

Transparent parsing
Head-driven processing of verb-final
structures

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phone: +31 30 253 6006
fax: +31 30 253 6000
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Transparent parsing
Head-driven processing of verb-final structures

Transparant parsen
Hoofdgestuurde verwerking van werkwoordsfinale structuren
(met een samenvatting in het Nederlands)

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ter verkrijging van de graad van doctor
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Iris Corine Margarethe Christine Mulders
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Promotoren:

Prof. dr. E.J. Reuland

UiL OTS, Universiteit Utrecht

Prof. dr. T. Reinhart

UiL OTS, Universiteit Utrecht/ Tel Aviv University

Co-promotor:

Dr. F. Wijnen

UiL OTS, Universiteit Utrecht

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Chapter 1

Introduction

1.1 A transparent parser

The conceptual force driving the research presented in this dissertation is the desire to construct a *transparent parser*. A transparent parser is a parser that uses only the operations that are available in the grammar. The appeal of the idea lies in its simplicity. We already have a structure-building operation defined in the syntax; this structure-building operation is available to the human language faculty; and the null hypothesis is that the Human Sentence Processor uses the exact same structure-building mechanism to assign structure to incoming strings of words. There is no a priori reason to think that structure building in syntax should be any different from structure building during sentence processing.

The matter becomes more acute if we take seriously the idea of Chomsky (1998) that the computational system is the optimal solution to the interface problem of connecting sound and meaning. If language as a whole is ‘optimally designed’ in this sense, we expect the processing systems to be optimally connected to the computational system as well, i.e. to not use heuristics that are completely independent from the computational system. At the same time, we also want to build a theory of the computational system that is within the capabilities of the human parser, i.e. we do not want to formulate a theory of grammar that involves enormous amounts of computation (see Reinhart (1999) for discussion).

For some theoretical linguists, this use of performance considerations as a guideline for formulating competence theory may come as a surprise. After all, the distinction between competence and performance has a long history in the generative framework.

Competence theory involves an idealization of the speaker and of the data. Since competence theory focuses on the knowledge the idealized speaker has of his language, rather than on his actual behavior, acciden-

tally uttered ungrammatical sentences are excluded from the data set. The data set does include, however, sentences that are grammatical (i.e. they can be generated by the grammar) but that are very difficult to process.

It is the latter phenomenon that we are concerned with here. One instance is found with sentences which display center embedding. An example is given in (1):

- (1) The man who the boy who the students recognized pointed out is a friend of mine
(Chomsky (1965): p.11: (2ii))

It is generally assumed that the reason that (1) is so hard to process, is that the human brain does not have enough memory resources to perform its analysis. Note that this does not entail that the structure-building mechanism per se has to be different in processing than it is in the computational system; the difference is just that competence theory abstracts away from the amount of memory resources available, while processing theory naturally does take into account that memory resources are finite.

Another instance of grammatical sentences that are difficult to process is constituted by so-called *garden paths*. Consider the sentences in (2):

- (2) a. ζ After Susan drank the water evaporated
b. ζ Without her contributions failed to come in
c. ζ Below the stairs collapsed

The sentences in (2) are very difficult to process, although they are grammatical. It is commonly assumed that the reason why these sentences are so difficult to process, is that they involve a locally ambiguous element that is attached by the parser in one position, while it should be attached in another position to yield the correct syntactic analysis.

To see this, consider for instance (2a). The locally ambiguous element there is the NP *the water*. In the grammatical analysis for the string in (2a), *the water* appears in the subject position of *evaporated*. However, the parser assigns a different structure to the string in (2): when it receives *the water*, it attaches it in the direct object position of *drank*. So, the parser locally makes a decision that turns out wrong at a later stage in the parse. The resulting confusion in the reader is what has been referred to as the *garden path effect*. Sentences which display this effect are marked with the symbol ζ .

Again, the existence of garden path effects does not show that the parser employs heuristic attachment strategies that are different from the attachment mechanism in the competence. It just shows that the parser attaches material within a certain time frame; this time frame is irrelevant for the competence, but not for performance.

We see that in theory, there is no reason to think that processing theory should resort to heuristic attachment strategies to account for the effects

described above; in practice, however, processing theory and competence theory have drifted apart.¹ The general feeling among linguists working on competence theory seems to be that processing is an uninteresting field, since performance is different from competence anyway. One of the goals of this dissertation is to show that processing actually is a field that does hold interest for theoretical linguists. At the same time, performance theory can benefit from competence theory; the formulation of a transparent parser is well within reach.

1.2 Merge as the structure-building operation in processing

In order to see how a transparent parser would build structure, we first have to define the structure-building operation in the syntax. The syntactic framework I adopt here is the Minimalist Program (Chomsky, (1995), (1998), (1999)). The Minimalist Program is a lexicalist approach to syntax, in which all language variation is encoded in the lexicon, as features on lexical and functional entries that determine how these elements are combined. Under the hypothesis that the parser is transparent, we expect the combinatory system to be usable as a parser, too; and we also expect, since language variation is encoded in the lexicon and nowhere else in the language system, that the parser will be the same for all languages.

The structure-building operation used in the Minimalist Program is called *Merge*. The operation Merge works as follows. It takes two elements α and β and puts them together:

$$(3) \quad \begin{array}{c} \wedge \\ \alpha \quad \beta \end{array}$$

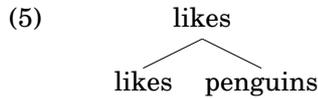
Next, a label is assigned to the newly formed structure. The label is either α or β . Which one of the two projects is determined by the selection properties; the selector always projects.

Let us consider how Merge builds the (simplified) syntactic structure for a very simple sentence such as the following:

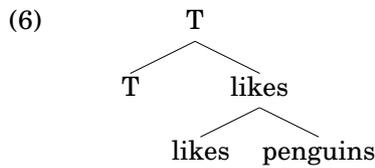
(4) Linus likes penguins

Syntactic structures are derived bottom-up in the Minimalist Program. This means that first *likes* and *penguins* are merged together. *Likes* is the element that projects, because it selects for the direct object *penguins*. The resulting structure looks like this:

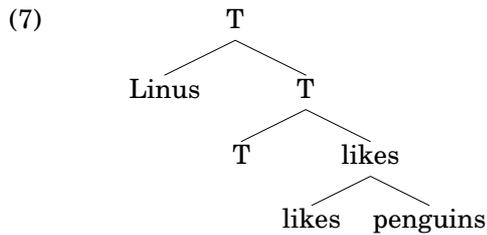
¹For a very interesting historical overview, see Phillips (1996), chapter 5.



Next, the VP is merged with a functional element T (which is used for checking subject-verb agreement; the details are of no importance for the current discussion). Since the functional element T selects for the lexical category V, it projects:



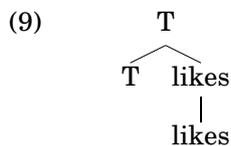
Finally, *Linus* is merged with the structure in (6). T has a feature which selects for an NP in its specifier position, so T again projects. We now get the structure in (7).



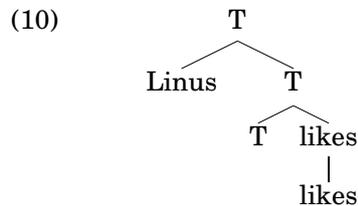
It is easy to see how the same Merge operation can be used for processing the string in (4). The first element in the input is *Linus*. It is put in store.

(8) *Linus*

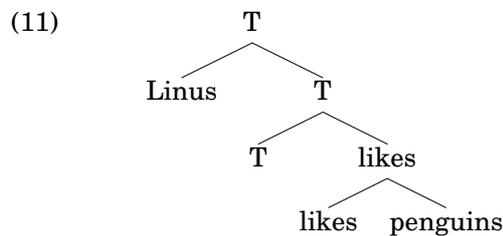
When the verb is encountered, it can be merged with *Linus*. I assume that the presence of tense and agreement information on the verb triggers retrieval of the phonologically empty functional element T from the lexicon. The following structure can then be built:



Linus can then be merged with the structure in (9), yielding (10):



The next word in the input is *penguins*, which can be merged in object position; this completes the parse of (4).



This last step, integration of *penguins* in object position, involves merger ‘inside’ a structure that has already been built. This is not the way it is usually done in syntactic derivations (the operation violates strict cyclicity); however, in Mulders (1997), I have shown that there are cases in syntax where we have to merge material countercyclically as well, so the operation must be available for the grammar (see also Richards (1997)).

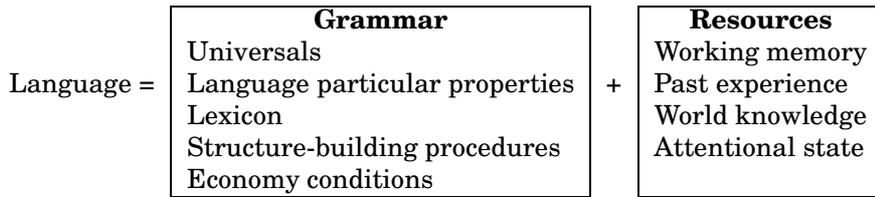
This should give an indication of how the Merge operation can be used as the structure-building mechanism during processing. It is important to note that Merge is a head-driven operation: two elements can be merged if one selects for the other, and then the selecting element projects.

There are reasons to assume that the structure-building operation that the parser uses, is indeed head-driven. As we will see in much more detail later on, head-final languages display far fewer garden path effects than VO-languages such as English. As we will see, this fact can be rather straightforwardly accounted for under a head-driven theory of processing.

Recently, two proposals have been formulated that use the Merge operation as inspiration for a parsing operation: Phillips (1996) and Schneider (1999).

Phillips argues that there is *no* distinction between the parser and the grammar. His conception of the language system is depicted in (12):

(12)



The PIG Model
 (Phillips's (1), ch.5, p.255)

Phillips defines a structure-building operation called Merge Right (which he uses to account for bracketing paradoxes in syntax, as well as for parsing). It is not identical to the Merge operation specified above: Merge Right merges all incoming material directly into one structure, it is not head-driven like the Merge operation used here (see section 3.1 for discussion). As I will argue, the head-driven property of Merge is actually a highly desirable property for processing.

The structure-building mechanism that is developed in Schneider (1999) is closer to Merge; however, Schneider uses an operation that employs empty or underspecified heads to assure immediate attachment of all incoming material in the structure that is being built, even when the licensing head has not been encountered yet. In chapter 3, I will argue extensively that this type of pre-head structure building is not necessary, and that the arguments that have been given for it in the literature are misguided. Throughout this dissertation, I will assume that the parser does not postulate phonologically empty functional elements, unless overt evidence has been encountered that shows that these functional elements must be present.

1.3 Local ambiguity

A parsing mechanism that is closer to the conception of Merge in the Minimalist Program can be found in the model of Pritchett (1992). Pritchett argues that the human sentence processor tries to satisfy global grammatical principles locally. The main guideline that his parser employs is Theta Attachment:

- (13) **Theta Attachment:** The theta criterion attempts to be satisfied at every point during processing given the maximal theta grid.
 Pritchett's (23), p.12

In this definition, *the maximal theta grid* refers to the theta grid of a theta-assigning element including optional theta roles. Theta Attachment is used to choose between alternative analyses of sentences which display local ambiguity. Recall (2a), repeated here as (14):

(14) ¿ After Susan drank the water evaporated

The water is locally ambiguous between attachment as the direct object of *drank*, or as the subject of the main verb. Since the main verb has not been encountered yet when *the water* is being processed, Theta Attachment favors attachment of *the water* as the direct object of *drank*.

In the Minimalist Program, the Theta Criterion is formulated at the meaning interface. As such, it can be used as a mechanism that chooses between alternative ways of merging incoming material. Theta Attachment can be understood as reflecting an eagerness to define semantic relations over incoming material, since it will always favor attachment to a theta-assigner that is already available (such as *drank* in (14)) over attachment to a potential theta-assigner that has not yet been encountered (*evaporated* in (14)). A very basic semantic relation is the relation between predicates and their arguments, and it is this relation that is reflected in Theta Attachment.

We see that Theta Attachment meets our criterion for a transparent parser; it is formulated in terms that we know are linguistically relevant. Note that the literature on sentence processing abounds with parser-specific structure building operations that have no counterpart in syntactic theory (to name but a few: Right Association, Early Closure (Kimball (1973)), Late Closure, Minimal Attachment (Frazier (1978))). The operation of Minimal Attachment, for instance, involves counting of nodes, which we know is not an operation that is available in syntax. As such, Minimal Attachment is not a transparent parsing mechanism.

Pritchett's model is a *serial* parsing model, i.e. it allows for only one analysis for a particular string at each point in the parse. Theta Attachment usually forces a choice between alternative structures, and when Theta Attachment does not force a choice, a choice is made randomly; consequently, there is always maximally one analysis available during the parse.

In this respect, Pritchett's model differs from parallel processing models, which allow for more than one analysis for a particular string to exist simultaneously. An important argument for deciding this issue in favor of allowing only one analysis, can be based on garden path sentences such as (14). The existence of these garden path effects strongly suggests that for a locally ambiguous string one analysis is chosen, which may turn out to be the wrong one at a later stage in the parse.

Crucially, there are cases of local ambiguity in an input string that do not result in the same psychological state of confusion in the reader.

Consider for instance the sentence in (15):

(15) John knows Mary left

(15) involves a similar type of ambiguity as (2a): the element *Mary* is also locally ambiguous between being a direct object (of *knows*) and a subject (of *left*). However, the sentence in (15) does not induce a garden path effect.

There clearly is a tension between the cases in (14) and (15). They both involve an element that is locally ambiguous between being the subject of one verb or the object of another verb, but where (14) leads to conscious processing difficulties, (15) does not.

There are different ways to resolve this tension. The ease with which (15) is processed, is taken as basic in parallel approaches to processing. In parallel processing models, a local ambiguity in a string leads to the formation of competing structures. To account for garden path effects like the one in (14), this type of model ranks the competing structures; the ‘right’ analysis will be ranked so low that it is not considered to constitute real competition for the analysis which yields the garden path effect.

Pritchett resolves the tension between (14) and (15) in a different way. His Theta Attachment forces the object attachment in both cases; he then claims that the Human Sentence Processor has access to a mechanism of *reanalysis*, which can reanalyze *Mary* in (15) from its original position (the object position of *knows*) to the subject position of *left*. He furthermore formulates a constraint on this reanalysis mechanism such that it is not possible for the Human Sentence Processor to reanalyze *the water* in (14) to the subject position of *evaporated*.

It is important to note that Pritchett uses the term ‘garden path’ exclusively for cases where reanalysis cannot be performed automatically and leads to a conscious processing problem, such as (14). In the literature, the term ‘garden path’ is sometimes used to refer to cases such as (15) as well, because there is evidence from reading time studies that readers perform reanalysis there. For Pritchett, the term only refers to processing problems that can be introspectively observed by the reader; I adopt this terminology here. The availability of introspective judgments is also the reason that this type of research does not make use of experimental techniques such as reading time studies; the garden path effect is such a robust psychological phenomenon that such experiments are not necessary to determine that the effect is there.

Pritchett’s model has been rejected in the processing literature, mostly because it is believed not to work for processing Japanese. As we will see, Mazuka and Itoh (1995) do indeed point out some problems for Pritchett’s reanalysis constraint with respect to Japanese. These problems will be solved in chapter 4 by modifying Pritchett’s reanalysis constraint.

On the whole, it is rather ironic that Pritchett’s model is rejected on the basis of the claim that it does not work for head-final languages, since

it comes much closer to working for head-final languages than most other processing models based on English. Most models predict that almost every sentence in Japanese will be a garden path. It is generally known that in fact it is the other way around: head-final languages display far fewer garden path effects than languages like English (see Mazuka and Lust, 1988, 1989; Mazuka et al., 1989). A major point in this dissertation is to show that a head-driven approach can account for this fact, while maintaining that the parser is universal.

1.4 Structure of the dissertation

In order to contribute to the goal of formulating a transparent parser, this dissertation examines some aspects of Pritchett's model, in particular its head-driven nature. I will do this by looking at processing of verb-final structures in Japanese, which is head-final throughout, and Dutch, which has a mixed system: verb-final in embedded clauses, verb-second in main clauses.

Chapter 2 is a detailed introduction to Pritchett's model. We will see how Theta Attachment and his reanalysis constraint, the OLLC, account for garden path effects in English. I will also discuss his mechanism of sending back to storage, and the treatment of optionality under Theta Attachment.

Chapter 3 is a critical discussion of objections that have been raised against head-driven processing in the literature. I will show that there is actually no evidence that the parser builds structure before it encounters the head. The discussion will involve a variety of locally ambiguous structures, such as relative clauses in Dutch, and PP-attachment ambiguities.

In chapter 4, I will look at the processing of Japanese under Pritchett's theory. For most processing theories, the virtual absence of garden path effects in Japanese is a mystery, since most models assume that all incoming material is attached into a structure as soon as it is encountered, which gives the parser much opportunity to make mistakes. For head-driven theories like Pritchett's, this is much less of a mystery. However, as we will see, even his model predicts processing difficulties in Japanese in some contexts which are actually processed without effort. To accommodate these cases, I will propose a revision of Pritchett's reanalysis constraint in terms of accessibility of material in the edge of a closed constituent.

In chapter 5, I will give an overview of the resulting system, and show how it accounts for the data that have been discussed so far. In chapter 5 I will also present some Dutch garden paths, and some Dutch cases which involve uncostly reanalysis.

Chapter 6 concludes that it is possible to construct a transparent parser that accounts for garden path phenomena in both OV- and VO-structures,

and that (the absence of) garden paths provide no evidence that there is a need to posit a separate parser for Japanese, as is sometimes proposed.

Chapter 2

Pritchett's model

2.1 Introduction

In this chapter, I will outline the head-driven parsing model developed in Pritchett (1992). As we will see, the two pillars of Pritchett's theory are Theta Attachment, and a reanalysis constraint, the On-Line Locality Constraint, which bars costly reanalysis. These two mechanisms are the implementations of the two major claims Pritchett makes:

1. syntactic processing is driven by local application of grammatical principles (specifically, the Theta Criterion)
2. reanalysis is not costly per se; some (structurally defined) types of reanalysis can be performed automatically by the human sentence processor. If reanalysis cannot be performed automatically, a (conscious) garden path effect arises.

Pritchett's model is in a sense the opposite of many other processing models. Most serial processing models assume that the parser is informationally encapsulated, and do not take lexical information into account in building the initial parse (categorical information excluded). Instead, these models rely on purely structurally formulated mechanisms specific to the parser (e.g. Minimal Attachment) for building the first parse. In Pritchett's model, the first parse is built by locally applying grammatical principles, most notably the Theta Criterion, and there is no structure-building mechanism that is specific to the parser. On the other hand, where most processing models take reanalysis to be a very complex phenomenon that can make use of lots of different sources of information, Pritchett maintains that reanalysis is a purely structural phenomenon.

In his chapter 2, Pritchett critically surveys a variety of processing models. I will not compare his model with other processing models here;

but in the next chapter, I will address counterarguments that have been given against head-driven processing in general by Frazier (1987), Frazier (1989), and Schneider (1999); and in chapter 4, I will modify Pritchett's reanalysis constraint based on counterarguments specifically against Pritchett's model from Mazuka and Itoh (1995).

