main ideas in how a TAG-based theory accomplishes its linguistic description. The first of these lies in the fact that all of the grammatical constraints and operations are localized within small, non-recursive chunks of phrase structure called *elementary trees*. The linguistic intuition behind these elementary trees is that they are simple clausal structures containing positions for all of the arguments of a single predicate, much like the kernel sentences of Chomsky (1957). In Frank (1992), I propose that a single elementary tree consists of the projection of exactly one lexical head, i.e. an open class item, optionally along with the projections of the associated functional heads, i.e. those heads which form an extended projection of the lexical head in the sense of Grimshaw (1991a). So, an elementary tree containing the lexical projection of a V^0 may include the projection of I^0 as well as that of C^0. Some sample elementary trees are given in (7) and (8).

(7)



(8)



In the leftmost tree in (8), we see the application of transformational movement within the domain of the elementary tree headed by the lexical head *likes*. Here we have movement of the NP object into the specifier of CP position, an typical instance of English Wh-movement. We will in general require that instances of transformational movement be limited to the domain of a single elementary tree.

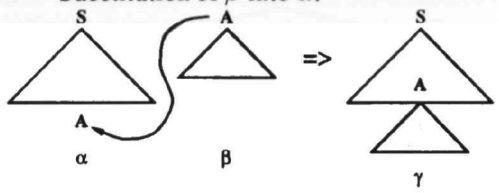
Note that the argument positions of the lexical verb *kissed* are not filled in the leftmost tree in (7). This is due to our condition on the size of elementary trees: only one lexical head may appear in each. The N^0 heading the NP in object cannot co-occur with the verb of which it is an argument, it follows that they must form separate elementary trees.[3] Therefore, the formalism must provide

[2] For work in this vein, see Kroch (1989), Kroch and Santorini (1991), Frank (1992).

[3] In the trees in (8) and those of the remainder of the paper, I have included lexical items for NPs for the sake of readability.

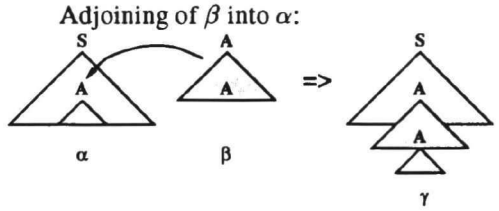
some way in which these pieces can come together. This is the second basic idea of TAG: elementary trees are combined into larger structural representations using two formally defined operations. The first of these is *substitution* in which one tree rooted in a node labelled A attaches at the frontier of the other at a node also labelled A. This is shown schematically in (9).

(9) Substitution of β into α:



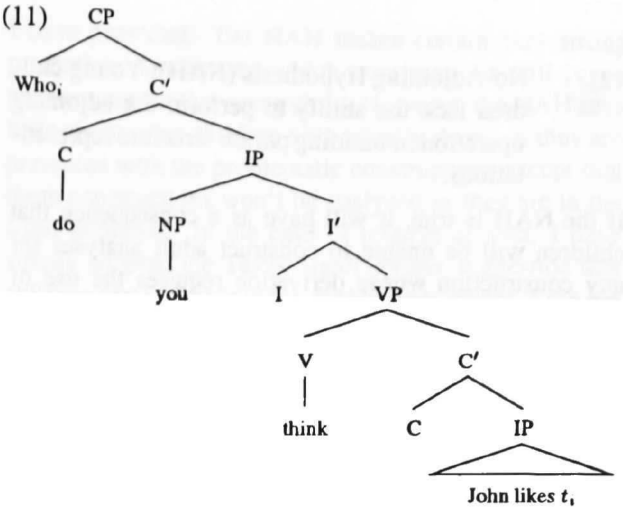
Using the trees in (7), we can substitute the NP tree into the object NP position of *kissed*, and thereby fill the argument position. The second operation of *adjoining* is somewhat more complex. Adjoining requires an elementary tree of a recursive character, called an *auxiliary tree*. Auxiliary trees must have a distinguished node along their frontier, called the *foot node* which is labeled identically to their root. During adjoining, an auxiliary tree, say with root and foot labeled A, is inserted within the body of another tree at a node also labelled A by removing the subtree dominated by A in the source tree, attaching the auxiliary tree, and reattaching the subtree at the foot node of the auxiliary. This is illustrated in (10).

(10) Adjoining of β into α:



We can use the adjoining operation to combine the trees in (8). The right tree, an auxiliary tree with root and foot C′, adjoins into the left tree at the node C′ to produce the structure in (11).