In this chapter, I will introduce Pritchett's model by showing how the model accounts for a range of English garden paths:

- (1) *Taxonomy of Garden Path Phenomena*
 - a. Main Clause-Relative NP Ambiguity
The boat floated down the river.
¿ The horse raced past the barn fell.
 - b. Complement Clause-Relative Clause Ambiguity
The tourists persuaded the guide that they were having trouble with their feet
¿ The doctor told the patient he was having trouble with to leave.
 - c. Object-Subject Ambiguity
John believed the ugly little man hated him.
¿ After Susan drank the water evaporated
 - d. Double Object Ambiguity
Rex gave her presents to Ron
¿ Todd gave the boy the dog bit a bandage.
 - e. Lexical Ambiguity
¿ The old train the children.
The church pardons many sinners.
(Pritchett's (22), p.12)

The structure of this chapter is as follows. In section 2.2, I will introduce Theta Attachment, the basis for structure-building in Pritchett's model. In section 2.3, I will introduce the reanalysis constraint that Pritchett proposes, and show which types of reanalysis it permits. Section 2.4 discusses how this reanalysis constraint bars costly reanalysis. In section 2.5, we will see how Theta Attachment predicts optionality in certain attachment decisions during processing. Section 2.6 introduces an auxiliary mechanism of sending back to store; and section 2.7 gives a brief summary.

The goal of this chapter is to just outline Pritchett's system as it stands without questioning it; a more critical discussion of some aspects of the model can be found in chapter 5.

2.2 Theta Attachment

In this section, I will explain how Theta Attachment builds initial structure in Pritchett's model. The definition of Theta Attachment is given in (2):

- (2) **Theta Attachment:** The theta criterion attempts to be satisfied at every point during processing given the maximal theta grid.
Pritchett's (23), p.12

The maximal theta grid of a theta-assigner is the theta grid including optional theta-roles, if any.

As a reminder, a definition of the theta criterion is given below:

- (3) **Theta Criterion:** Each argument α appears in a chain containing a unique visible theta position P, and each theta position P is visible in a chain containing a unique argument α . (Chomsky 1986b, 97)
Pritchett's (24), p.12

Let us first see how Theta Attachment serves to process a simple, unproblematic string such as the following:

- (4) The vampire bit the child.

First, *the vampire* is encountered. It is probably structured as an NP right away (see Pritchett's fn.67). This NP is kept in store; it is important to note that in Pritchett's model, no TP is projected before the verb has been encountered; structure-building is strictly theta-driven. In this respect, the model is very different from most other processing models.

When *bit* is encountered, it is identified as a verb which can assign two theta roles:

- (5) bit
V
 $\Theta_1 \Theta_2$

I'm assuming that since *bit* contains tense and agreement information, it can project a TP. Now, structure can be built under Theta Attachment. The grammar of English allows for attachment of *the vampire* in the subject position, where it gets the external theta role of *bit*:

- (6)
-
- ```

graph TD
 TP --> NP["NP Θ₁"]
 TP --> T_prime["T'"]
 NP --- the_vampire["the vampire"]
 T_prime --> T["T"]
 T_prime --> VP["VP"]
 VP --- bit["bit"]
 bit --- Theta_2["Θ₂"]

```

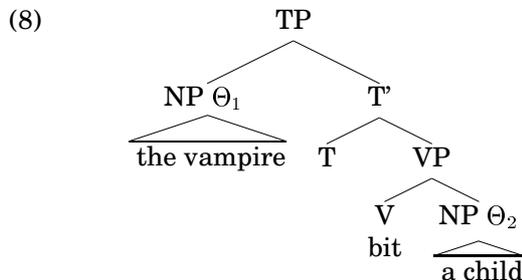
This attachment maximally satisfies the Theta Criterion: *bit* has assigned a theta role, and *the vampire* has received a theta role. Compare this to a

situation where *the vampire* is not attached as the subject of *bit*:



(7) represents the situation where *the vampire* and *bit* have been assigned to the store separately. In this situation, *bit* is stuck with two unassigned theta roles, and *the vampire* does not receive a theta role. This means that in the storage situation in (7), the Theta Criterion is violated three times, while in the structure in (6), it is violated only once (since the internal theta role of *bit* has not been assigned there). Hence, (6) satisfies the Theta Criterion better than (7); Theta Attachment forces the structure in (7) to be built obligatorily.

The next input consists of *a*. Since *a* can't receive a theta role, it is stored until *child* is encountered. Then, an NP *a child* can be built, which in turn can be attached as the direct object of *bit*. Since this attachment satisfies the unassigned internal theta role of *bit* as well as the requirement of *a child* to receive a theta role, attachment is obligatory under Theta Attachment: the Theta Criterion is satisfied maximally through attachment of *a child* as the direct object of *bit*. The parse is completed successfully, resulting in the following structure:



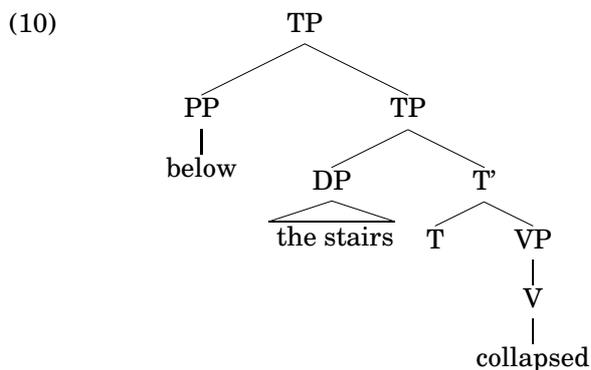
This discussion should give us a basic feel for the way in which Theta Attachment works.

Some remarks are in order about the structural representations that we are building here. Note that I'm assuming, with Pritchett, that the subject is merged directly in spec,TP. This is a simplification with respect to the Minimalist Program, where it is assumed that the VP has a functional layer, small vP, on top of it, which hosts the (trace of) the subject. Furthermore, determiners are analyzed as specifiers of NP here, and do not head their own DP-projection. Throughout this dissertation, I'm using syntactic representations that are simplified in ways like these, and that are very similar to the ones Pritchett uses. The expectation is that the insights acquired on the basis of these simple representations will be translatable to a theory that applies to more sophisticated representations.

I will come back to this in chapter 5, section 5.3. Let us now see how Theta Attachment accounts for the initial misanalysis in a simple garden path such as the following:

(9) ¿ Below the stairs collapsed.

The grammatical analysis of the string in (9) can be represented as follows:



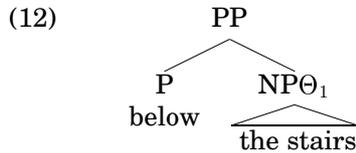
The grammatically correct analysis of the string in (9) involves topicalization of *below*. This, however, is not the structure first assigned by the Human Sentence Processor. Let us consider step by step how a parser employing Theta Attachment deals with the string in (9).

The first input in processing (9) consists of *below*. *Below* can optionally select for a complement, to which it can assign a (location) theta role. Let us represent the lexical entry of *below* as follows:

(11) below  
P  
( $\Theta_1$ )

The next input is *the*. *The* cannot assign or receive a theta role, so no structure can be built at this point; *below* and *the* are stored separately.

The next input consists of *stairs*. At this point, *the* and *stairs* are merged together, forming an NP. This NP is then attached as the complement of *below*, since *below* can assign its theta role to it. This theta role is optional (which I indicated by including it in brackets in the representation of the lexical entry of *below* in (11)), but it is relevant for Theta Attachment because Theta Attachment refers to the *maximal* theta grid. The resulting structure is the following:



The next input is *collapsed*. There is no way in which this element can be fit into the existing structure conforming to Theta Attachment: *collapsed* has an obligatory theta role to assign, but there is no NP available that it can assign the theta role to. Therefore, the parse fails; the string has to be reanalyzed (taking out the NP and attaching it as the subject of *collapsed*), and the sentence is a garden path.

Theta Attachment predicts that whenever there is, locally, a choice between attachment as an argument and attachment as an adjunct, argument attachment is obligatory, since it discharges a theta role, and thus brings the structure as a whole closer to satisfying the Theta Criterion. This explains the garden path effect in cases of ambiguity between complement clause attachment and relative clause attachment, such as the following:

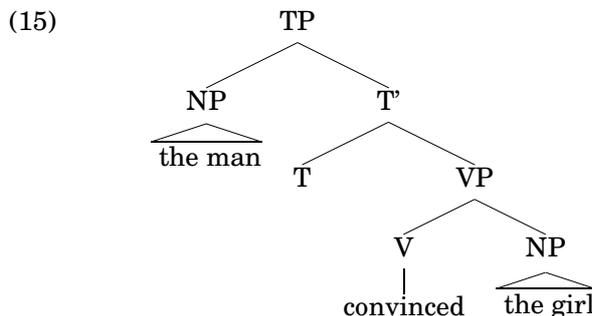
(13) ¿ The man convinced the girl that he left to smile.

Let us go over the parse in detail. The first point of interest comes when *convinced* is discovered. Its root *convince* can assign three thematic roles:

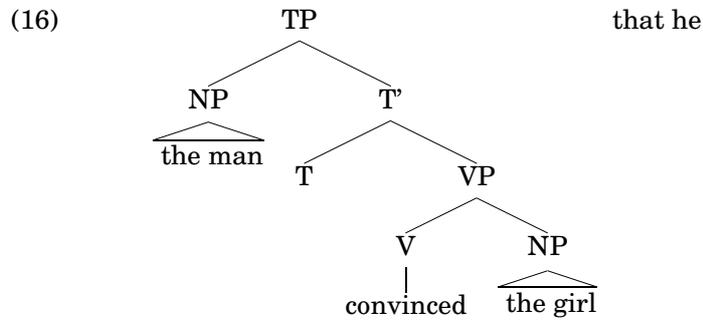
(14) convince  
 $\Theta_1 (\Theta_2) \Theta_3$

This means that structure can be built which satisfies Theta Attachment: *the man* is attached as the subject of *convinced* and receives  $\Theta_1$ .

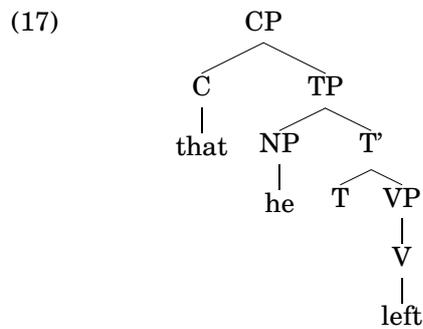
Next, *the girl* is retrieved. It can be attached as a VP-internal argument of *convinced*, receiving  $\Theta_2$ . The structure now looks like this:



Next, *that* is encountered and stored. Since there is no theta assigner available that can assign a theta role to it, *he* is also stored. The buffer now looks like this:

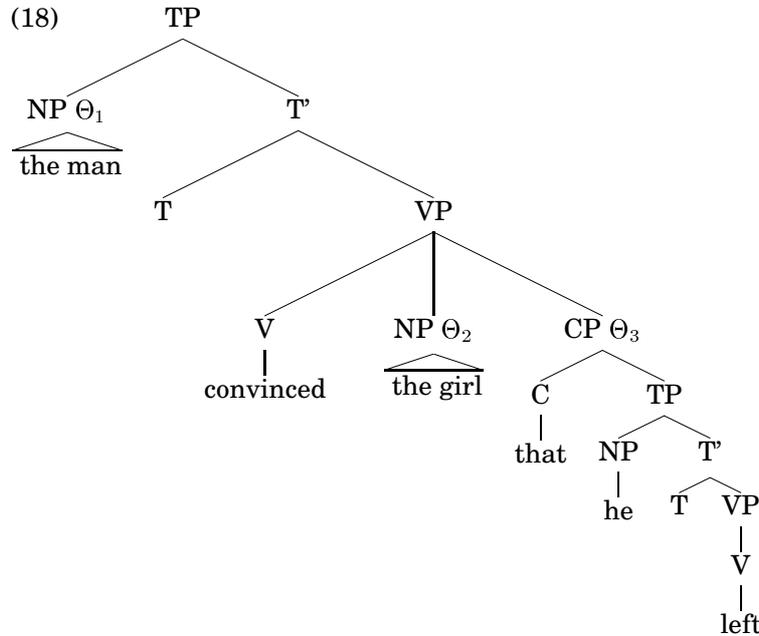


When *left* is encountered, the elements *that*, *he* and *left* can be integrated into an embedded clause:



This building of the structure in (17) is obligatory under Theta Attachment, because *left* can assign a theta role to *he*.

Next, this embedded clause can be attached as an internal argument of *convinced*, where it receives the second internal theta role of *convinced*. This attachment maximally satisfies the Theta Criterion. The structure now looks like this:



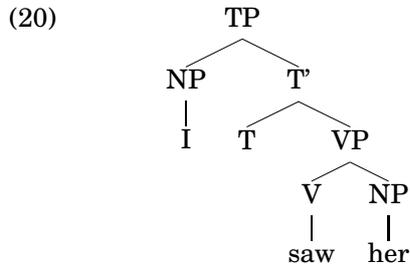
Next, upon discovery of *to smile*, it turns out that attachment of the embedded clause as an argument of *convinced* was wrong; it should have been attached as a relative clause to *the girl*. The sentence needs to be reanalyzed, and it is a garden path.

### 2.3 Conscious versus unconscious reanalysis: the On-Line Locality Constraint

In the previous section we saw how Theta Attachment predicts misanalysis in the garden path sentences in (9) and (13): the structure that is initially built under Theta Attachment turns out to be incompatible with later input. We implicitly assumed that this is what causes the garden path effect. However, there are cases where an initial analysis that has been made in accordance with Theta Attachment is disconfirmed by later input, without leading to a garden path effect. Consider the sentence in (19):

(19) I saw her house.

Let us go over the parse step by step. As soon as *saw* is encountered, *I* is theta-attached as the subject in the familiar way. Then, *her* is encountered. *Her* can be attached as the direct object of *saw*:



In this structure, all thematic requirements have been satisfied: *saw* has discharged both its external and its internal theta-role, and both *I* and *her* have a theta-role.

It is clear that this initial analysis made by Theta Attachment proves incorrect when the actual head of the direct object of *saw*, *house*, is encountered. Note, however, that there is no conscious problem in processing it: the string in (19) is not a garden path. Obviously, reanalysis has to occur in processing the string in (19); and apparently, the Human Sentence Processor is capable of performing this reanalysis without difficulty.

We see that it cannot be the need for reanalysis per se that is responsible for the garden path effect; reanalysis is possible in certain circumstances without leading to a conscious processing problem. Pritchett proposes the following constraint on uncostly reanalysis:

- (21) **On-Line Locality Constraint (OLLC):** The target position (if any) assumed by a constituent must be *governed* or *dominated* by its source position (if any), otherwise attachment is impossible for the automatic Human Sentence Processor.  
(286), p.101

The definition of government is given below:

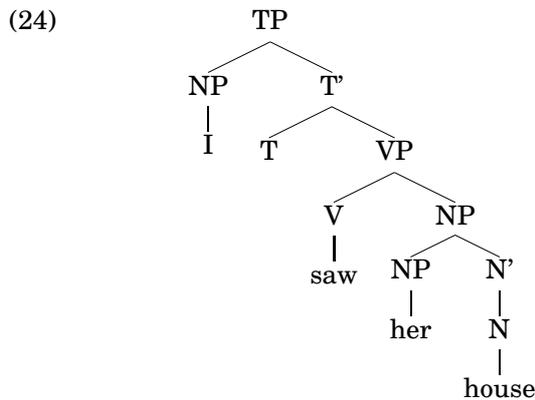
- (22) **government:**  $\alpha$  governs  $\beta$  iff  $\alpha$  m-commands  $\beta$  and every  $\gamma$  dominating  $\beta$  dominates  $\alpha$ ,  $\gamma$  a maximal projection. (Adapted from Chomsky (1986))  
Pritchett, fn.101
- (23) **m-command:**  $\alpha$  m-commands  $\beta$  iff  $\alpha$  does not dominate  $\beta$  and every  $\gamma$  that dominates  $\alpha$  dominates  $\beta$ ,  $\gamma$  a maximal projection. (Adapted from Chomsky (1986))  
Pritchett, fn.101

The source position is the position in which an element is first theta-attached; the target position is its position in the ultimate, grammatical structure. The OLLC looks upon reanalysis as a kind of 'movement' which is constrained by the familiar syntactic concepts of government and dominance. The underlying intuition is that an element can only be reanalyzed

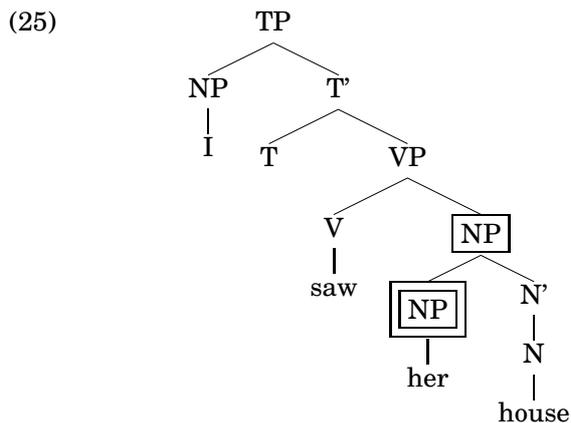
without conscious effort if it stays in the same domain; this will become clearer as we proceed.

Let us see how the OLLC allows for reattachment of *her* as the possessor of *house* in processing the string in (19).

Consider the structure assigned to the string up until *her*, given in (20), and compare it to the correct structure for (19), given below in (24):



We can see that in (24), *her* has been reanalyzed from the direct object position of *saw*, to the specifier position of the actual object of *saw*, *her house*. Pritchett uses a special notation to signal this in the final structure: the source position of the reanalyzed element is indicated by a single box, and the target position is indicated by a double box, as in (25):



This notation makes it easy to see whether the OLLC, as given in (21), has been obeyed. In (25), the source position (the direct object position of *saw*) dominates the target position (the specifier position of *house*); so reanalysis of *her* from the object position to the specifier position of the object is permitted by the OLLC.

The OLLC is formulated in structural terms; in the remainder of this section, we will see which types of changes in the structure it allows for, and which types of reanalysis it disallows. In section 2.3.1, we will look at the domination clause, and in section 2.3.2, we will see which types of reanalysis are permitted by the government clause.