(11)



Note that through adjoining, the dependency between the moved wh-element and its trace in the elementary tree in (8) is stretched. In this way, TAG allows for the derivation of unbounded dependencies without the use of intermediate traces. The adjoining operation is used generally in constructions involving inter-clausal movement as well as in the derivation of adjunct structures. For a fuller account of wh-dependencies within a TAG-based theory, see Frank (1992).

Towards a Unified Explanation: the "No Adjoining Hypothesis"

In the discussion above, we saw associated with each acquisitional difficulty a separate explanation for why and in what way that particular construction proves difficult. Difficulty in relative clause constructions was related to the lack of the adjoin-α operation or the conjoined clause analysis and problems in adjunct control constructions were associated either with the possibility of VP attachment of temporal adjuncts or the unavailability of PRO and empty operators.

Since these problems dissipate at roughly the same age,[4] it would be desirable to relate these difficulties to a single cause.[5] Armed now with the operations of the TAG formal system, I propose the following hypothesis:

[4] This is admittedly extremely rough, but it is not clear that one can hope to do much better on the basis of consulting different studies by different authors using distinct experimental paradigms. Clearly, this issue can only be resolved through a longitudinal study over a wide range of constructions.

[5] Such coincidental emergence is not actually a necessary consequence of any proposal which relates multiple acquisitional difficulties to a single cause. If multiple constructions rely on a single grammatical construct or process, then a delay in the utilization of that construct until some point p will only set a lower bound on the time of the emergence of these constructions. Other unrelated factors might serve to delay the appearance of one but not others of these construction.

(12) No Adjoining Hypothesis (NAH): Young children lack the ability to perform the adjoining operation in building phrase structure representations.

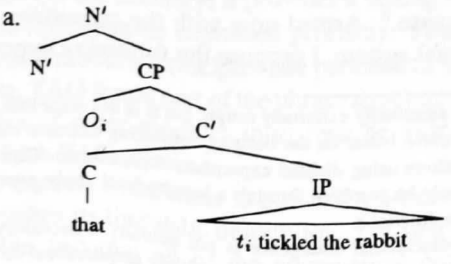
If the NAH is true, it will have as a consequence that children will be unable to construct adult analyses for any construction whose derivation requires the use of the adjoining operation. The constructions I discussed above have in common the property that they all involve the adjoining operation. Consequently, the NAH predicts that children's grammatical representations of these constructions will differ from those of adults.

When such a situation arises, I suggest that children attempt to construct an analysis which fits the input data as well as possible, in which only the substitution operation is employed. When the adjoining operation finally becomes available, if a conflict remains between the data and the child's best attempts at a substitution-only analysis, the child will change her grammar so as to take advantage of adjoining. Note that the particular character of the child's analysis is not dictated by the NAH beyond the requirement that adjoining not be involved.

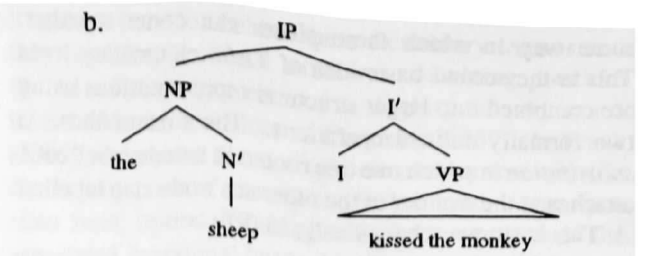
This proposal relieves us of the necessity of positing maturational changes in substantive grammatical principles or grammatical representations. Even young children, on this view, possess full-fledged versions of grammatical principles and elementary-tree internal representations. However, when they are unable to build certain complex structures due to the absence of the adjoining operation, the application of these same universal grammatical principles can yield different results.

In light of the NAH, let us reconsider each of the constructions discussed above. Relative clauses, as adjuncts, are introduced into a tree via the application of the adjoining operation. Thus, example (1)a above with a subject relative clause is derived by adjoining the relative clause tree in (13)a into the elementary tree for the transitive verb *kissed* in (13)b at the subject NP node to yield the structure in (14).

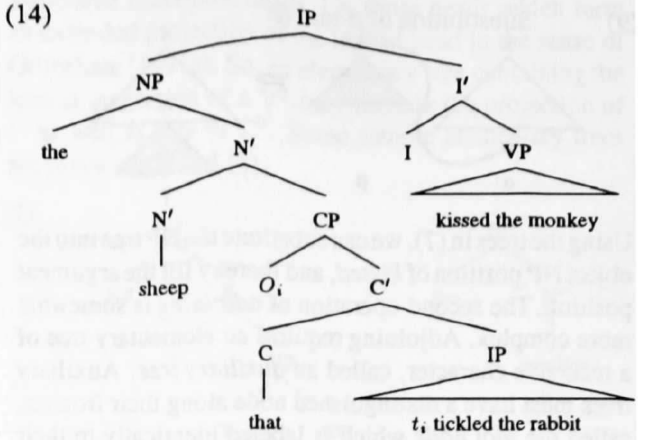
(13) a.



b.



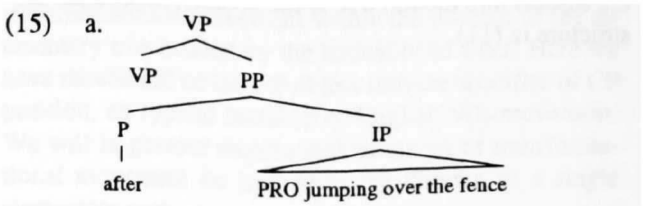
(14)



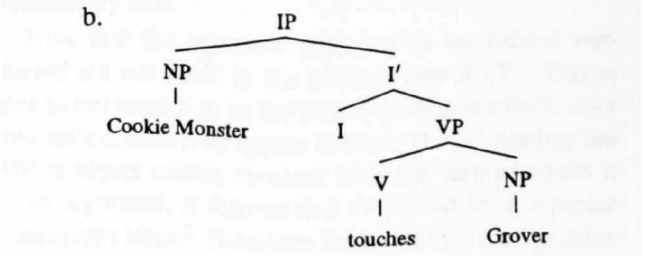
If a child lacks adjoining, she will be unable to perform this derivation. If we suppose, following Tavakolian and Lebeaux that the child does possess the ability to handle some simple type of coordination, and that such coordination does not rely on the adjoining operation, then we can predict the asymmetry in performance on subject and object relatives as discussed above.

Turn next to the analysis of control constructions. We saw above that children differ as to whether they exhibit adult-like behavior in the complement and adjunct cases. The TAG derivations of these two constructions differ accordingly. In order to derive the sentence modified by a temporal adjunct given in example (5), we must adjoin a temporal adjunct auxiliary like that given in (15)a into the main clause given in (15)b.

(15) a.



b.

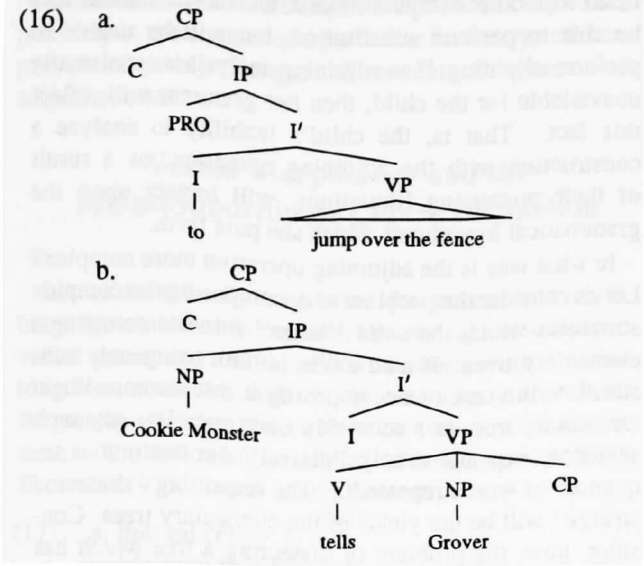


By the NAH, the child cannot perform this derivation and therefore constructs some representation different

from the one constructed by the adult. Consequently, the child's application of the principles of control seems to go awry. I should emphasize, however, that under the view taken here the child's knowledge of control is identical to the adult's. The only difference lies in their inability to build appropriate representations over which such principles can apply.

These adjunct cases contrast with the sentences involving infinitival complements given in (6). These can be generated using only substitution. A child could construct a derivation for example (6) by substituting the CP elementary tree in (16)a into the matrix elementary tree in (16)b at the CP node along the frontier.

(16) a.



b.