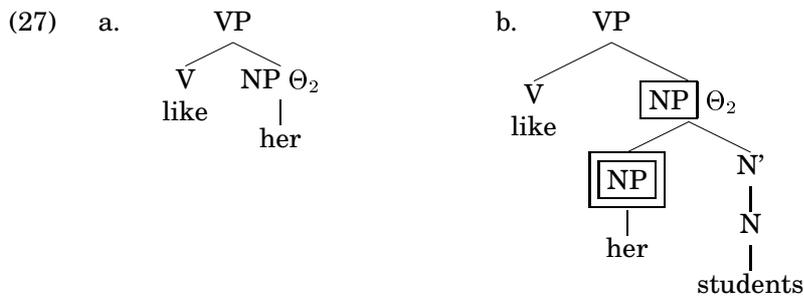
### 2.3.1 Domination

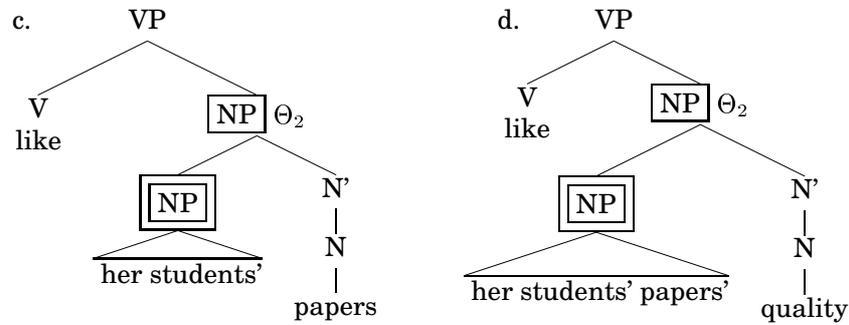
The intuition underlying the domination clause of the OLLC is that reanalysis is possible if the Human Sentence Processor continues to work on the ‘same’ constituent: reanalysis of *her* to the specifier position of *house* in (19) involves the same constituent, namely the direct object of *saw*.

In general, the domination clause of the OLLC allows for reanalysis to the specifier position of the original attachment site. We already saw an example of this type of reanalysis in (19) above. This type of reanalysis never leads to a garden path effect, and it can occur recursively:

- (26) a. I like her  
 b. I like her students  
 c. I like her students’ papers  
 d. I like her students’ paper’s quality

In each subsequent sentence in (26), the element originally attached as the direct object of *saw*, is reanalyzed as the specifier of the actual direct object. Consider the subsequent steps of this NP-internal reanalysis:



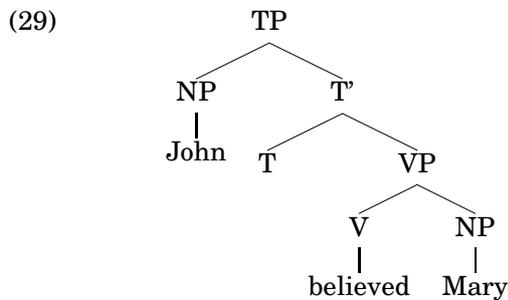


In each of the reanalysis steps depicted in (27), the source position (the direct object position of *like*) dominates the target position (the object position's specifier). The OLLC thus allows for this type of reanalysis to occur unconsciously.

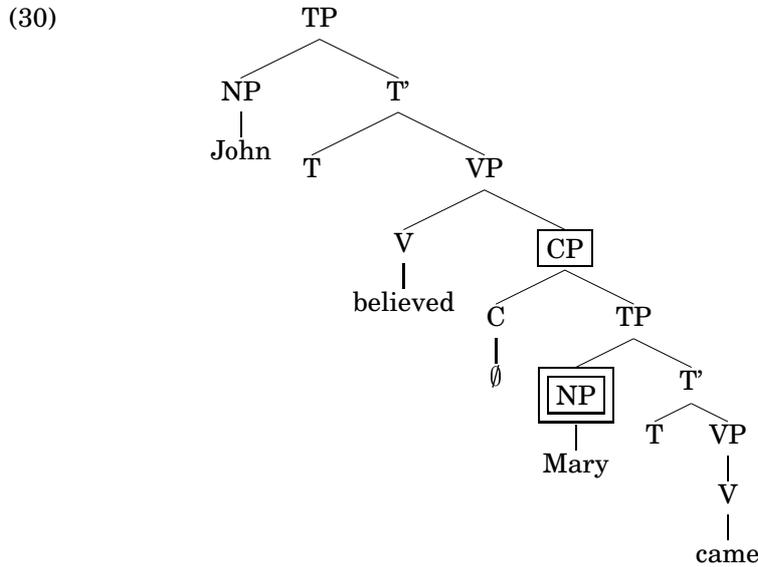
A similar case of reanalysis where the source position dominates the target position, is given in (28):

(28) John believed Mary came

When *Mary* is encountered, it is theta-attached as the direct object of *believed*:



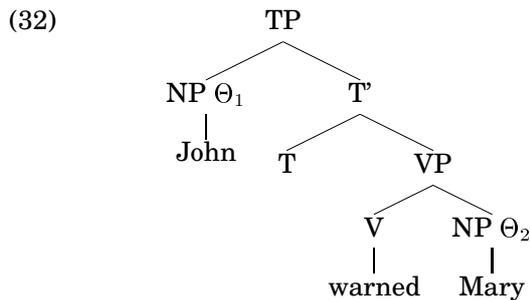
This turns out to be wrong when *came* is encountered: *Mary* turns out to be the subject of the embedded clause which is the direct object of *believed*. The reanalysis that has to take place in order to build the structure accordingly, is permitted by the OLLC because the source position (the direct object position of *believed*) dominates the target position (the subject position of the embedded clause):



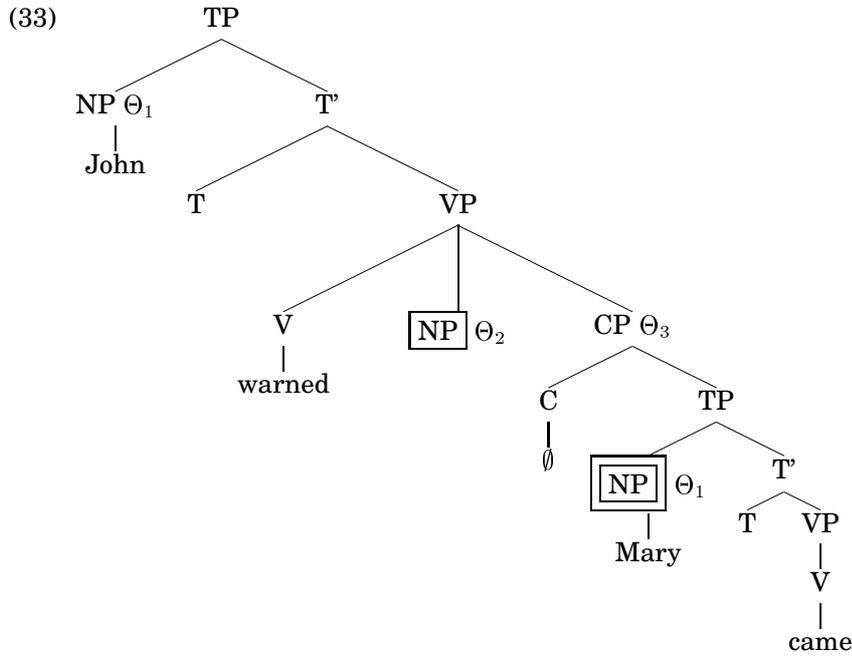
Compare this case to a superficially very similar case, given in (31b):

- (31) a. John believed Mary came  
 b. ζ John warned Mary came

Contrary to (31a), (31b) in fact does induce a garden path effect. The difference lies in the difference in thematic structure between *believe* and *warn*. While *believe* can assign only one internal thematic role, *warn* can assign two: one to the person who is warned, and one expressing the content of the warning. When *Mary* is discovered in (31b), it is attached in accordance with Theta Attachment as an internal argument of *warned*:



This analysis has to be revised when *came* is encountered: *Mary* must be reanalyzed as the subject of the clause expressing the content of the warning. This reanalysis is not permitted by the OLLC.



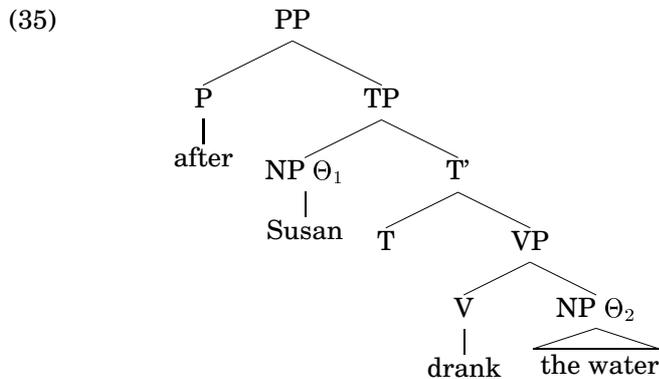
The source position does not dominate the target position. It does not govern it either, since there are two maximal projections intervening (the embedded CP and the embedded TP). In the reanalysis needed to process (31b), *Mary* has to move from one structural domain (the position of the first internal theta role of *warn*) to an entirely different structural position (the subject position inside the position where the second internal theta role of *warn* is assigned). This reanalysis is too drastic for the Human Sentence Processor to perform automatically.

The difference in processing difficulty between the minimal pair in (31) shows that it is not just the original position of the reanalyzed constituent, nor just the position it reanalyzes to, that is of importance; the crucial factor in determining whether reanalysis can be performed automatically, lies in the *relation* between the original position and the new position of the reanalyzed element. The OLLC constrains this relation in terms of the grammatical notions of dominance and government.

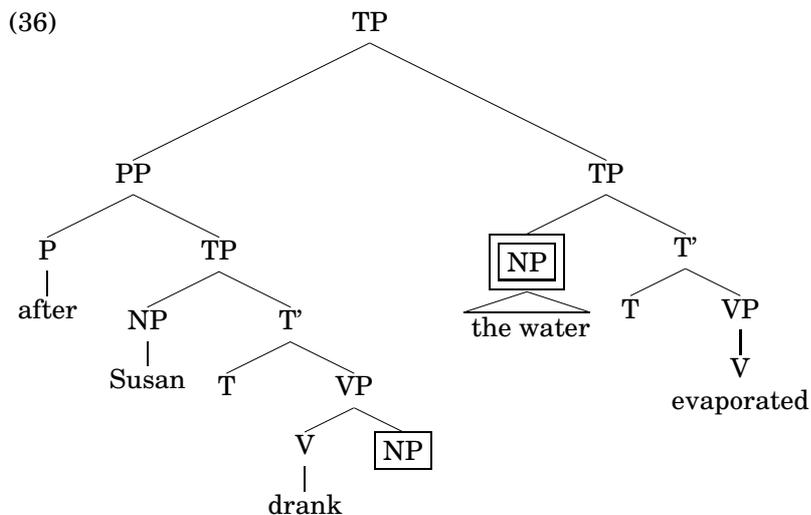
Another example of unpermitted reanalysis of a direct object of one clause to the subject position of another clause, is the following:

(34) ¿ After Susan drank the water evaporated

When *the water* is encountered, it is attached as the direct object of *drank*, as forced by Theta Attachment:



Upon discovery of *evaporated*, it turns out that this is not the right analysis. However, reanalysis of *the water* as the subject of the main clause is not possible; the source position (the object position of the adjunct clause) does not dominate or govern the target position (the subject position of the main clause).



Again, we see that the relation between the original position and the new position determines whether reanalysis is possible.

To summarize: the OLLC quite impressively accounts for the differences in reanalyzability of the object to the subject position in the minimally different cases in (28), (31b) and (34), repeated here in (37):

- (37)
- a. John believed Mary came.
  - b.  $\zeta$  John warned Mary came.
  - c.  $\zeta$  After Susan drank the water evaporated.

In all three cases in (37), there is a constituent that is initially theta-attached as an internal argument of the first verb: *Mary* is initially analyzed as the direct object of *believed* in (37a), *Mary* is initially analyzed as the indirect object of *warned* in (37b), and *the water* is initially analyzed as the direct object of *drank* in (37c). In all three cases, this constituent has to be reanalyzed as the subject of a later verb; this later verb appears inside an embedded clause which is an argument of the matrix verb in (37a) and (37b), and it's the main verb in (37c). But only in (37a), where the reanalyzed constituent is reattached inside its original domain (the direct object position of the main verb), reanalysis is permitted by the OLLC. This explains why the sentences in (37b) and (37c) induce a garden path effect.

### 2.3.2 Government

So far, we have seen only the domination part of the OLLC in action. The additional government part is needed to account for the possibility of reanalysis in double object constructions.

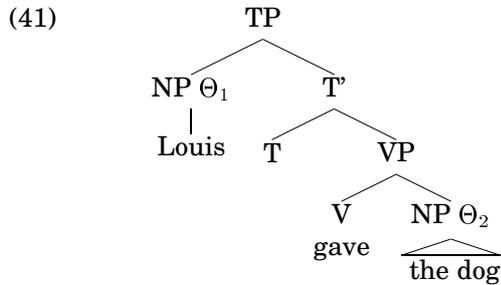
As Pritchett points out, the Human Sentence Processor has no difficulties with double object constructions, even though the actual content of the thematic roles assigned is often locally ambiguous. Consider the following sentences:

- (38) a. Louis gave the dog to Barbara.  
b. Louis gave the dog a treat.
- (39) a. Joe loaded the truck with bananas.  
b. Joe loaded the truck onto the boat.
- (40) a. Zeny rented the apartment to Theresa.  
b. Zeny rented the apartment from Theresa.  
(Pritchett's (275)-(277))

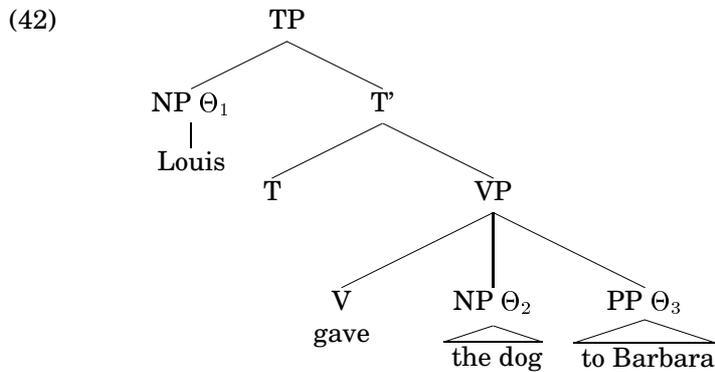
The NP *the dog* occupies the same position in the string in examples (38a) and (38b), but it is assigned the THEME role of *gave* in (38a), and the GOAL role in (38b). The same goes for *the truck* in (39b) and (39a), respectively. In the examples in (40), the subject may turn out to receive either the SOURCE or the GOAL role. However, interestingly, this local vagueness with respect to the actual content of the theta role assigned does not lead to any processing difficulties.

Let us briefly consider how a sentence such as (38a) is processed.

First, *Louis* is encountered and stored. When *gave* is encountered, *Louis* can be attached as the subject. Next, *the dog* is processed, and it is attached as the first complement of *gave*:



When *to Barbara* is encountered, it is attached in the VP as the second complement of *gave*:

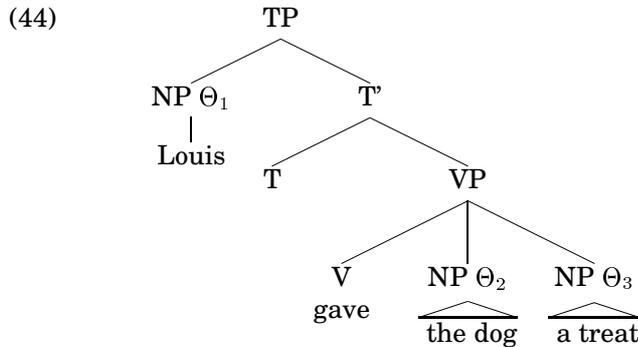


Note that we're abstracting away from VP-internal structure here; following Pritchett, I use a ternary branching VP to schematically indicate the VP-internal position of both of the internal arguments, and I use the labels  $\Theta_2$  and  $\Theta_3$  to indicate 'first internal theta role' and 'second internal theta role', respectively. Again, this is a structural simplification: the different VP-internal theta roles may be associated with specific positions in the VP-structure.

Let us now look at the parse of (38b), repeated here as (43):

(43) Louis gave the dog a treat.

Up until *the dog*, the parse is identical to the parse of (38a). The resulting structure is the structure in (41) above. When *a treat* is received, the following structure is built:

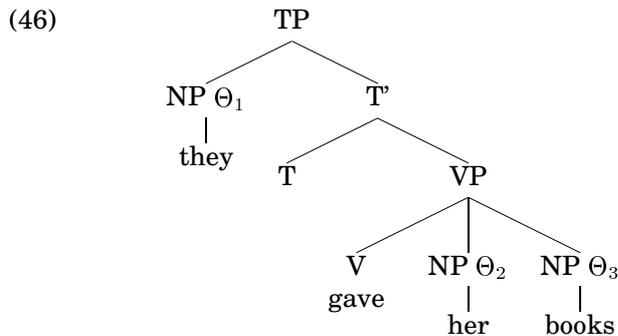


As noted above, *the dog* occupies the same position here, with the same thematic label, as it does in (42); but the content of the thematic role assigned to it is not the same (THEME in (42), GOAL in (44)).

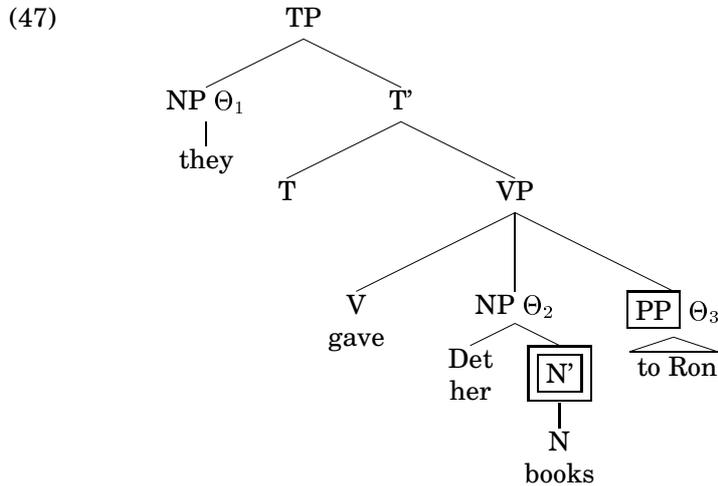
Now, let us look at a more interesting case. Consider the sentences in (45), neither of which poses a conscious processing problem:

- (45) a. They gave her books  
 b. They gave her books to Ron

The interesting case is (45b). Theta Attachment predicts initial attachment of *her* as the indirect object of *gave*, and attachment of *books* as the direct object, since this attachment maximally satisfies the Theta Criterion. The schematic structure is given below:



Upon discovery of *to Ron*, the attachment of *books* has to be revised; the discovery of a PP that can get the third theta role of *gave* (and can serve no other function) forces reanalysis of *books*. This reanalysis can be performed automatically; it is permitted by the government clause of the OLLC:



The source position of *books* (the second internal argument position in the VP, occupied by the PP in the final analysis) governs the target position (the head of the first VP-internal argument position), since the source position governs the maximal projection of the target position. The underlying intuition is that the reanalysis is permitted here, because *books* stays in the same domain after reanalysis: it remains an internal argument of *gave*.<sup>1</sup>

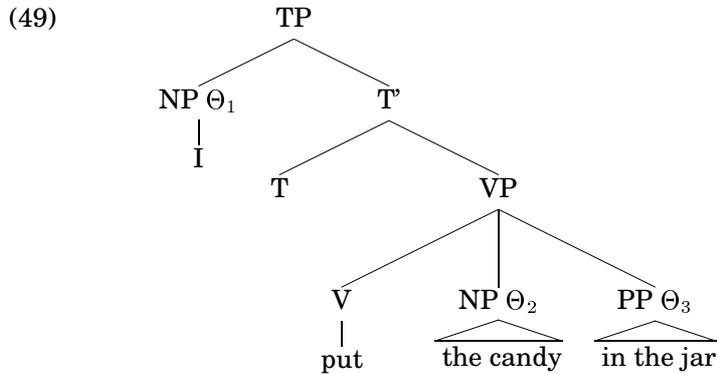
Note that the actual content of the theta roles doesn't matter; in the initial analysis, the first VP-internal argument position received the GOAL role, and the second one received the THEME role, whereas in the final parse this is reversed. For the OLLC, only the structural position of the arguments matters, the semantic content of the positions is not relevant (cf. the discussion of (38)-(40)).