Given these structures, the child can apply her competence concerning the possible controllers of PRO, yielding the same interpretation as shown by the adult grammar. In the case of the passive example in (6)b, the child will know that that the NP embedded within the *by* phrase is not a possible controller of PRO.

The NAH can be seen as a radical generalization of the proposal in Lebeaux (1988) that young children cannot utilize adjoin-α. However, in Lebeaux's system, the adjoin-α operation was involved only in the derivations of adjunct structures. In contrast, the TAG adjoining operation is involved in a much larger set of constructions. For the cases of relative clauses and control, the two are indistinguishable. However, Frank (1992) shows that the NAH may be used to explain complex patterns of acquisition of wh-movement and raising, both of which exploit adjoining but neither of which make use of Lebeaux's adjoin-α. The general applicability of the adjoining operation will become relevant when we discuss the acquisition of verbal morphology.

I would like to close this section with some general comments concerning the nature of the explanations that I have provided. The NAH makes certain very strong predictions concerning which constructions will prove problematic for the young child. However, the NAH says little about what children will actually do when they are presented with the problematic constructions except that these constructions won't be analyzed as they are in the adult grammar. In the case of relative clauses, I have simply adopted the Tavakolian/Lebeaux suggestion that children instead conjoin the problematic clause. Like the original authors, I have given no explanation for why the children proceed to analyze relative clauses in this way, except to say that whatever analysis they employ, it must not utilize the adjoining operation.[6] What needs to be provided is an additional theory which specifies exactly how children come to choose the phrase structural analyses for the data at hand that they do within the limits of the formal grammatical system that they are capable of employing.

Why is Adjoining Hard?

I have not as yet provided an explanation for why children should be unable to employ the adjoining operation. There are a number of possible reasons that this might be. One is that the adjoining operation becomes available as a result of maturation of the grammatical system. If this is true, it would have the interesting effect of making the developmental sequence proceed incrementally upward through a hierarchy of systems with ever increasing formal descriptive complexity. It is straightforward to show that the TAG formalism without the adjoining operation has only the weak generative capacity of context free grammars. With the adjoining operation, however, it falls in the class of mildly context sensitive languages (Joshi, Vijay-Shanker and Weir 1991). Perhaps one might be able to find a stage, prior to the one discussed here, during which the generative capacity of children's grammars was limited to regular languages.

An alternative to a maturational view is one in which the absence of adjoining results from a processing limitation. If the adjoining operation imposed demands that were too great for the child's limited resources, then derivations which necessitated its use would fail. Some further experiments on the acquisition of relative clauses are suggestive in this respect. Goodluck and Tavakolian (1982) reconsidered relative clauses attached to the object

[6] Note that *prima facie* this suggestion seems at odds with the data for the cases of adjunct control. Recall that children incorrectly assume that the PRO subject of an adjunct clause can be controlled by the object NP. In contrast, children interpret the empty subject of a relative clause appearing after the object NP is interpreted as modifying the subject NP. We are forced to say, then, that children do not employ the same alternate analyses in these two case. Exactly how this apparent paradox is to be resolved I leave for future work.

nominal with a subject gap, the type that were shown to cause children a great deal of difficulty in Tavakolian (1981). They found that manipulating the type of predicate within the relative clause had a large effect on the child's performance in an act out task. For 4 and 5 year olds, when the relative verb is intransitive, 76.25% of the responses given are correct, when the relative verb is transitive with an inanimate object, 69.38% of the responses are correct, and when the relative verb is transitive with an animate object, 49.48% of the responses are correct. They conclude that children's difficulties do not result from a grammatical deficit, since they are able to construct the correct analysis in an overwhelming number of cases in the intransitive relative clause case. Instead, they suggest that they result from processing difficulties.

Hamburger and Crain (1982) reconsider children's knowledge of these object relative clauses with subject gaps. They conjecture that children had difficulty with the act out task in the experiments of Tavakolian (1981) because of infelicity of the relative in the context of use. Since relative clauses serve to further restrict elements from some background set, the fact that there was only a single possible referent for *the monkey that tickled the rabbit* which was present in the experimental context might lead the child into confusion. Hamburger and Crain controlled for this and found that children of age 3 gave 69% correct answers, children of age 4 74% correct, and children of age 5 95% correct. In an elicited production task, Hamburger and Crain were able to get 72% correct responses for these relative clauses from 4 and 5 year olds. Hamburger and Crain interpret their results in a manner somewhat similar to Goodluck and Tavakolian: the problem with children's interpretation is not grammatical, but rather results from processing difficulties. In the case of Hamburger and Crain, processing difficulties arise because the child must devote some of her resources to accommodating the infelicitous utterance in the experiment to the the context, and cannot devote her full resources to the problem of constructing a syntactic analysis.[7]