The lack of processing difficulty in (45b) contrasts in an interesting way with the following sentences, which do pose conscious processing difficulties:

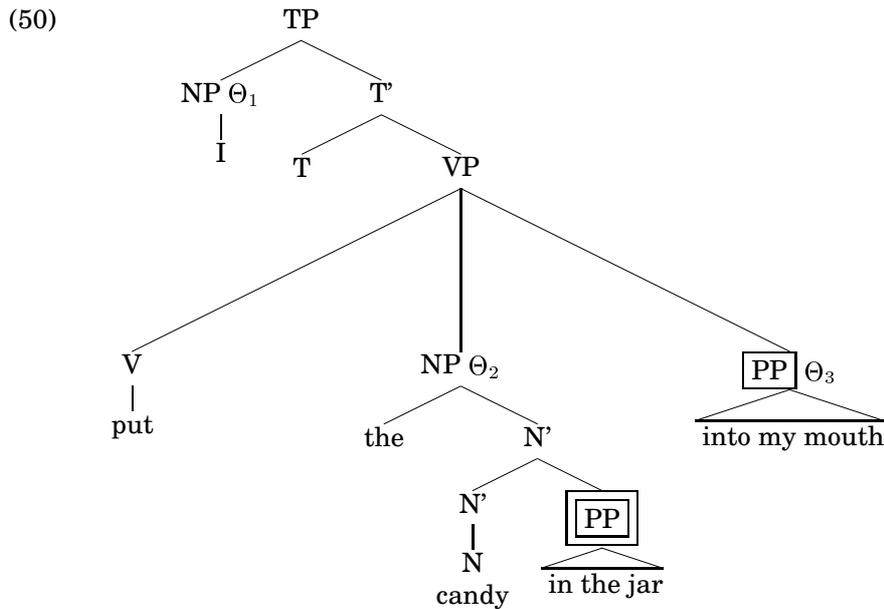
- (48)
- a. ? I put the candy in the jar into my mouth.
  - b. ? I sent the letters to Ron to Rex.
  - c. ? I loaded the bananas on the truck into the boat.

To see what's going on here, let us take a closer look at (48a). Theta Attachment predicts initial attachment of the PP *in the jar* as the second internal argument of *put*:

<sup>1</sup>Note that *her* is also reanalyzed, from its original position to the specifier of that position. As we have seen, this reanalysis is allowed by the dominance clause of the OLLC.



This structure has to be revised when the actual second internal argument of *put*, *into my mouth*, is encountered. However, the necessary reanalysis of *in the jar* as an adjunct of *candy* is not permitted by the OLLC.



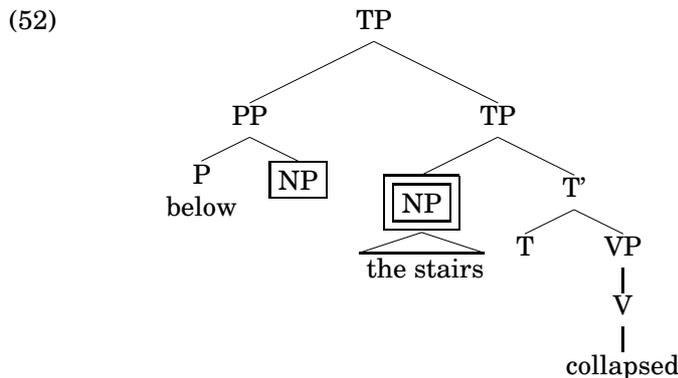
In the resulting structure, the source position does not govern the target position; there is a maximal projection intervening (the NP projection of *candy*). The crucial difference between the structures in (47) and (50) is that in (50), the reanalyzed element doesn't become the head of the first VP-internal argument position, whereas it does in (47). Of course, the source position does not dominate the target position in (50) either; hence the examples in (48) give rise to a garden path effect.

## 2.4 Impossible reanalysis

We have seen in the previous sections which kinds of reanalysis the OLLC permits, and we've also seen a couple of garden paths that the OLLC correctly predicts to be unreanalyzable. Let us now turn to a brief discussion of how the OLLC accounts for the examples we discussed in section 2.2. We discussed two garden path sentences, and recognized the need for reanalysis in those sentences. We did not yet, however, check whether the OLLC correctly predicts that reanalysis cannot be performed unconsciously in those cases. Let us first look at the garden path in (51):

(51) ¿ Below the stairs collapsed.

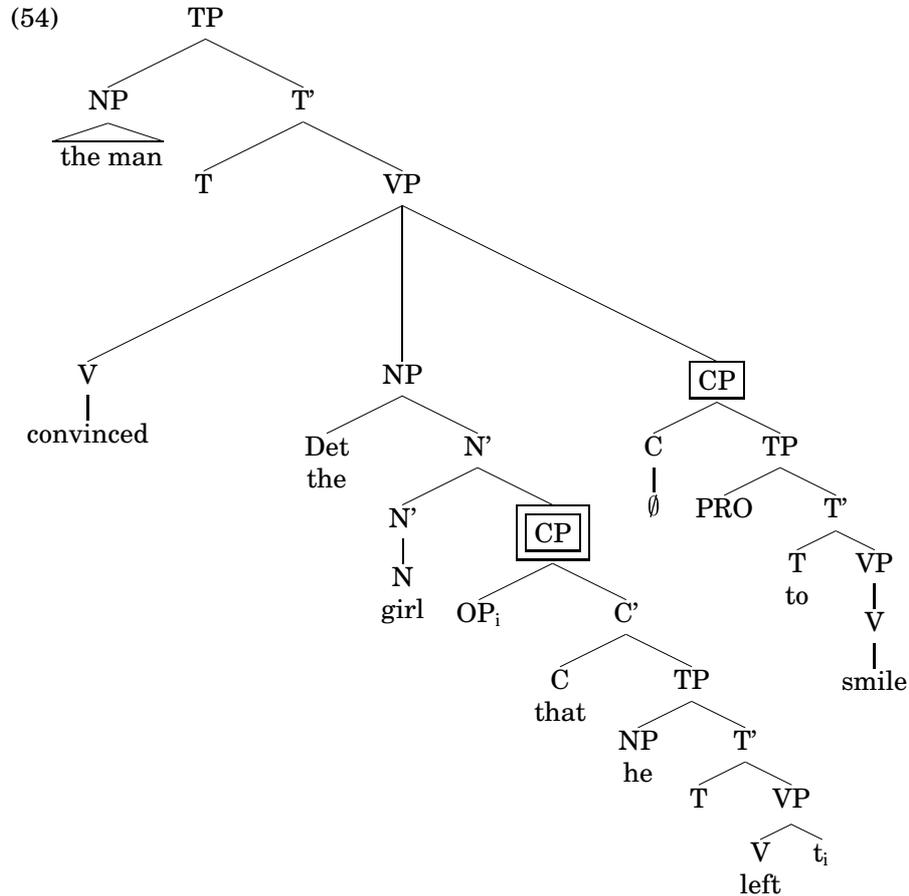
As we saw in section 2.2, Theta Attachment predicts initial attachment of *the stairs* as the complement of *below*. This analysis proves to be wrong when *collapsed* is encountered. The correct analysis of the string, with source and target position indicated for the necessary reanalysis of *the stairs*, is given below:



In this structure, the source position (the complement position of *below*) does not dominate the target position (the subject position). The source position does not govern the target position either; it doesn't even m-command it. We see that the OLLC correctly predicts (51) to be a garden path.

The other case we saw in section 2.2 is the following:

(53) ¿ The man convinced the girl that he left to smile.

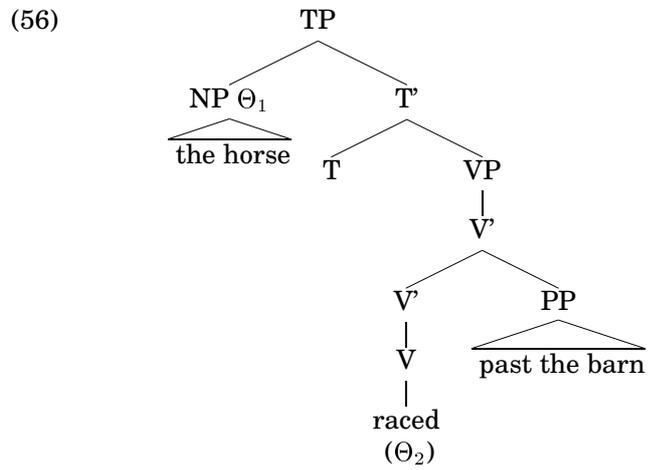


Again, the source position (the second complement position of *convinced*) does not dominate the target position (the position adjoined to the N' projection of *girl*). The source position does not govern the target position either, since there is a maximal projection intervening (the maximal projection of *girl*).

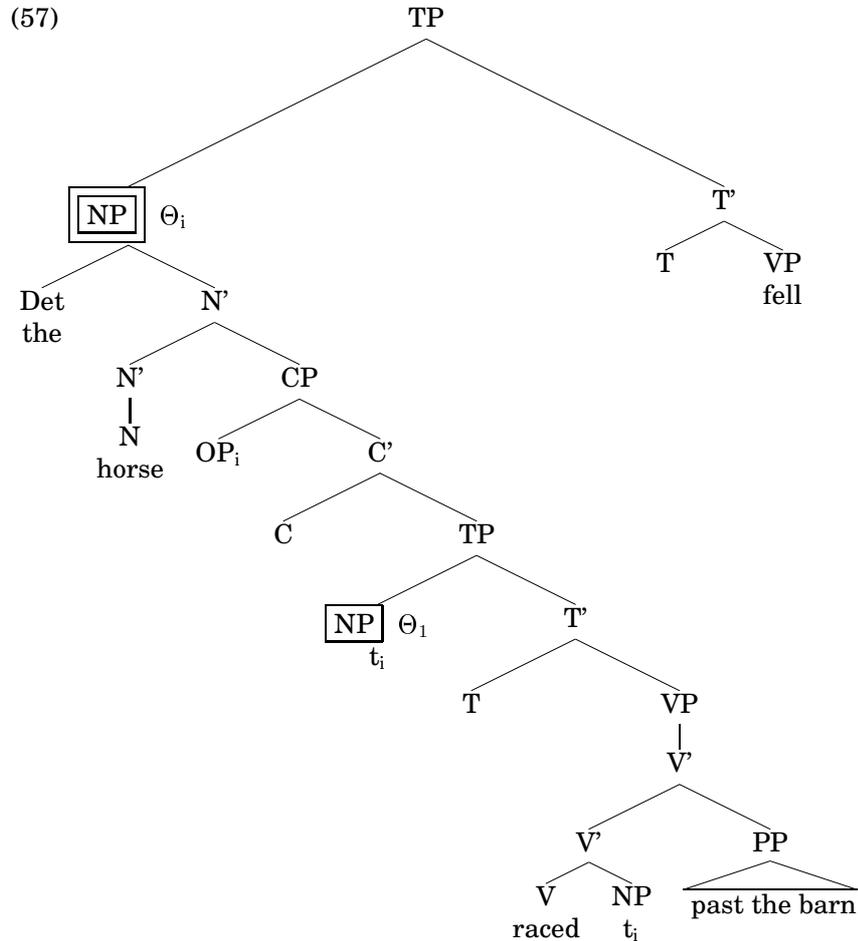
There is one other type of local ambiguity leading to a garden path effect that needs to be mentioned here, which is the classic main clause-reduced relative clause ambiguity exemplified in (55):

(55)  $\downarrow$  The horse raced past the barn fell.

Initially, the parser pursues a main clause analysis of the string in (55) (for discussion, see chapter 5.6). The resulting structure looks as follows:

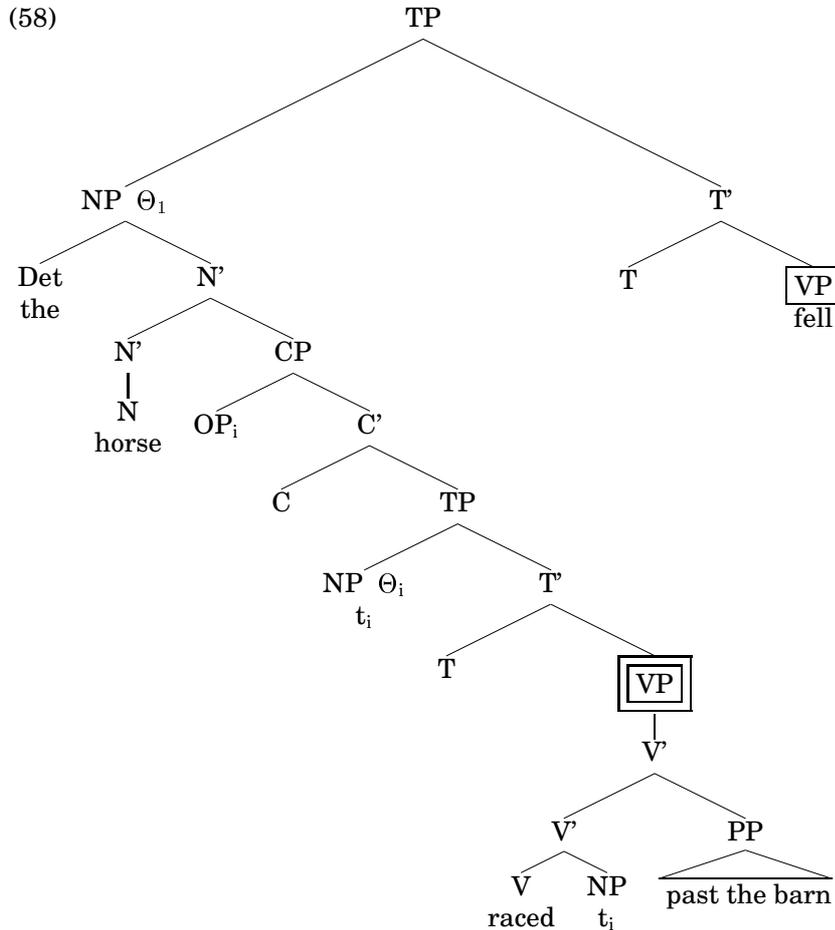


When *fell* is encountered, the initial main clause analysis must be revised; *horse* must be reanalyzed as the subject of *fell*, and the string *raced past the barn* turns out to be a reduced relative clause.



As can be seen in the structure in (57), the source position (the subject position of *raced*) does not dominate or govern the target position (the subject position of *fell*). This reanalysis is therefore barred by the OLLC; the sentence in (55) is a garden path.

Note the assumption here that the reanalyzed element is the argument. In principle, one could also assume that the reanalysis here removes the original main clause VP, builds a functional layer on top of it and attaches the resulting reduced relative clause to the subject *the horse*. Under that conception, the reanalysis would look like this:



However, Pritchett apparently assumes that reanalysis applies to arguments, not to other parts of the structure. I will make the same assumption throughout this dissertation.<sup>2</sup>

## 2.5 Optionality

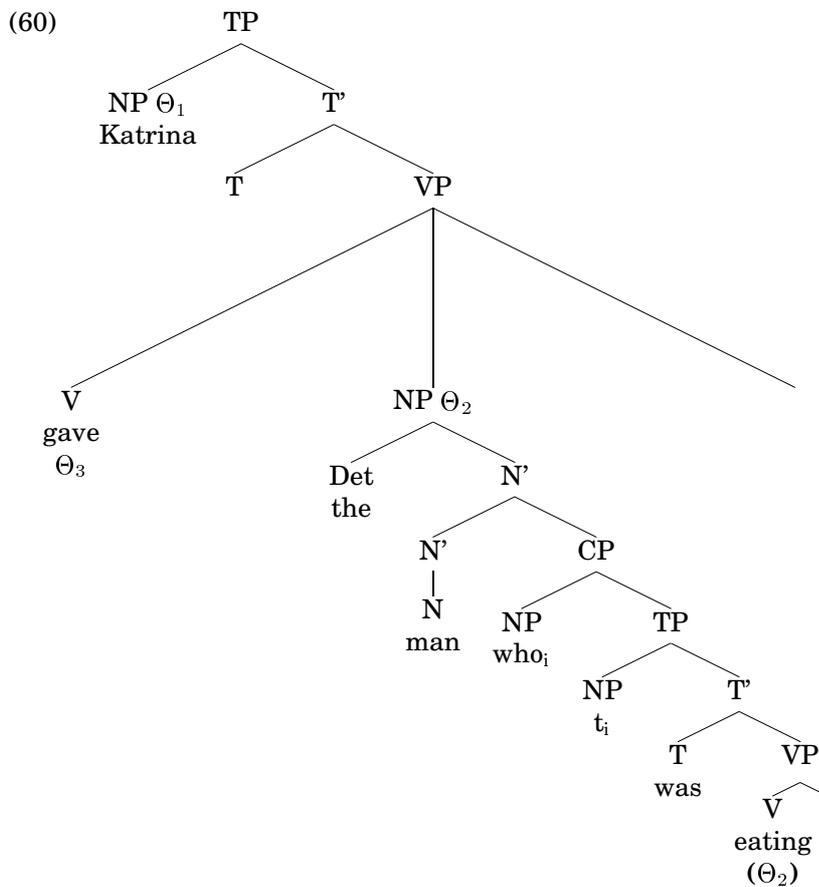
In the previous sections, we saw how Theta Attachment forces a decision between alternative structures for a given string, and we saw that the decision taken on the basis of Theta Attachment cannot always be undone

<sup>2</sup>Constraining reanalysis to arguments only makes life easier because calculating the predictions the theory makes involves fewer alternatives; it also seems a reasonable choice because reanalysis is usually triggered by either a theta-assigner which requires an argument, or by an argument that expels an argument from its original position. In both cases, it does indeed make sense to look at the reanalysis as involving the misattached argument.

without conscious reanalysis. In this section, we will discuss examples where Theta Attachment does not force a decision between two (or more) alternative structures. Consider (59):

- (59) Katrina gave the man who was eating the fudge  
(Pritchett's (301))

Now take a look at the parse of this string up until *eating*:

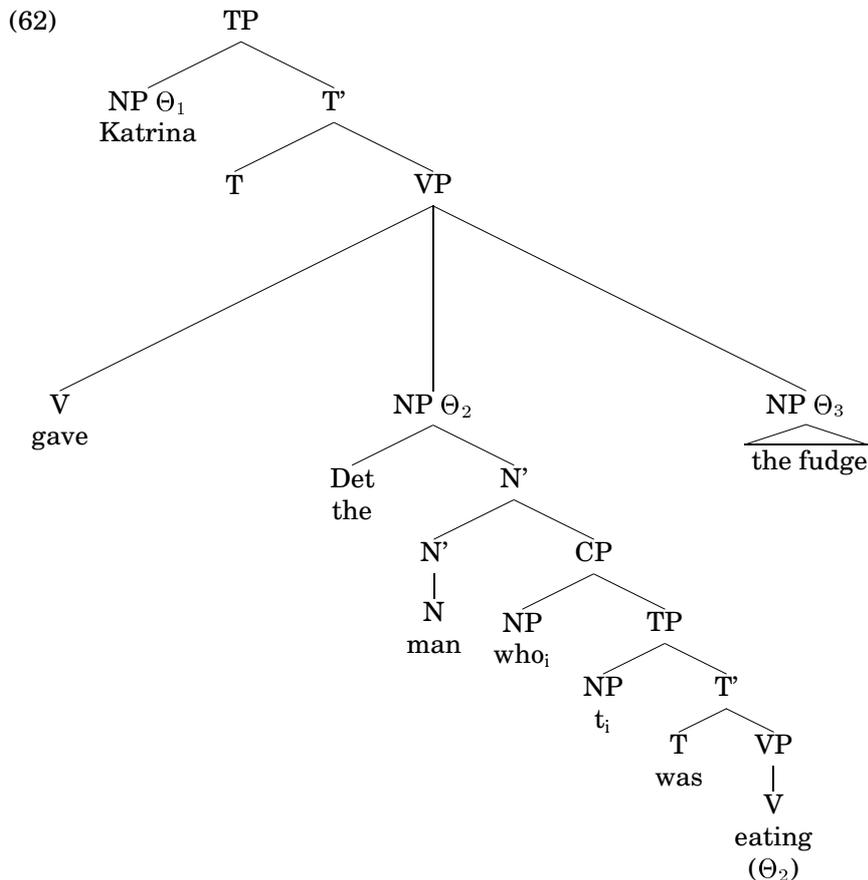


There are two points in the structure above where *the fudge* could be theta-attached: it can either get the (optional) internal theta role of *eating*, or it can be theta-attached as the (obligatory) second internal argument of *gave*. The latter attachment is the correct one, but for Theta Attachment, there is a local choice at the point of *the fudge*; attachment of *the fudge* as the direct object of *eating* is also possible: that option satisfies Theta Attachment equally well (remember that Theta Attachment refers to the **maximal** theta grid). Note that *the fudge* in (59) could also be followed by

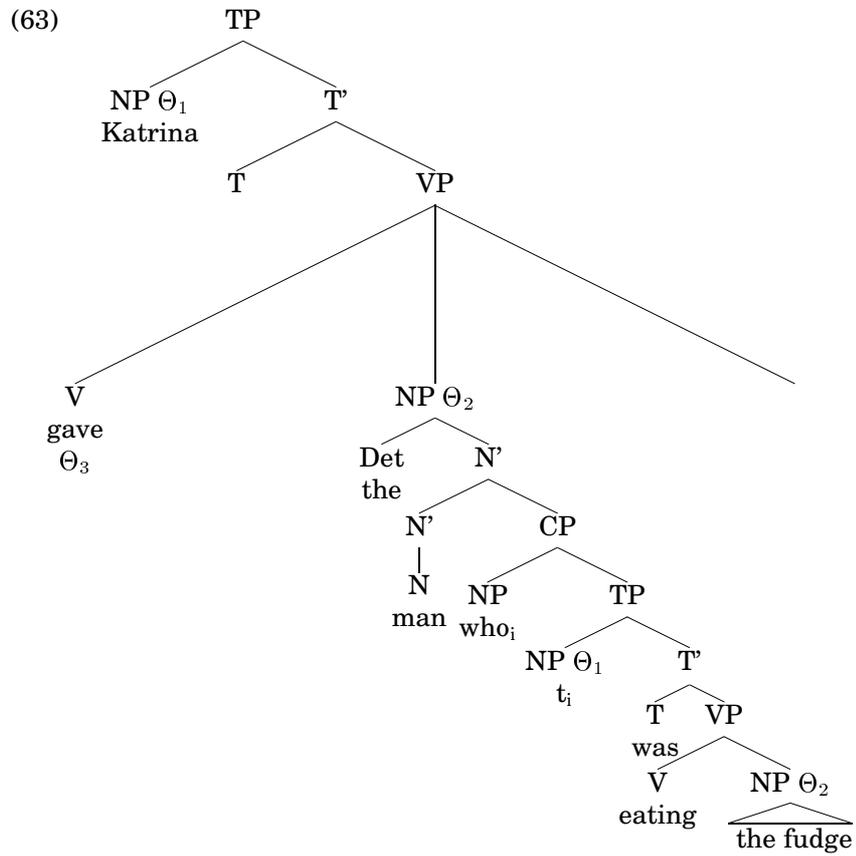
another NP that takes on the obligatory third role of *gave*, so attachment of *the fudge* as the direct object of *eating* is a real option:

- (61) Katrina gave the man who was eating the fudge the wine  
(Pritchett's (302))

Now, what does the Human Sentence Processor do when facing a situation like this? The null hypothesis seems to be that it just randomly chooses one of the two alternatives. In processing (59), it will start with the analysis where *the fudge* is attached to *eating* 50% of the time, and in the other 50% it will start with the analysis where *the fudge* is attached to *gave*. If the parser happens to choose the latter alternative, the parse is successful: (62) is a grammatical structure.

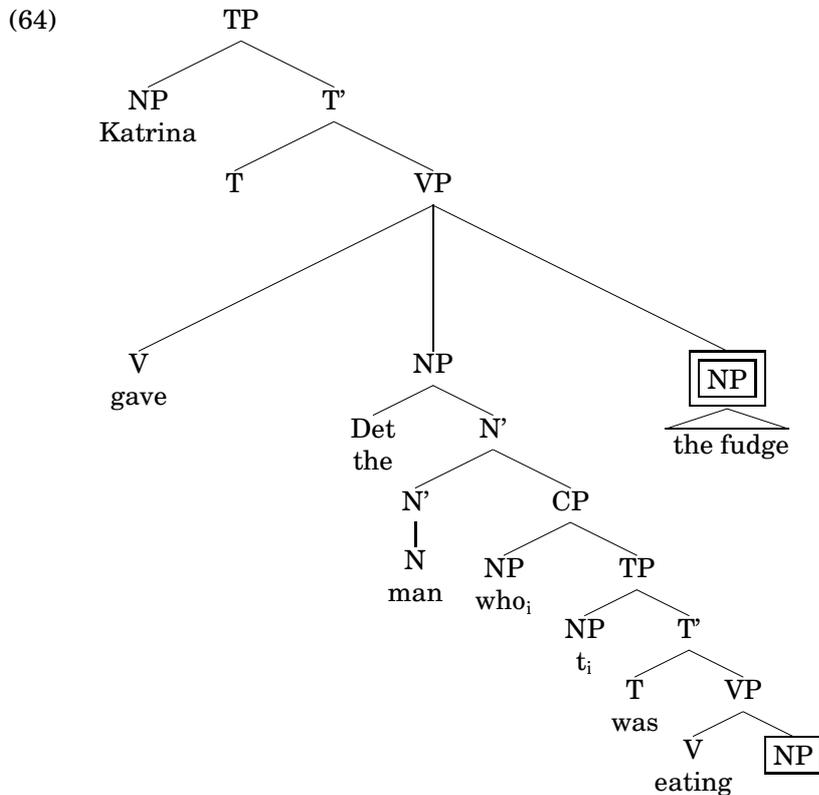


However, there is a problem if the parser takes the option of theta-attaching *the fudge* as the direct object of *eating* in processing (59). The structure that results under that scenario is the following:



In (63), *gave* cannot assigned its obligatory third theta role; therefore, the structure is ungrammatical.

The Human Sentence Processor cannot recover from its mistake, since reanalysis of *the fudge* to the direct object position of *gave* is impossible:



In (64), the source position does not dominate or govern the target position; the necessary reanalysis from the embedded object position to the object position in the main clause is barred by the OLLC.

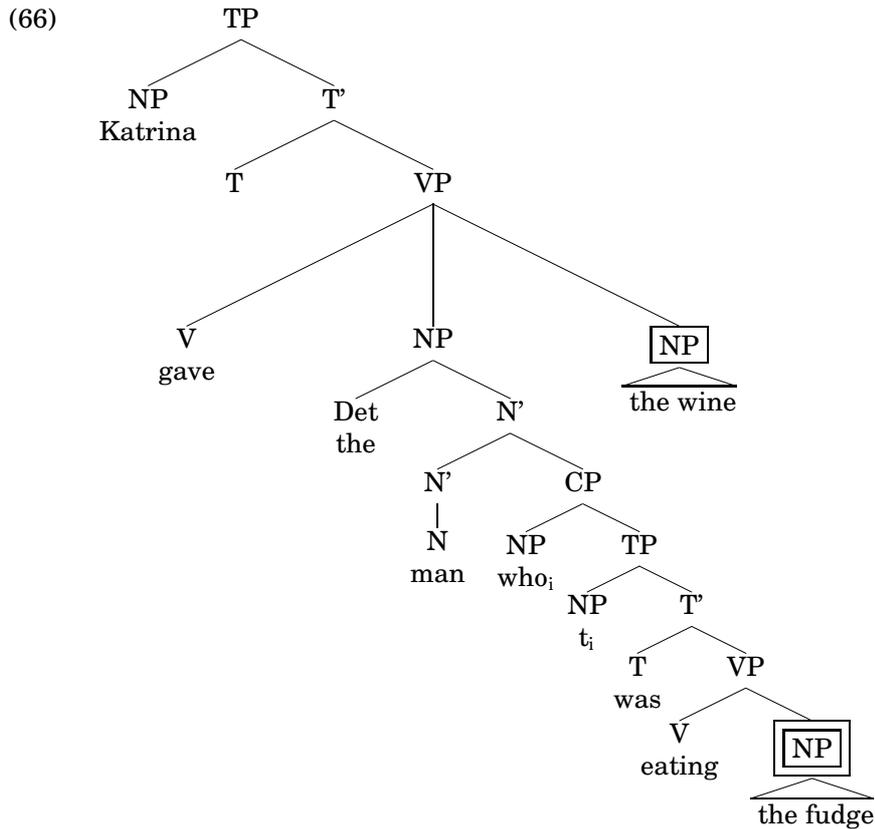
This means that (59) will be a garden path 50% of the times it is processed. If the parser randomly chooses the analysis in (62), the parse succeeds, but if it chooses the analysis in (63), the parse fails. I will use the symbol  $\frac{1}{2}$  to represent the prediction of this effect.

A similar reasoning applies to the example in (61), repeated here as (65):

(65)  $\frac{1}{2}$  Katrina gave the man who was eating the fudge the wine

In this case, if the parser chooses to attach *the fudge* as the direct object of *eating*, the parse can be completed successfully, since *the wine* can receive the obligatory theta role of *gave*. However, if the parser chooses to attach *the fudge* as an argument of *gave*, leaving the internal theta role of *eating* without syntactic realization, the parse fails. The reanalysis that is necessary under that alternative, removing *the fudge* from the complement position of *gave* and reattaching it as the complement of *eating*, obviously

violates the OLLC:



In the structure in (66), the reanalysis is ruled out by the OLLC; the source position does not govern the target position because there are four maximal projections intervening. The source position does not dominate the target position either.

We have seen that Theta Attachment predicts optionality when the amount of theta assigners locally exceeds the amount of potential theta role receivers, if we assume that the parser randomly chooses one of the available attachment sites. Pritchett points out that this prediction seems to be right; it seems to be the case that in processing (59) or (61), some people do get a garden path effect, and some people do not<sup>3</sup>. He also observes that results for similar structures differ within as well as across individuals; so the pattern does indeed seem to be essentially random.

Two important conclusions can be drawn if the random attachment pattern predicted under Theta Attachment turns out to be indeed confirmed

<sup>3</sup>In his footnote 111, Pritchett alludes to a survey conducted at Harvard University which confirms this prediction.

by additional experimental evidence. First, the global obligatoriness of *gave*'s internal theta role, and the optionality of *eating*'s internal theta role in (59) and (61) apparently do not influence the parser's local decision. Second, as pointed out by Pritchett in his footnote 113, the random attachment pattern cannot be accounted for under structural heuristics such as Minimal Attachment or Late Closure.

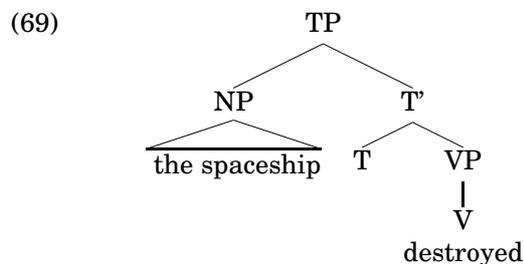
## 2.6 Rebuffering

In the previous sections, we saw how the two main ingredients of Pritchett's model, namely Theta Attachment and the OLLC, work together to account for a range of garden path phenomena. The third and final ingredient in Pritchett's theory is a mechanism of sending back to storage, which is needed to explain why some sentences that are predicted to induce a garden path effect under his theory, are in fact easily processed. Specifically, he notes that reduced relative clauses do not lead to a garden path effect if the verb in the relative clause is obligatorily transitive and is followed by an adjunct, as exemplified by the contrast between the sentences in (67) and (68):

- (67) a.  $\zeta$  The horse raced past the barn fell  
 b.  $\zeta$  (Rex knows) the boy hurried out the door slipped
- (68) a. The spaceship destroyed in the battle disintegrated  
 b. The bird bought in the store flew away  
 c. The children found in the woods were frozen

This appears to be a problem for the OLLC. In both (68) and (67), Theta Attachment predicts an initial analysis as a main clause (but see the discussion in chapter 5.6); and reanalysis to a reduced relative structure should be equally costly in both cases. In order to save the OLLC, Pritchett resorts to a mechanism of rebuffering. The reasoning goes as follows.

Consider for instance (68a). Initially, *the spaceship* is attached as the subject of *destroyed*:



When the parser encounters the PP in the sentences in (68), it becomes clear that this initial parse was not correct. This is because a direct object in English must in general be adjacent to the verb, which is why the sentence in (70) is ungrammatical:

- (70) \*The spaceship destroyed in the battle the planet.  
(Pritchett's (271))

According to Pritchett, the appearance of the PP (and hence the absence of a direct object) leads the parser to infer that the initial analysis in (69) is not correct. Pritchett claims that the discovery of the PP plus the fact that the PP is not a theta-assigner, lead the parser to break up the structure: the elements are put back into the buffer. The buffer then looks like this:

- (71) 

Note that this move, sending material back to the buffer, can never violate the OLLC; this is because if material is sent back to store, there is no target position, and hence the OLLC does not apply.

Now, when the main verb *disintegrated* is encountered, the parser can build the correct structure (with a reduced relative) using the elements in the buffer in (71).

## 2.7 Summary

In this chapter, we made our acquaintance with the main ingredients in Pritchett's processing model. These are:

- (72) **Theta Attachment:** The theta criterion attempts to be satisfied at every point during processing given the maximal theta grid.
- (73) **On-Line Locality Constraint (OLLC):** The target position (if any) assumed by a constituent must be *governed* or *dominated* by its source position (if any), otherwise attachment is impossible for the automatic Human Sentence Processor.

The definitions of government and m-command are repeated below:

- (74) **government:**  $\alpha$  governs  $\beta$  iff  $\alpha$  m-commands  $\beta$  and every  $\gamma$  dominating  $\beta$  dominates  $\alpha$ ,  $\gamma$  a maximal projection.
- (75) **m-command:**  $\alpha$  m-commands  $\beta$  iff  $\alpha$  does not dominate  $\beta$  and every  $\gamma$  that dominates  $\alpha$  dominates  $\beta$ ,  $\gamma$  a maximal projection.

In addition, we saw that a mechanism of sending back to store is also needed. Together, these assumptions account for a wide range of processing effects.



## Chapter 3

# Theta Attachment versus Immediate Attachment

### 3.1 Introduction

In the previous chapter, I introduced Pritchett's model. We saw that his structure-building operation, Theta Attachment, is a head-driven operation; this means that arguments have to be stored until a theta-role-assigner is encountered.

This concept of temporary storage has encountered some resistance in the literature (Frazier (1989), Frazier (1987), Schneider (1999)). It seems to be widely believed that all incoming material has to be integrated immediately into a structure during sentence processing, a concept that I will refer to as *Immediate Attachment*. In this chapter, I will discuss the arguments for Immediate Attachment, and argue that they do not stand up to scrutiny.

To get a first impression of the difference between the two approaches, let us first consider how a simple sentence like (1) is processed under Immediate Attachment and Theta Attachment, respectively.

(1) John saw the child.

In the table below, I give the structure at each position in the input string under Theta Attachment and under Immediate Attachment.

| input | Theta Attachment                                                                                                                                                      | Immediate Attachment                                                                                                      |
|-------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------|
| John  | <p>NP<br/> <br/>John</p>                                                                                                                                              | <p>TP<br/>/ \<br/>NP T'<br/>  / \<br/>John T VP</p>                                                                       |
| saw   | <p>TP<br/>/ \<br/>NP <math>\theta_1</math> T'<br/>  / \<br/>John T VP<br/> <br/>V<br/>saw<br/><math>\theta_2</math></p>                                               | <p>TP<br/>/ \<br/>NP T'<br/>  / \<br/>John T VP<br/> <br/>V NP<br/>saw</p>                                                |
| the   | <p>TP<br/>/ \<br/>NP <math>\theta_1</math> T'<br/>  / \<br/>John T VP<br/> <br/>V<br/>saw<br/><math>\theta_2</math></p> <p>Det<br/> <br/>the</p>                      | <p>TP<br/>/ \<br/>NP T'<br/>  / \<br/>John T VP<br/> <br/>V NP<br/>saw<br/> <br/>Det N'<br/>the</p>                       |
| child | <p>TP<br/>/ \<br/>NP <math>\theta_1</math> T'<br/>  / \<br/>John T VP<br/> <br/>V NP <math>\theta_1</math><br/>saw<br/> <br/>Det N'<br/>the<br/> <br/>N<br/>child</p> | <p>TP<br/>/ \<br/>NP T'<br/>  / \<br/>John T VP<br/> <br/>V NP<br/>saw<br/> <br/>Det N'<br/>the<br/> <br/>N<br/>child</p> |

As can be seen in this table, Theta Attachment and Immediate Attachment process a simple English sentence like (1) slightly differently, the biggest difference being that under Immediate Attachment, a full TP is built as soon as the subject is encountered. However, it is obvious that the two approaches cannot be distinguished empirically on the basis of sen-

tences like (1).

As for the conceptual criterion I formulated in chapter 1, the transparency of the parser, the two approaches seem equally transparent; they just build on different conceptions of the grammar. The Immediate Attachment approach is transparent with respect to a top-down conception of grammatical structure building (by means of rewrite rules, for instance), while Theta Attachment is compatible with a lexicalist way of structure-building such as Merge as used in the Minimalist Program.

However, Theta Attachment and Immediate Attachment do make different empirical predictions for head-final languages. In this chapter, I will discuss the empirical arguments for Immediate Attachment given by Frazier (1987), Frazier (1989), and Schneider (1999).