This evidence suggests that children's difficulties in acquisition might stem from a difficulty in processing. When some other task is imposing demands on the child, such as accommodation to a discourse context or keeping track of multiple animate entities, the child is unable to deal with these constructions as in the adult grammar. However, when these demands are lifted, the child's performance more directly reflects an adult-like competence. As the child grows older and her memory and processing abilities develop, she is able to perform the appropriate analyses even in the face of these other demands.

These processing accounts of difficulties in acquisition do not obviate the need for something like the NAH. On the contrary, a structural metric which determines which structural analyses are difficult for the child is necessary in determining exactly when the demands from other tasks involved in comprehension and production will impinge most on the syntactic processor. I would like to suggest that the adjoining operation is a more computationally complex operation than substitution. Thus, a child who is faced with other computational demands will nonetheless be able to perform substitution, but will be unable to perform adjoining. If an adjoining analysis is consistently unavailable for the child, then her grammar will reflect this fact. That is, the child's inability to analyze a construction with the adjoining operation, as a result of their processing limitations, will impact upon the grammatical hypotheses which she puts forth.

In what way is the adjoining operation more complex? Let us consider the problem of decomposing the complex structures which the child "hears" into the constituent elementary trees. If a structure is built using only substitution, the task of decomposing it into its constituent elementary trees is a relatively easy one. For any such sentence, we must simply "dissect" out continuous sequences of words repeatedly. The remaining "dissected strings" will be the yields of the elementary trees. Consider, now, the problem of dissecting a tree which has been built using adjoining. Recall the schematized view of adjoining given in (10). In order to extract the portion of the derived tree γ which forms the auxiliary tree β, we must extract two discontinuous strings, i.e. those which are dominated by the grey structure in γ. For α, this leaves three disconnected substrings, i.e. those dominated by the white structure in γ, which must be put back together. If we simply count up the number of string operations which must be done in each of these cases, the adjoining operation comes out as a far more complex operation.[8]

Of course, this proposal is not the first to suggest that processing limitations are a source of children's problems in syntactic acquisition. Otsu (1981), Goodluck and Tavakolian (1982) and Lebeaux (1988) all argue the children find particular constructions difficult to parse,

[7] One thing that Hamburger and Crain's proposal fails to account for is the asymmetry which Tavakolian (1981) observes between subject attached and object attached relative clauses. It is simply unclear why the analysis of subject relatives should require less effort than the analysis of object relatives and should, as a result, be possible in the face of infelicity.

[8] All applications of the adjoining operation need not be as complex as the general case shown in (10). Certain instances of adjoining, for example, will result in string-identical dissections of the derived tree. Thus, we might expect that some adjoinings are within the range of an otherwise unimpeded child, while others are uniformly beyond their capacity. I leave it for future work to determine an appropriate complexity metric on the range of adjoining operations.

and as a result build alternative representations from those licensed by the adult grammar. Crain and Fodor (1992) take a slightly different tack and suggest that when the demands of the child's grammar conflict with those imposed by the parser, the parser "wins".

However, what is novel about the NAH in its processing guise is that it serves to relate the acquisitional difficulties which children experience on a set of rather diverse constructions through a single computational limitation. Note that computational limitations of a general sort such as "complex sentences are difficult for the child to parse" are too coarse grained to account for the intricate patterns of data found in syntactic acquisition. The NAH demonstrates how computational factors expressed precisely in the context of a particular formal system can provide relatively fine grained accounts for patterns of acquisition data.

Verbal Morphology and the Main--Subordinate Clause Distinction

Let us turn finally to another phenomenon in child language which has engendered a great deal of discussion: verbal agreement and its effects on word order. As has long been observed, verbs in children's early utterances frequently occur in their infinitival forms or as a bare stem. The following examples of Eve's speech from Brown's (1973) corpus are representative:

(17) a. doll eat celery. (1;6)
b. Mommy find # it (1;7)
c. Eve make tower. (1;7)

In order to account for this phenomenon, Lebeaux (1988) and Radford (1990), among others, suggest that children's early grammars lack functional categories. Since the functional head I^0 and its projection are responsible for the presence of inflectional morphology on the verb, the absence of such a projection in the child's grammar renders the process of verbal inflection inert. Apparently inflected forms which do appear, on this proposal, are assumed to actually consist of unanalyzed verbs generated as head of VP.