In sections 3.2 through 3.4, we will see that many of these counterarguments against head-driven processing involve verb-final sentences. Typically, these arguments point out some (mild) processing difficulty with a particular verb-final structure; it is then hypothesized that this processing difficulty shows that there is some form of structure-building in verb-final sentences before the verb has been encountered, and that the observed processing difficulty is due to reanalysis of this initial structure. I will argue that this is not the only way to look at these effects; it is clear that structure building per se is more complex in some cases than in others, and this provides an equally plausible explanation for the observed effects.

In section 3.6, we will see that the processing of relative clauses in Dutch provides an argument against Immediate Attachment; we will also see that the idea that processing complexity can arise from complexity of integrating material rather than from reanalysis is independently supported by relative clause processing data.

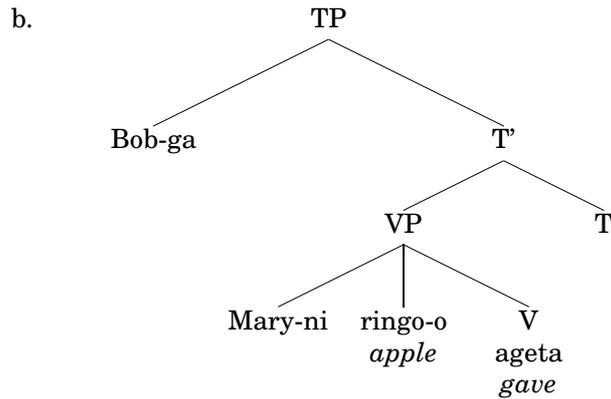
## 3.2 Structural simplicity

As noted above, most arguments against head-driven processing involve data that are meant to show that in processing verb-final structures, there is structure-building before the verb has been encountered. A very straightforward example of this type of argument is given by Schneider (1999), citing Inoue and Fodor (1995). The argument involves sequences of three NPs in Japanese, a strictly head-final language.

- (2) Bob-ga Mary-ni ringo-o ...  
 Bob-NOM Mary-DAT apple-ACC ...  
 (Schneider's (96))

Inoue and Fodor argue that the three NPs in (2) are preferably understood as arguments to one verb, as in the continuation in (3):

- (3) a. Bob-ga Mary-ni ringo-o ageta.  
 Bob-NOM Mary-DAT apple-ACC gave  
 'Bob gave Mary the apple'  
 (Schneider's (97))

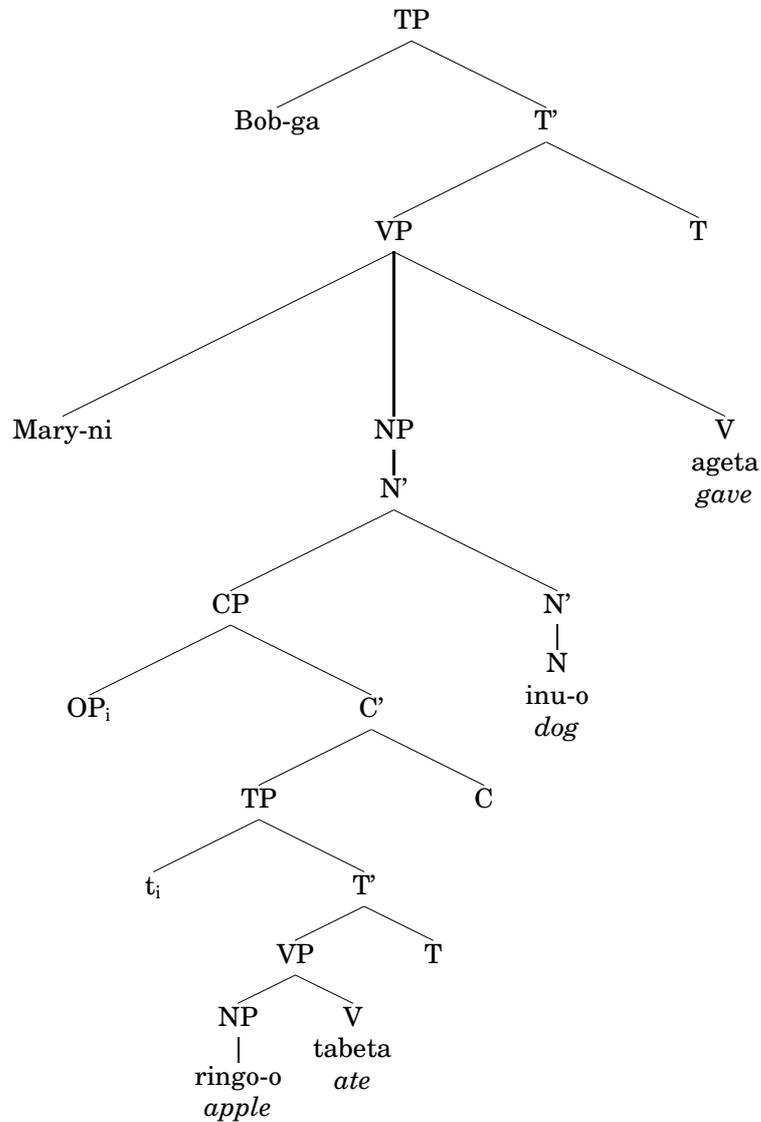


However, the sequence in (2) can also be continued in the following way:

- (4) Bob-ga Mary-ni [ ringo-o tabeta ] inu-o ageta.  
 Bob-NOM Mary-DAT apple-ACC ate dog-ACC gave  
 'Bob gave Mary the dog that ate the apple'  
 (Schneider's (98))

This continuation involves a relative clause. Its structure is given below:

(5)



When Japanese speakers are presented with (4) 'they often report some sense of surprise, slight but detectable, at the verb *tabeta*' (Inoue and Fodor (1995), p.15). Inoue and Fodor take this as evidence that a sequence of NPs is analyzed as arguments to a single verb before the verb has been encountered.

As Schneider notes, there are many other possible explanations for the surprise effect noted by Inoue and Fodor. Under Theta Attachment, no structure can be built before a theta-assigner has been encountered. In

(3b), structure-building is pretty straightforward and involves all available arguments; but in (4), when the first verb is encountered, only one of the available arguments can be attached. The fact that the other two NPs have to remain unattached, may also explain the differences here. Note that if this explanation is on the right track, it means that there is some kind of expectation in the reader that the verb will incorporate all the arguments available in the buffer; this is not the same as saying that actual structure must be built before the verb has been encountered, but the difference seems very subtle indeed.

In a similar vein to Inoue and Fodor's, Frazier (1987) argues that sequences of three NPs in Dutch embedded clauses, which are also verb-final, are preferably interpreted as arguments of a single verb.

- (6) De leraar heeft het kind het katje...  
 the teacher has the child the kitten
- a. laten-zien  
 shown  
 'The teacher showed the child the kitten'
- b. zien helpen  
 see help  
 'The teacher saw the child help the kitten'

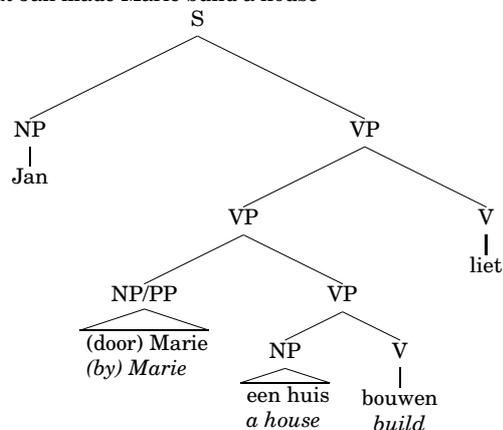
Frazier reports that speakers of Dutch prefer the continuation in (6a) over the continuation in (6b). If we consider the structures that have to be built, this is hardly surprising; the continuation in (6a) leads to a much simpler

structure<sup>1</sup> than the continuation in (6b)<sup>2</sup>.

<sup>1</sup>Frazier labels *laten zien* a lexical verb. Although *laten* behaves as an independent verb syntactically (for instance, it can undergo verb second), there are indeed reasons to assume that *laten zien* is a lexical verb.

Coopmans (1985) argues that causative constructions in Dutch have a structure where the causative verb *laten* takes a VP-complement:

- (i) a. ... dat Jan (door) Marie een huis liet bouwen  
       that Jan by Marie a house made build  
       ‘.. that Jan made Marie build a house’  
    b.



Coopmans notes that a subset of these VP-complements (namely the ones where the embedded verb is a perception verb, or *weten* ‘know’, *lezen* ‘read’ or *merken* ‘notice’), behave differently from the regular causative construction depicted above. For instance, causative constructions with any of this small set of verbs as their complement, allow for the causee to be expressed with the preposition *aan*:

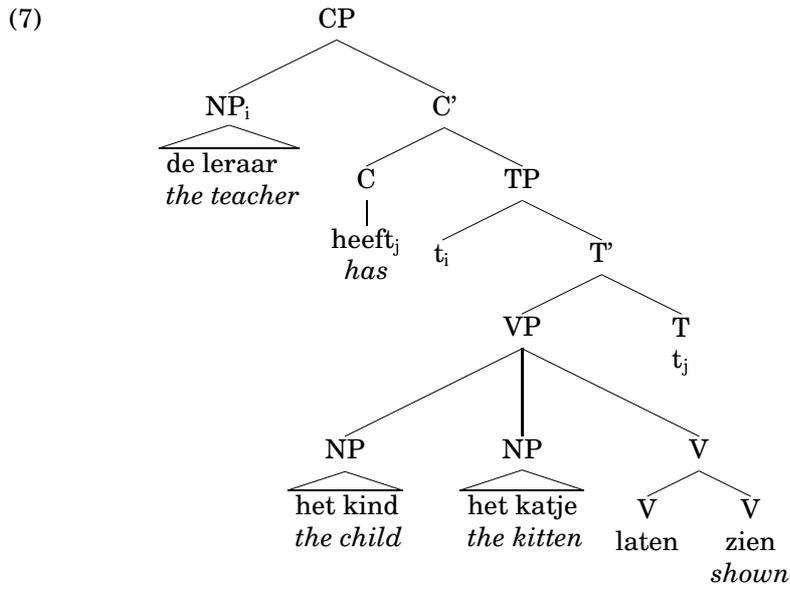
- (ii) a. ... dat de leraar aan het kind het katje heeft laten zien  
       that the teacher to the child the kitten has shown  
       ‘... that the teacher showed the child the kitten’  
    b. \*... dat de leraar aan het kind het katje heeft laten helpen  
       that the teacher to the child the kitten has made help

Furthermore, it seems to me that the behavior of the ‘laten-zien’-construction with respect to binding shows that the three arguments in this case really are clause-mates, which they are not in the regular causative construction:

- (iii) a. ... dat de leraar<sub>i</sub> het kind<sub>j</sub> zichzelf<sub>i/j</sub> heeft laten zien  
       that the teacher the child himself has shown  
       ‘... that the teacher showed the child himself’  
    b. ... dat de leraar<sub>i</sub> het kind<sub>j</sub> zichzelf<sub>\*i/j</sub> heeft laten helpen  
       that the teacher the child himself has made help  
       ‘... that the teacher made the child help himself’

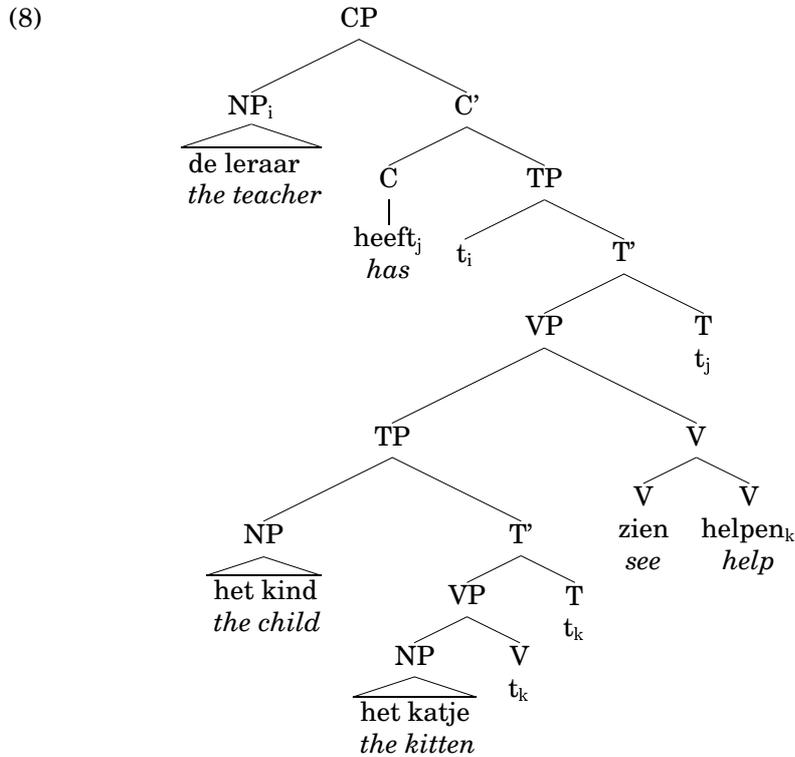
<sup>2</sup>I’m assuming that the complement of matrix verb *zien* ‘see’ is a TP, mainly because the subject is obligatorily realized with the verbal complement of perception verbs; in this respect, perception verbs behave differently from the causative verb *laten* discussed in the previous footnote:

The structure of the continuation in (6a) is given below:



Compare this to the structure of (7b):

- 
- (i) a. \*... dat Jan het huis zag bouwen  
that Jan the house saw build  
b. ... dat Jan het huis liet bouwen  
that Jan the house made build



But can we conclude on the basis of evidence like this, that structure has to be built before the verb is encountered in verb-final structures, as Frazier argues?

The logic of such arguments for Immediate Attachment is the following. For a given string, two possible continuations X and Y are identified (which contain the verb). It is noted that continuation X is easier than continuation Y. The claim then is that the complexity of Y arises as follows. The analysis of the initial string is the same for both X and Y, and is already built before the verb has been encountered. This initial analysis happens to be the right analysis for the continuation in X, but it does not turn out right for continuation Y; therefore, reanalysis has to apply to build the correct structure for continuation Y; and hence the complexity of Y.

However, reanalysis is not the only way to explain the difference in complexity between X and Y. It may very well be that the structure for continuation X is just easier to build (because it is simpler in some sense) than the structure for continuation Y.

To make this more concrete, take a look again at the contrast between (8) and (7). Frazier says that the reason that (8) is more difficult to process than (7), is that in processing (8), the parser initially assigns the structure

in (7) to the first part of the string, and this analysis has to be revised later. However, there is a simpler and equally plausible way to account for the difference in parsing complexity between (8) and (7) under the hypothesis that the arguments are stored and not Immediately Attached: the integration of the stored material is a more complex process in (8) than it is in (7), simply because the structure that has to be built in (8) is more complex (for instance, (8) contains two clauses, and (7) only one).

It is important to note that none of the ‘more difficult’ continuations presented above lead to a garden path effect. In fact, Schneider makes a point of showing that if any structure is being built before the verb is found, it has to be ‘flexible’, precisely because sequences like (2) can be continued in so many ways, which are all processed without problems. As an example, consider the following German sentences, all involving the same initial sequence of three NPs:

- (9) NP<sub>NOM</sub> NP<sub>ACC</sub> NP<sub>DAT</sub> V<sub>DITRANS</sub>

... dass er        den Hund    dem Kind     gab  
 ... that he<sub>NOM</sub> the dog<sub>ACC</sub> the child<sub>DAT</sub> gave

‘...that he gave the dog to the child’  
 (Schneider’s (103))

- (10) NP<sub>NOM</sub> [NP<sub>ACC</sub> NP<sub>DAT</sub> V<sub>DAT</sub>] V<sub>TRANS</sub>

... dass er        den Hund    dem Kind     entfliehen sah  
 ... that he<sub>NOM</sub> the dog<sub>ACC</sub> the child<sub>DAT</sub> flee        saw

‘...that he saw the dog flee from the child’  
 (Schneider’s (104))

- (11) NP<sub>NOM</sub> [NP<sub>ACC</sub> NP<sub>DAT</sub> V<sub>DITRANS</sub>] V<sub>TRANS</sub>

... dass er        den Hund    dem Kind     gekauft zu haben bereut  
 ... that he<sub>NOM</sub> the dog<sub>ACC</sub> the child<sub>DAT</sub> bought to have regrets

‘...that he regrets having bought the dog for the child’  
 (Schneider’s (105))

- (12) NP<sub>NOM</sub> NP<sub>ACC</sub> [NP<sub>DAT</sub> P] V<sub>TRANS</sub>

... dass er        den Hund    dem Kind     zuliebe gekauft hat  
 ... that he<sub>NOM</sub> the dog<sub>ACC</sub> the child<sub>DAT</sub> to-love bought has

‘...that he bought the dog to please the child’  
 (Schneider’s (106))

Schneider’s system starts building a main clause structure in all cases, before the verb has been encountered. Since the grammatical framework

his parser is based on is the Minimalist Program, he has to come up with a parser-specific mechanism that allows him to build structure before the verb has been encountered. The mechanism he uses is a search on the lexicon which yields the intersection of all verbs; the resulting, almost featureless, verb, can then be used to build ‘flexible’ structure, i.e. structure that can be altered later in the derivation without processing cost.

It seems to me that an operation like this is only warranted (i.e. preferable to not building structure preverbally at all) if the arguments for Immediate Attachment are convincing enough, which as yet does not seem to be the case: we did not find any true garden path effects in the verb-final structures discussed so far, just differences in complexity which are consistent too with Pritchett’s model. So on the basis of these arguments we cannot decide between head-driven processing and Immediate Attachment. In the next section, I will discuss another type of argument that Schneider puts forward in favor of Immediate Attachment.

### 3.3 Binding

Schneider argues that the following German sentences provide evidence for Immediate Attachment:

- (13) Die Frau glaubt, dass der Junge wegen seiner schlechten  
 the woman thinks that the boy because of his bad  
 Noten sich selbst... erschossen hat.  
 grades him/her self shot has  
 ‘The woman thinks that the boy shot himself because of his bad  
 grades.’ (Schneider’s (99))
- (14) Der Mann glaubt, dass der Kollege wegen  
 the man thinks that the colleague<sub>MASC</sub> because of  
 Geisteskrankheit ihn... erschossen hat.  
 mental illness him shot has  
 ‘The man<sub>i</sub> thinks that the colleague<sub>j</sub> shot him<sub>i</sub> because he was men-  
 tally ill.’ (Schneider’s (100))

His reasoning goes as follows. Native speakers of German report that they know immediately, before the embedded verb has been encountered, which NP is the proper antecedent for *sich selbst* in (13), and for *ihn* in (14). These words themselves don’t give any clues for determining the antecedent. So, Schneider argues, on the reasonable assumption that binding theory requires syntactic structure to operate, these sentences provide evidence for structure-building before the verb has been found.

This seems reasonable. However, note that it is possible to continue the preverbal string in (13) in such a way, that *der Junge* ‘the boy’ actually is

not the antecedent for *sich selbst* ‘him/herself’. Consider (15)<sup>3</sup>:

- (15) a. Die Frau glaubt, dass der Junge sich selbst<sub>i</sub> die  
 the woman thinks that the boy him/her self the  
 Katherina<sub>i</sub> nicht erschiessen laesst  
 Katherina not shoot lets  
 ‘The woman thinks that the boy won’t let Katherina shoot her-  
 self’
- b. Die Frau glaubt, dass sich selbst<sub>i</sub> der Junge die  
 the woman thinks that him/her self the boy the  
 Katherina<sub>i</sub> nicht erschiessen laesst  
 Katherina not shoot lets  
 ‘The woman thinks that the boy won’t let Katherina shoot her-  
 self’

The sentences in (15) involve a permissive embedded clause, with the anaphor in a scrambled position, which is allowed in German. The point is that in these cases, the anaphor does *not* refer to *der Junge* ‘the boy’, but to the subject of the most deeply embedded verb, *die Katherina*. Both sentences are perfectly grammatical (although (15b) seems to be somewhat more natural).

Under Schneider’s theory, we would expect the interpretation of the anaphor to be determined at the point of discovery of *sich selbst* in (15a), and at *der Junge* in (15b). It is of course possible for Schneider to say that this initial interpretation is reanalyzed when the remainder of the sentence is encountered. The point is that the sentences in (15) show that it is not actually true that German speakers ‘know’ the interpretation of the anaphor before they encounter the verb; the antecedent of the anaphor can also be located further in the sentence.

My suspicion is that the effect that Schneider reports, arises from the task his informants were asked to perform. It seems to me that what actually happens when German speakers are presented with a sentence like (13) with the embedded verb chopped off, they will mentally fill in a verb which allows them to finish the sentence as simply as possible (i.e. a single verb that takes *der Junge* and *sich selbst* as its arguments), and then say that they know which antecedent the anaphor refers to; it seems to me that this computation is made on the basis of the structure, including the verb they hypothesize, and that this is not an argument that structure is being built before the verb in ‘regular’ sentence processing.

<sup>3</sup>I thank Patrick Brandt (p.c.) for providing these examples.

### 3.4 PP-attachment ambiguities in Dutch embedded clauses

In this section, we will look at PPs in Dutch that occur right after an NP, and right before the verb:

(16) NP PP V

These PPs are locally ambiguous between being arguments of the verb, and modifiers of the preceding NP:

(17) a. NP [ PP V ]  
b. [ NP PP ] V

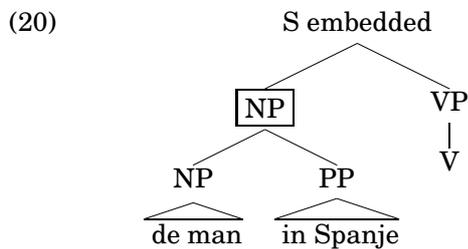
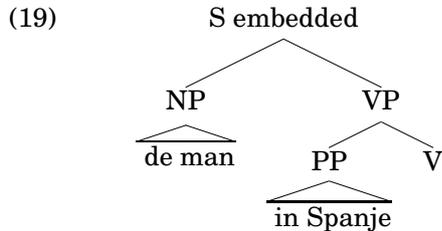
This temporary ambiguity is relevant to the present discussion, because Frazier (1987) brings it up as an argument against head-driven processing. In this section, I will explain her argumentation, and explain how Theta Attachment works for the data in question, compared to Frazier's Minimal Attachment. As we will see, no conclusive argument for either Immediate Attachment or Theta Attachment can be drawn from these data.

Frazier (1987) included the following sentences as fillers in an experiment on attachment preferences of *en NP ook* 'and NP, too' phrases in Dutch.

(18) a. Ik weet dat de man in Spanje in Holland investeert  
I know that the man in Spain in Holland invests  
'I know that the man in Spain invests in Holland' or 'I know that the man invests in Holland (while being) in Spain'  
b. Ik weet dat de man in Holland investeert  
I know that the man in Holland invests  
'I know that the man invests in Holland'

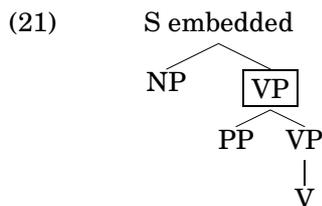
Frazier found that the reading time on *in Holland investeert* was greater in (18a) than in (18b) (1796msec. vs. 1679 msec. for the total frames; the difficulty with (18a) is also detectable through introspection). She interprets this as a reflex of reanalysis, and argues that this shows that *in Holland* is attached before the verb has been encountered, as a result of the mechanism of Minimal Attachment. Let us see how this works.

In Frazier's system, attachment is immediate; material is attached in accord with rewrite rules found in the grammar. Minimal Attachment is a parser-specific principle that forces a choice between potential attachments (rewrite rules) in the absence of other information; it prefers attachments that introduce fewer nodes over attachments that introduce more nodes. For instance, it prefers attachment of the PP *in Spanje* in (18a) as an argument in the VP (depicted in (19)) to attachment as an adjunct of *de man* (depicted in (20)).



The structure in (20) contains one node more than the structure in (19) (the boxed NP-node); therefore, the structure in (19) is the one that is built according to Minimal Attachment. Frazier argues that this structure must be revised when the second PP and the verb are encountered in (18a); the second PP has to be the argument of *investeert*, and this forces reanalysis of the first PP as an adjunct of *de man*.

Note that there are actually three possible analyses for the string in (18a); next to the structures in (20) and (19), an analysis according to which *in Spanje* is attached as a VP-adjunct is also possible. The resulting structure is the following:



This attachment of the PP as an adjunct to VP also introduces an extra node (the boxed VP-node in (21)); therefore, this analysis is barred as a first parse by Minimal Attachment, just like (20).

Now, if Frazier's analysis of the slow-down in (18a) is on the right track, it poses a problem for head-driven approaches to processing. The crucial point in the analysis is the attachment of *in Spanje* to the VP before the verb has been encountered; that implies that it must be possible to build a VP before the verbal head is present, which in turn implies that the parser cannot be head-driven; a head-driven parser cannot build a VP before it

encounters a verb. Under Theta Attachment for instance, both the subject and the two PPs remain stored in the buffer until the verb has been encountered. Only after the verb becomes available, does the stored material get attached; the second PP and the subject via Theta Attachment, the first PP via adjunction to the VP or NP.

In order to evaluate the validity of Frazier's argument against head-driven processing, let us first try to establish whether the oddness of (18a) relative to (18b) is really due to a general problem associated with adjunction, as predicted by Minimal Attachment. To determine this, we have to compare sentences where a PP functions as a complement to sentences where the same PP functions as an adjunct. It is important to note the strength of the prediction entailed by Minimal Attachment. The prediction is that a preverbal PP will *always* be initially attached as an argument of the expected verb, and that in every instance where this initial attachment turns out to be wrong, a processing difficulty occurs due to reanalysis of the PP.

In the absence of experimental evidence, we will have to rely on intuitions in order to find out if that prediction is correct. Relying on intuitions should be OK, since the oddness of (18a) is also intuitively detectable.

What types of continuations following a PP would provide the parser with evidence that attaching the PP as a VP-internal argument was the wrong choice? We are looking for VPs that do not allow for a prepositional object. We have at least the following three possibilities:

- (22) SUBJECT PP ...
- a. PP + verb that selects for a prepositional object
  - b. NP + transitive verb
  - c. intransitive verb

Type (22a) is the structure that Frazier tested. Let us first see if the effect she found is generally found with this type of structure. Consider the sentences in (23):

- (23) a. ... dat de man uit Spanje op een brief wachtte  
           that the man from Spain for a letter waited  
           'that the man from Spain waited for a letter'
- b. ... dat de brief uit Amerika in de brievenbus lag  
           that the letter from America in the mailbox laid  
           'that the letter from America sat in the mailbox'

These sentences do not have the oddness associated with (18a); they are perfectly natural Dutch sentences. Let us now see if we find the oddness effect in structures of the type (22b).

- (24) a. ... dat de man uit Spanje z'n moeder opbelt  
 ... that the man from Spain his mother phones  
 'that the man from Spain phones his mother'  
 b. ... dat de man van mijn karatelerares jonge meisjes  
 ... that the man of my karate teacher young girls  
 begeert  
 fancies  
 'that my karate teacher's husband fancies young girls'

Again, these sentences are not as strange as (18a). The same goes for continuations of type (22c):

- (25) a. ... dat de jongen uit Spanje verdrongen is  
 ... that the boy from Spain drowned has  
 'that the boy from Spain drowned'  
 b. ... dat de brief aan Jan verdwenen is  
 ... that the letter to Jan disappeared has  
 'that the letter to Jan has disappeared'

The absence of surprise effects in (23), (24), and (25) shows that the oddness of (18a) is exceptional, and that Frazier's interpretation therefore may be an overgeneralization; we find no evidence for a general problem with attaching a preverbal PP as an adjunct to the subject in Dutch.

In the examples in (23), (24), and (25), I used PPs that are rather easily interpreted as NP-adjuncts. If we use PPs that are preferably interpreted as VP-adjuncts (which should also involve reanalysis under Minimal Attachment), we find no conscious processing problems either:

- (26) a. dat de kat in de keuken achter een muis aanrent  
 that the cat in the kitchen after a mouse chases  
 'that the cat is chasing a mouse in the kitchen'  
 b. dat de kinderen op de speelplaats met een bal spelen  
 that the children on the playground with a ball play  
 'that the children are playing with a ball in the playground'
- (27) a. dat de jongen onder de dekens een boek las  
 that the boy under the blankets a book read  
 'that the boy was reading a book under the blankets'  
 b. dat de jongen in de tuin de bomen snoeide  
 that the boy in the garden the trees pruned  
 'that the boy was pruning the trees (while he was) in the garden'
- (28) a. dat de buurvrouw in de tuin rookt  
 that the neighbor in the garden smokes  
 'that the neighbor smokes in the garden'

- b. dat de vrouw in de wachtkamer flauwviel  
 that the woman in the waiting room fainted  
 ‘that the woman fainted in the waiting room’

It seems safe to conclude that Minimal Attachment does not provide us with the right explanation for the oddness of (18a): we do not find any oddness whatsoever associated with preverbal PP-adjuncts in general.

That leaves us with the question what it is that causes the oddness in (18a).<sup>4</sup> It seems to me that the oddness in (18a) arises from a problem with the interpretation, rather than an initial misattachment of the first PP.

Let us consider how a head-driven parser would process (18a), repeated here as (29):

- (29) ?Ik weet dat de man in Spanje in Holland investeert  
 I know that the man in Spain in Holland invests  
 ‘I know that the man invests in Holland in Spain’

At the point where it encounters the verb, it has one NP in store (*de man*), and two PPs (*in Spanje* and *in Holland*). The parser has to decide how to attach this material to the verb. The NP can be straightforwardly attached as the subject, and the second PP *in Holland* as a prepositional argument of *investeert*. But there is an option for the first PP *in Spanje*: it can be attached as an adjunct of either *de man* or the VP.

As we have seen in the examples in (26) through (28) above, locative PPs are preferably interpreted as VP-adjuncts rather than NP-adjuncts, so the VP is the preferred adjunction site for *in Spanje*. We then get the following interpretation:

- (30) ?Ik weet dat de man in Spanje in Holland investeert  
 I know that the man in Spain in Holland invests  
 ‘I know that the man invests in Holland in Spain’

This interpretation is strange. The feeling with respect to (30) is that there is something going on in two places at the same time. It is not entirely clear why we get this interpretation, since *in Holland* is an argument in (30); it does not refer to a location.

<sup>4</sup>To support the same argument, Frazier (1987) also provides the next example:

- (i) a. ... dat het meisje van Holland houdt  
 ... that the girl of Holland keeps  
 ‘... that the girl loves Holland’  
 b. ? ... dat het meisje van Holland glimlachte  
 ... that the girl of Holland smiled

She didn’t test these sentences empirically, but it is intuitively clear that (ib) is much harder to read than (ia). This is not due to structural processing preferences, however; (ib) is ill-formed, because the preposition *van* cannot be used with the intended meaning *from*.

Note that if we replace the investee *in Holland* with a PP like *in hotels*, the oddness disappears completely:

- (31) ... dat de man in Spanje in hotels investeert  
 ... that the man in Spain in hotels invests  
 'that the man invests in hotels in Spain'

Note furthermore, that if we replace *in Spanje* with a non-locative PP, the oddness disappears again:

- (32) Ik weet dat de man vanuit Spanje in Holland investeert  
 I know that the man from Spain in Holland invests  
 'I know that the man invests in Holland; he is in Spain while arranging his investments'

To sum up the discussion so far: we have seen that there is something suspicious about the evidence that Frazier uses to argue that post-subject PPs in Dutch are generally attached as VP-arguments by Minimal Attachment before the verb has been encountered: input consisting of VPs that would disprove this hypothesized initial attachment, do not generally lead to surprise effects. Left with the question what is going on in the cases where such a surprise effect does occur, such as sentence (18a), we noted that attachment of *in Spanje* as an adjunct of the VP *in Holland investeert* leads to semantic oddness. It is not exactly clear what the source of this oddness is, but we hypothesized that this semantic effect explains the longer reading times found in (18a) as compared to (18b).

Of course we cannot know for sure from introspection whether the longer reading time for (18a) really is related to the semantic oddness associated with it. In fact, Pritchett provides an other explanation for the longer reading times for (18a). In an article arguing for head-driven processing, partly in response to Frazier's arguments against head-driven processing, Pritchett (1991) hypothesizes that the difficulty in (18a) is caused by the mere fact that attachment of the first PP in (18a) involves adjunction. According to Pritchett, the longer reading time in (18a) arises because adjunction does not involve thematic relations, it takes more time to perform it.

Note that if a general problem associated with adjunction indeed explains the longer reading times found for (18a), Minimal Attachment and Pritchett's theory cannot be empirically distinguished on the basis of the contrast between (18a) and (18b) or similar facts; both Minimal Attachment and Pritchett's alternative explanation predict a general preference for argument-attachment over adjunction. Note that this means that both Frazier and Pritchett expect to find a contrast in reading times between pairs like the following:

- (33) a. ... dat de buurvrouw op de bank van haar ouders  
 ... that the neighbor on the couch of her parents  
 flauwviel  
 fainted  
 ... ‘that the neighbor fainted on her parents’ couch’
- b. ... dat de buurvrouw op de bank van haar ouders  
 ... that the neighbor on the couch of her parents  
 aasde  
 eager was  
 ‘that the neighbor was eager to have her parents’ couch’

According to Pritchett and Frazier, (33a) should be more difficult to process than (33b), since *op de bank van haar ouders* ‘on her parents’ couch’ is an adjunct in (33a), but not in (33b). Intuitively, both sentences are equally easily processed; but we can’t know for sure if there really is no difference just on the basis of intuitions: it may be that there is some general difference between adjunction and theta-attachment that is reflected in reading times but just isn’t noticed consciously. Crucially, this difficulty does not have to arise from reanalysis; it could also arise from the adjunction process itself.

This means that ambiguities like the ones discussed so far do not help us to decide between Immediate Attachment and head-driven processing. Let us see what other arguments involving PP-attachment ambiguities have been given in the literature regarding this issue.

In a footnote, Pritchett (1991) brings up the case of locally ambiguous German sentences such as the following:

- (34) a. ... dass der Nachbar mit dem grossen Hund verzweifelt  
 that the neighbor with the big dog desperately  
 gerungen hat  
 fought has  
 ‘that the neighbor desperately fought with the big dog’
- b. ... dass der Entdecker von Amerika erst in 18. Jahrhundert  
 that the discoverer of America first in 18th century  
 erfahren hat  
 learned-of has  
 ‘that the discoverer learned of America originally in the 18th century’  
 (Pritchett’s (1) and (2) in footnote 10, examples from Crocker (1990) )

The ambiguous PP yields a garden path effect in (34b), but not in (34a). As Pritchett notes, this contrast is easily accounted for under Theta Attachment: *mit dem grossen Hund* in (34a) is left unattached until the verb is

encountered, since there is no other theta assigner available for it. The garden path in (34b) arises because *von Amerika* is attached to *Entdecker*, since *Entdecker* can assign a theta-role to it; upon discovery of the verb, this proves to be a mistake. The OLLC does not allow the required reanalysis, hence the garden path effect.

The same effect can be found in Dutch. Consider (35) and (36):

- (35) ¿... dat de uitvinder van de gloeilamp heeft gehoord  
 ... that the inventor of the light bulb has heard  
 (example from Koornwinder, Mulders and Schuytplot (1996))
- (36) ¿Dat betekent dat de huidige generatie onvervangbare  
 that means that the current generation irreplaceable  
 natuurgebieden zoals de Waddenzee ongeschonden aan volgende  
 wildlife areas like the Waddenzee intact to next  
 generaties moet overdragen.  
 generations must transfer  
 Constructed (garden path) meaning: \*‘That means that the current  
 generation (of) irreplaceable wildlife areas must transfer to next  
 generations’  
 Intended meaning: ‘That means that the current generation must  
 transfer irreplaceable wildlife areas to next generations’  
 (Press release Jonge Democraten)<sup>5</sup>

(35) shows the same problem as (34b). The problem with (36) is that upon initial analysis, the NP *onvervangbare natuurgebieden* ‘irreplaceable wildlife areas’ is analyzed as belonging to the subject *de huidige generatie* ‘the current generation’. This attachment is not licensed by Theta Attachment, but it is by Generalized Theta Attachment:

- (37) **Generalized Theta Attachment:** Every principle of the Syntax attempts to be maximally satisfied at every point during processing.  
 (Pritchett (1992), p.138)

*Generatie* ‘generation’ in (36) can assign partitive case to *onvervangbare natuurgebieden* ‘irreplaceable wildlife areas’. Therefore, *de huidige generatie onvervangbare natuurgebieden* ‘the current generation of irreplaceable wildlife areas’ is constructed as one NP, which has to be reanalyzed as soon as the obligatorily transitive verb *overdragen* ‘transfer’ is encountered.

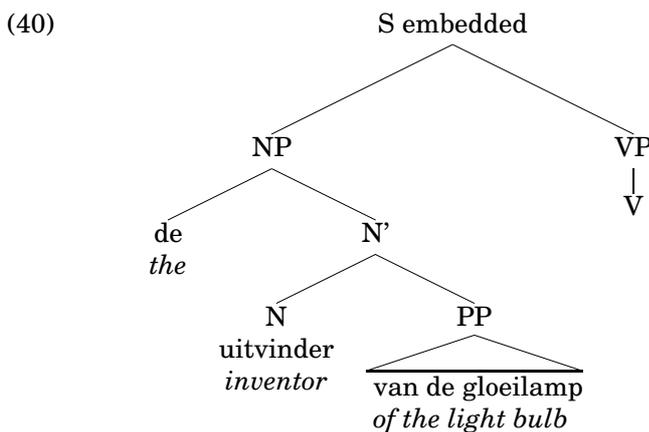
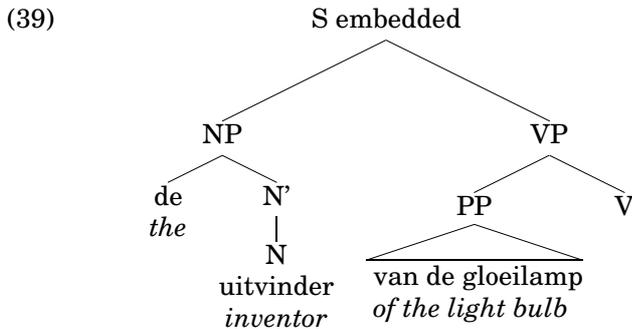
The garden path effects in sentences (34b), (35) and (36) all support the same point: preverbal objects and PPs are not generally attached to the VP as arguments before the verb has been encountered. In that sense, they constitute counterexamples to Minimal Attachment, since Minimal Attachment predicts that preverbal PPs do have to be attached to the VP

<sup>5</sup>I thank Oele Koornwinder (p.c.) for providing this example.

as arguments. However, the picture is probably slightly more complicated than this. To see that, let us take a look at (35), repeated here as (38).