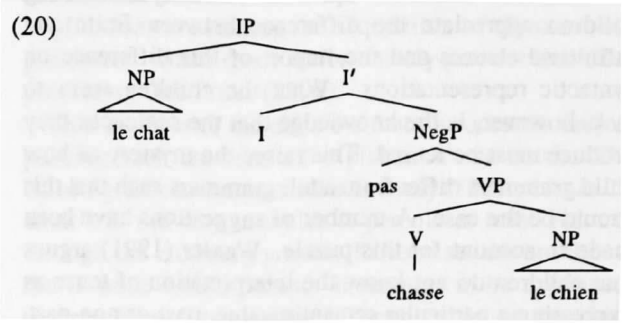
In adult grammars of many languages, the process of verbal inflection is known to interact with word order in significant ways. In French, for example, the negative morpheme *pas* appears post-verbally when the verb is tensed, but post-verbally when the verb is untensed. This contrast is shown in the examples in (18) and (19).

(18) a. Le chat (ne) chasse pas le chien.
The cat chases not the dog
'The cat doesn't chase the dog.'
b. * Le chat (ne) pas chasse le chien.

(19) a. Il est difficile de ne pas manger.
It is difficult COMP not eat-INF
'It is difficult not to eat.'
b. * Il est difficile de ne manger pas.

In (18), the verb *chasser* 'chase' appears in a tensed form and requires *pas* to occur after it. In (19), on the other hand, the verb *manger* 'eat' appears in its infinitival form and requires that the negative morpheme precede it. Simplifying slightly, Emonds (1978) and Pollock (1989) account for this contrast by suggesting that the negative morpheme *pas* appears just above VP but below the position of I^0, inside of a NegP projection for Pollock, and that the verb raises to I^0 only in case it is tensed. Thus, the representation of example (18) prior to movement of the verb is as follows:

(20)



If this were an infinitival sentence, the verb would remain within VP, and hence would appear after *pas*. However, in a tensed sentence, the verb raises to I^0 and therefore obligatorily precedes *pas*.

Suppose young children's uses of tensed verbs are indeed unanalyzed forms and are not the result of the morphological change induced by the movement of verb to the head of a functional projection, which they putatively lack. This predicts that children's placement of negation will not interact with tense marking in the way that it does in the adult grammar. Pierce (1989) and Deprez and Pierce (1993) tested this prediction on a corpus of naturalistic utterances of children acquiring French. Strikingly, the vast majority of the examples which they found contained either non-finite verbs with pre-verbal *pas* (cf. (21)) or finite verbs with postverbal *pas* (cf. (22)).

(21) a. pas manger la poupee
not eat-INF the doll
b. pas tomber bebe
not fall-INF baby
c. pas attraper une fleur
not catch-INF a flower

(22) a. Patsy est pas la-bas
Patsy is not over there
b. marche pas
walks not

c. est pas mort
is not dead

Pierce's results for three children of mean age around two years are given in (23).

(23)

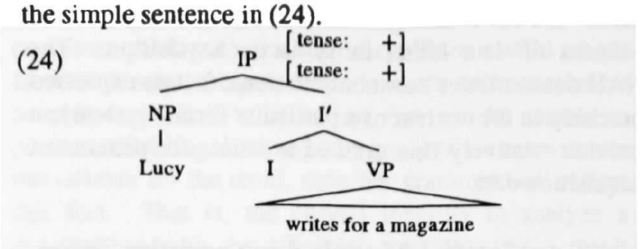
	[+ finite]	[- finite]
pas Verb	11	77
Verb *pas*	185	2

These figures evidence a highly significant correlation between finiteness of the verb and its position relative to negation. This seems to suggest that children's tensed forms are syntactically complex, and therefore that children are able to utilize functional projections in the same fashion as adults.[9]

The French data show quite dramatically that young children appreciate the difference between finite and infinitival clauses and the import of this difference on syntactic representations. What the children seem to lack, however, is the knowledge that the sentences they produce must be tensed. This raises the mystery of how child grammars differ from adult grammars such that this should be the case. A number of suggestions have been made to account for this puzzle. Wexler (1991) argues that children do not know the interpretation of tense as expressing a particular semantic value, past or non-past. As a result, French children's grammars will not require that the verb raise so as to take scope over the property expressed by the VP. Grimshaw (1991b) proposes a processing account of this phenomenon. She suggests that children construct their clausal representations around the core of a verbal projection. If children are placed in a position where they have other demands competing with sentence production, they adopt a strategy of realizing fewer of the functional projections associated with the verbal core. Grimshaw argues that if the IP layer is "peeled away" by the French child, then the verb has no place to move and hence does not pick up its tense.

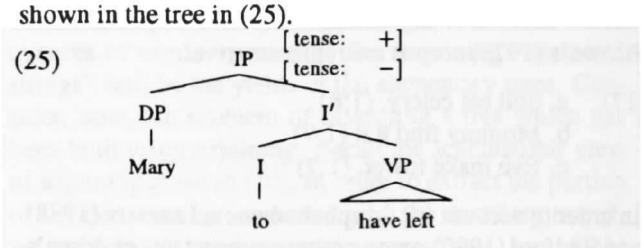
Both Wexler's and Grimshaw's explanations seem tailored to account for this phenomenon. In general, we would like not to have to make separate stipulations for each new paradigm of data we encounter. In this spirit, I would like to suggest that we can use the NAH to account for the child's lack of obligatory tense marking in clauses.[10] To understand how this might go, let us consider how the requirement that sentences be tensed is encoded in our TAG-based theory. The feature system of Vijay-Shanker (1987) allows us to place a pair of feature values, so-called top and bottom features, at each node. At the conclusion of a TAG derivation, these features must collapse with one another. If they conflict, the derivation fails. Suppose that we place a feature at the top of each clausal elementary structure specifying a + value for tense. If there is a tense specification on the I^0 head of an elementary tree, the tense value for the bottom feature structure at this node is also +. This is the situation with the simple sentence in (24).

(24)



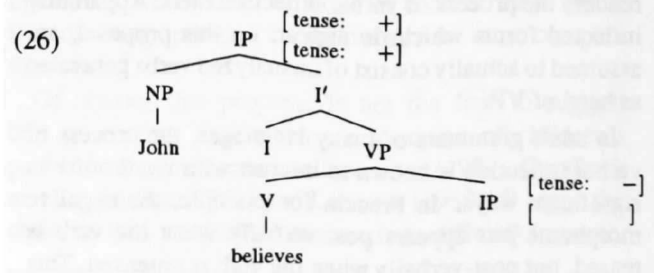
This tree need not enter into a derivation with any other trees since the pairs of feature structures at each of its nodes may be collapsed. Thus, the system of features tells us that this elementary may by itself constitute a sentence. In the case of an infinitival clause, however, the feature specification in the top feature structure will not match that of the bottom feature structure since the infinitival I^0 element gives a − value for tense. This is shown in the tree in (25).

(25)



This tree cannot appear in isolation since the features in its root cannot be collapsed. In order to derive a well-formed structure, we can adjoin a tensed matrix clause, such as the one in (26), into the root of the tree in (25).

(26)



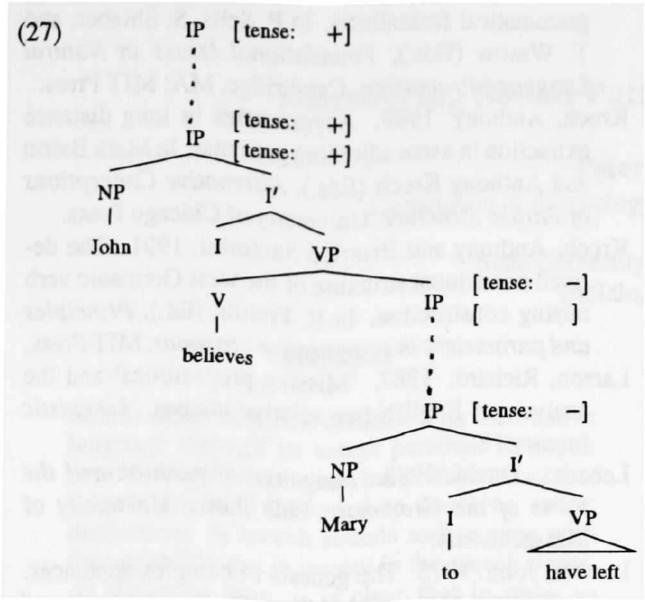
During the adjoining, the node which is the adjoining site is "split" into two with the top feature structure going

[9] A similar argument may be made on the basis of the verb second phenomenon in German. See Poeppel and Wexler (1991) and Deprez and Pierce (1993).

[10] One potential problem with this line of explanation is that children's problems with tense realization subside long before the problems discussed above. This might be due to the fact that this instance of adjoining is an especially easy one and is thus one which the child is able to perform at a fairly young age. This seems plausible since the structures produced by this instance of adjoining are identical to ones which can be produced using only substitution. A complexity metric on the different cases of adjoining remains to be provided, however. Of course, to pursue this line, we must adopt the processing-based explanation of the NAH.

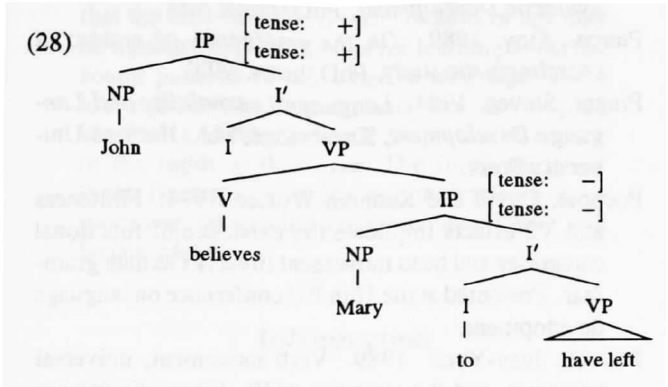
with one half of the node, and the bottom feature structure going with the other. This situation is pictured in (27).

(27)



The feature structures associated with the "half nodes" of the adjoining site are then collapsed with the adjacent feature structures to give the following derived structure.

(28)



In this derived tree, the pairs of feature structures at each node may be collapsed and this structure is therefore ruled in.

Notice that the adjoining operation is crucial to the separation of incompatible feature structures present in an elementary tree. The substitution operation allows us only to add further specification to the featural information at a node, but does not in any way allow feature conflicts to be resolved. This yields the following interesting prediction: if a child produces complex sentences in which there are embedded infinitival clauses at a point when she is able only to use the substitution operation, then she will be unable to stop herself from producing embedded infinitival clauses as independent structures. The reason for this is simple. If infinitivals are substituted into a tensed matrix clause, then there is no possibility that there was a feature conflict on the root of the infinitival as we saw in (25) since the substitution would not have resolved the conflict. Consequently, the child's grammar must allow such infinitival elementary trees without the feature conflict at the root.

Note that this explanation depends upon the child's actually producing, or at least having the ability to produce, sentences of a fair amount of complexity. Limber (1973) cites sentences with embedded infinitival clauses as among the first complex constructions to appear in the child's grammar, around the age of 2;1. Thus, it is not unreasonable that children are able to parse sentences of the necessary complexity at the ages in question.

This analysis conflates the child's production of infinitival sentences with her inability to distinguish main and subordinate clauses. This has a number of interesting implications concerning the acquisition of German verb placement, which space unfortunately prevents me from presenting. See Frank (1992).

This analysis of the child's situation succeeds only in pushing back the level of explanation one notch. The child's grammar remains substantively different from the adult's in the way in which it percolates tense features through the elementary trees. Otherwise, the conflict at the IP node would persist. It remains to be explained, though, how this conflict is permissible in the child grammar, yet is impossible in the adult grammar. One possibility, perhaps related to Wexler's proposal mentioned above, is that the child does not know that there are tense features expressed on the I^0 head which need to be percolated up through the IP projection. If no such feature appear on the bottom feature structure of the IP node, then no conflict will arise as a result of the UG derived demand that all clauses be tensed.

Concluding Comments

I have argued in this paper that positing the single distinction between the grammatical systems of children and adults, the absence of the operation of adjoining, gives rise to a uniform account of which constructions pose difficulties in syntactic acquisition. We have seen, in particular, difficulties in the acquisition of relative clauses, control and verbal morphology that receive an account under the NAH. Further evidence for the NAH is provided by Frank (1992) who discusses its implications for the acquisition of wh-movement, raising and adjectival modification.

One particularly important aspect of this proposal is that it allows us to understand exactly why certain constructions prove problematic for the child while others which are superficially similar are acquired effortlessly. The sharp dichotomy drawn by the TAG formalism as

to whether a construction requires the adjoining operation allows us to make specific predictions concerning the time course of acquisition without resorting to stipulated differences between the substantive grammatical principles in child and adult linguistic competence.

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