- (38) ¿... dat de uitvinder van de gloeilamp heeft gehoord  
 ... that the inventor of the light bulb has heard  
 ‘that the inventor has heard of the light bulb’

Suppose that the fact that *uitvinder* can assign a theta-role to *de gloeilamp* entails that *de gloeilamp* is attached as a complement rather than an adjunct. That would mean that Minimal Attachment in fact predicts an option between attachment of *de gloeilamp* as an argument of *uitvinder*, or as an argument of a predicted verb: both attachments involve the same number of nodes (only adjuncts introduce an extra projection).



However, Frazier’s system also includes the principle of Late Closure; whenever Minimal Attachment leads to optionality, Late Closure forces attachment to the most recently parsed constituent. In (38), the most recently parsed constituent is *uitvinder*; so Frazier predicts a garden path affect as well. Thus, we again find that Frazier’s system and Pritchett’s system

make the same prediction; on the basis of examples like those discussed above, we cannot decide between the two approaches.

### 3.5 Categorical ambiguity

The arguments against head-driven processing that we have been looking at so far, are all intended to provide evidence for attachment of NPs and PPs before the verb has been encountered. Frazier (1989) gives a different type of argument against what she calls ‘lexical generation of syntax’ (i.e. head-driven processing). The argument runs as follows.

Frazier (1989) argues that structure-building is independent of lexical information. She claims that in general, the choice for a particular meaning of an item is made quickly; but that for lexical items which display a categorial ambiguity, the parser does not decide immediately which category the lexical item belongs to. To support this claim, she refers to an eye-tracking experiment reported in Frazier and Rayner (1987). They tested sentences like the following:

- (41) a. The warehouse fires numerous employees each year.  
 b. The warehouse fires harm some employees each year.  
 c. That warehouse fires numerous employees each year.  
 d. Those warehouse fires harm some employees each year.

(41c) and (41d) are unambiguous controls; in (41a) and (41b), the string *The warehouse fires* is ambiguous; *fires* could be interpreted as a verb ((41a)) or a noun ((41b)). The results of the experiment were that the first three words in sentences like (41a) and (41b) are read faster than first three words in (41c) and (41d), but the disambiguating forms (the rest of the sentence) take longer to read in (41a) and (41b) than in (41c) and (41d).

Frazier’s interpretation of these results is that the decision on the category of *fires* is delayed until the disambiguating forms are discovered; this explains the longer reading times for the final frame in (41a) and (41b) in the following way. Under Frazier’s assumptions, structure-building is delayed until a decision is made with respect to the category of the ambiguous items; so in (41a) and (41b), all the structure has to be built when the category of the ambiguous element can be determined, i.e. during reading of the final frame. The longer reading times in the final frames of (41a) and (41b) are thus interpreted by Frazier as a reflex of structure-building.

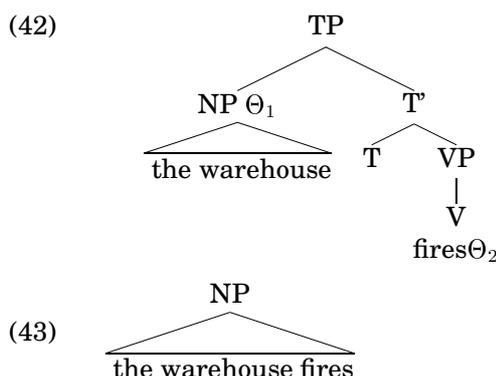
There is a catch here, however. Frazier takes the sum of the reading times of the final frames in (41a) and (41b), and compares those with the sum of the reading times of the final frames in (41c) and (41d). The catch is that the sum of the reading times of the final frames of (41a) and (41b), is greater than the sum of the reading times of the final frames of (41c) and (41d), because the reading time for (41b) is much greater than the reading

time for (41a), (41c) or (41d). The reading times are given in the table below, in milliseconds per character:

|       | <i>warehouse</i> | <i>fires</i> | remainder of sentence |
|-------|------------------|--------------|-----------------------|
| (41a) | 35               | 48           | 44                    |
| (41b) | 38               | 52           | 49                    |
| (41c) | 39               | 52           | 43                    |
| (41d) | 46               | 50           | 44                    |

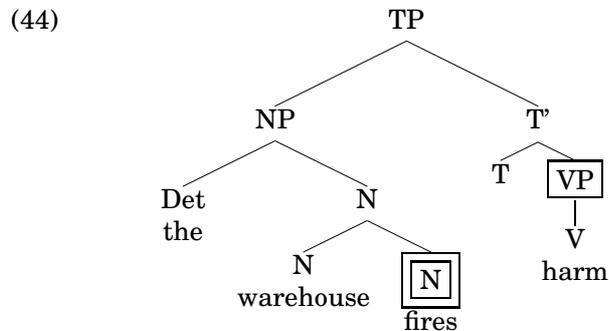
Under Frazier's theory of resolution of categorical ambiguity, the difference between (41a) and (41b) is unexpected.

Pritchett discusses cases of categorical ambiguity like those in (41) in some detail. He argues that under Theta Attachment, *the warehouse fires* is constructed as a subject-verb combination (as depicted in (42)), rather than as a theta-role-less NP (as depicted in (43)).<sup>6</sup>



When in (41b) the verb *harm* is encountered, *fires* has to be reanalyzed as a noun. This reanalysis is allowed by the OLLC:

<sup>6</sup>Actually, it is not entirely clear that this is true. Note that if the nominal entry of *fires* is chosen, a single NP is constructed which must receive a theta role, hence there is one violation of the theta role criterion if that option is chosen. The alternative, construction of a main clause with *the warehouse* as the subject and *fires* as the main verb, also results in one temporary violation of the theta criterion, since the verb *fires* is transitive, and the object theta role position cannot be filled at the point of discovery of *fires*. So it seems that Theta Attachment in fact predicts optionality between the nominal entry for *fires* and the verbal entry. Similar optionality is predicted in processing reduced relative clauses, which will be discussed in some detail in chapter 5.6.



In (44), the source position (the VP), governs the target position, since it governs the maximal projection of *fires*. The fact that (permitted) reanalysis has to occur could explain the longer reading times in (41b).

As another argument against lexically based processing models, Frazier argues that a self-paced reading study reported by Mitchell (1987) shows that in sentences like the ones in (45), the NP following the first verb is attached as the direct object of the verb, even when the verb is obligatorily intransitive, such as *departed* in (45b):

- (45) a. *After the audience had applauded the actors / sat down for a well deserved drink.*  
 b. *After the audience had departed the actors / sat down for a well deserved drink.*

Frazier concludes that the parser does not actually look at lexical information such as subcategorization properties. This finding is of course incompatible with Theta Attachment, where subcategorization information is the crucial driving force for structure-building.

However, as Pritchett points out, it is not actually true that *depart* is strictly intransitive, although the intransitive usage is probably more frequent:

- (46) The actors departed the stage

He also points out that real intransitive verbs do not lead to a garden path effect in structures like these, whereas transitive verbs do:

- (47) ; As soon as John read the book fell on the floor.  
 (48) As soon as John fainted the book fell on the floor.  
 (49) ; After the actors departed the stage collapsed.

These effects show that subcategorization properties do affect initial attachment of material.

## 3.6 Subject-object ambiguities in Dutch relative clauses

In this section, I will discuss another apparent argument for structure-building before the verb has been encountered, namely preferences for the subject reading of relative pronouns in Dutch relative clauses.

### 3.6.1 Subject preferences: the Active Filler Strategy

In this section, we will look at an argument that Frazier (1987) gives against head-driven processing. The argument involves Dutch relative clauses like the following:

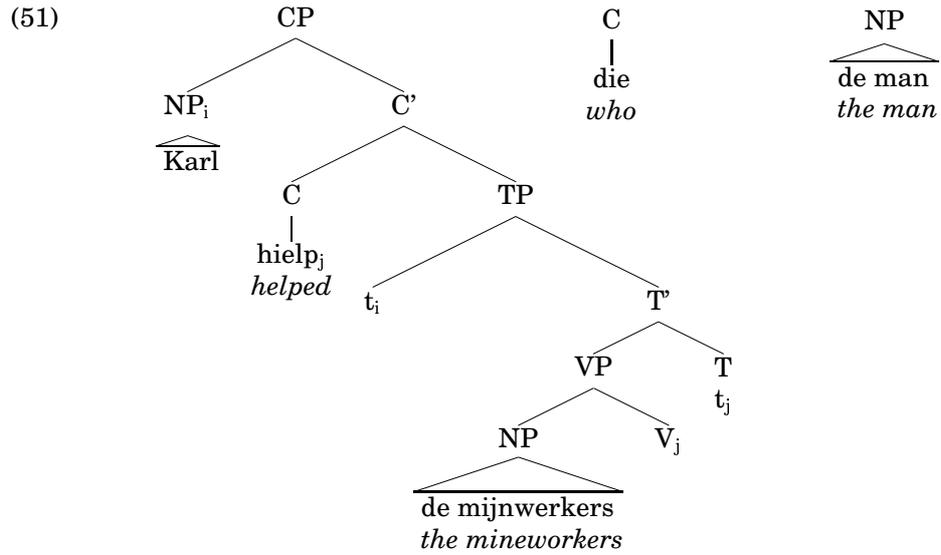
- (50) a. Karl hielp de mijnwerkers die de man vonden.  
 Karl helped the mineworkers-PL REL the man found-PL  
 ‘Karl helped the mineworkers who found the man.’  
 b. Karl hielp de mijnwerkers die de man vond.  
 Karl helped the mineworkers REL the man-SG found-SG  
 ‘Karl helped the mineworkers who the man found.’

A reading time study showed that there was no significant difference in reading time for these sentences. A comprehension task revealed, though, that in 31% of the cases in which verbal agreement should force an object interpretation for the relative pronoun (such as (50b)), Dutch speakers in fact interpreted the relative pronoun as the subject of the relative clause.

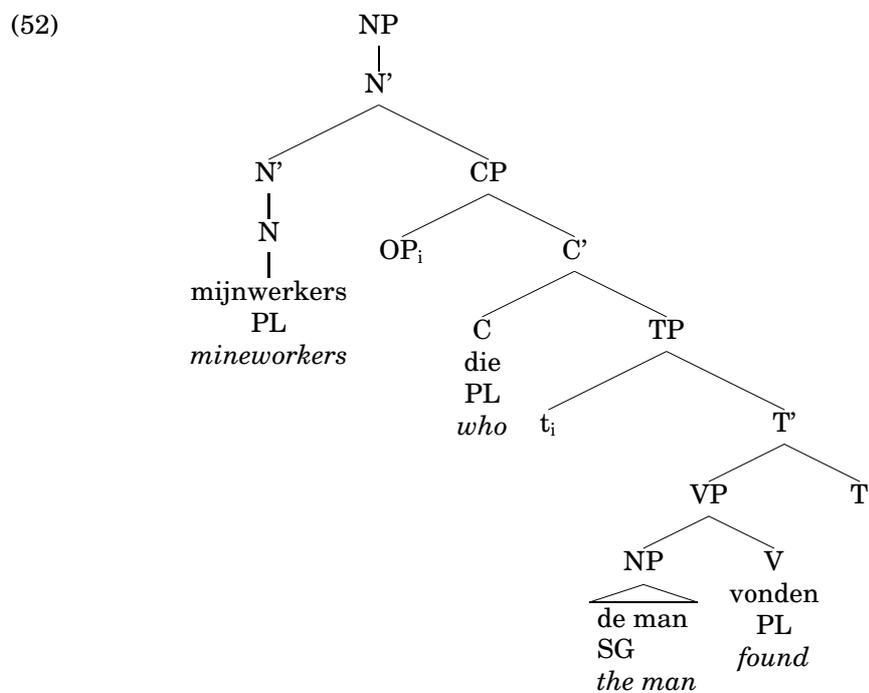
Let us first consider in detail how the sentences in (50) would be processed under Theta Attachment. Up until the embedded verb, (50a) and (50b) are the same. Processing of the main clause is uneventful: when the main verb is discovered, the subject is integrated, and then the direct object *de mijnwerkers* is integrated when it is encountered.

The first point of interest is the discovery of the relative pronoun *die*. Since there is no theta-assigner for *die*, it is stored. The same goes for the NP following it, *de man*. The buffer now looks like this:<sup>7</sup>

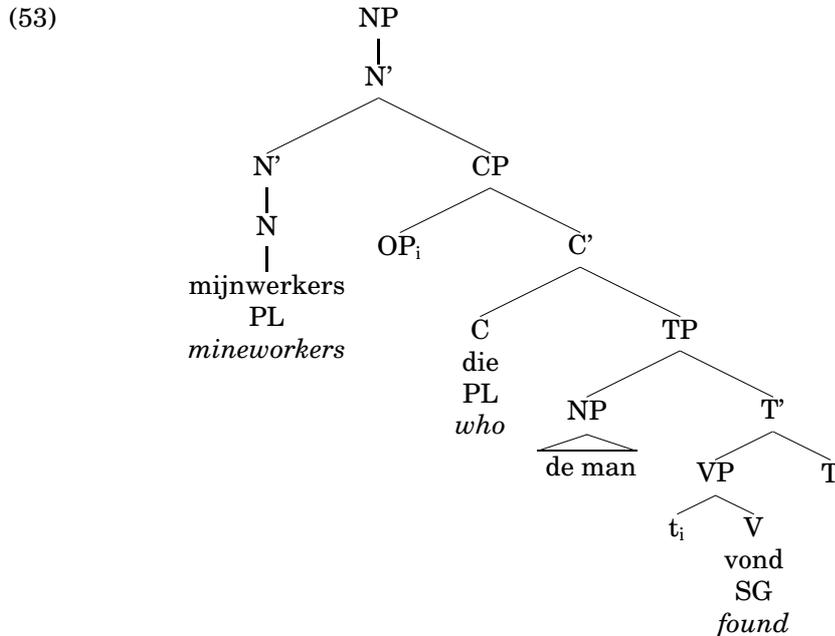
<sup>7</sup>Recall that Dutch is verb-second in main clauses, so that the matrix verb appears in C; embedded clauses are verb-final.



Next, the embedded verb is discovered; at this point, the relative clause can be built under Theta Attachment. In (50a), the agreement on the embedded verb forces the subject reading of the relative pronoun. The corresponding structure can be built without problems:



Consider now (50b). Here, the agreement on the embedded verb forces the object reading of the relative pronoun:

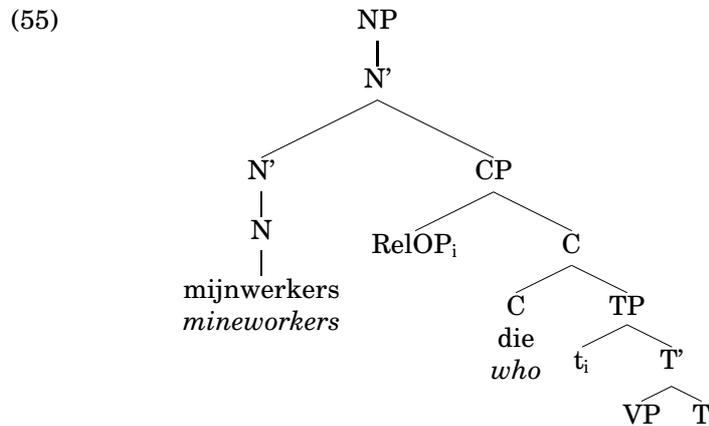


However, as we saw before, Frazier found a 31% subject reading for the relative pronoun in (50b). Under Theta Attachment, this is rather surprising; we have to wait for the verb before the relative clause can be built, and since the verb also carries the agreement information which should force the object reading for the relative pronoun, the subject preference is unexpected.

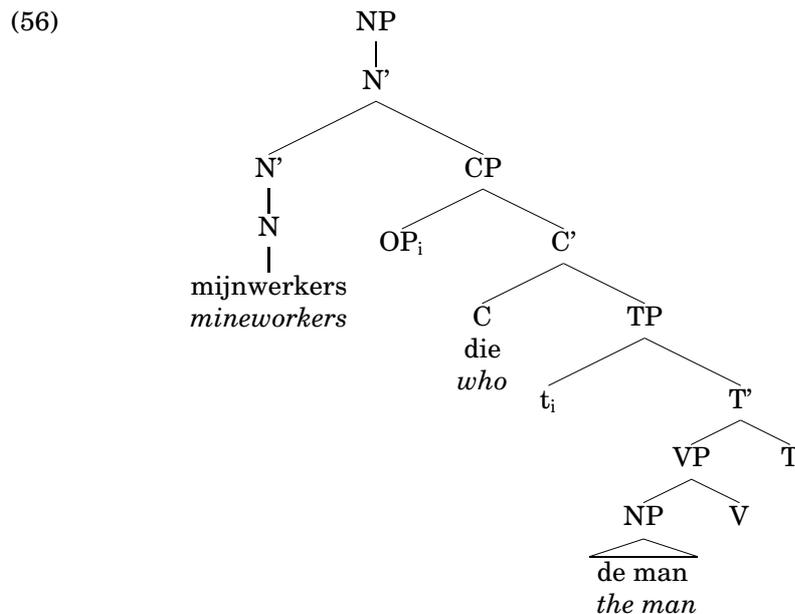
Frazier concludes that head-driven processing cannot account for these subject preferences, and she takes the 31% subject reading for (50b) as evidence for the Active Filler Strategy.

(54) **Active Filler Strategy:** traces must be attached in the structure as soon as possible

Let us see how the AFS accounts for the subject preference in (50b). Under Immediate Attachment, the relative pronoun, like any other element, has to be integrated into the structure as soon as it is encountered. The relative pronoun is associated with a relative operator, which is integrated into the structure at the same time. The relative operator in its turn is associated with a trace, since it is a moved element. The AFS now, says that this trace must be attached as soon as possible. The first available position where it can be attached, is the subject position in the relative clause. The structure of the relative clause then looks like this:



The next input consists of *de man*. It is integrated into the object position:



The next input is the embedded verb. In (50a), there is no problem integrating the verb; the agreement on the verb is consistent with the analysis made so far. But in (50b), the agreement on the verb is not consistent with the analysis in (56). The number of mistakes in interpretation that Frazier found, suggests that speakers of Dutch can ignore the agreement on the verb, and just integrate it into the structure in (56); this explains the large number of interpretation errors that she found.

To summarize: Dutch relative clauses exhibit a "preference" for the subject reading of the relative pronoun. Frazier takes this subject preference

as evidence against head-driven parsers, because a head-driven parser has to wait for the verb before attaching the relative pronoun and the other argument into the relative clause; it is clear that the agreement information on the verb should prohibit attachment of the relative pronoun as the subject in (50b). Frazier accounts for the data with Immediate Attachment combined with the Active Filler Strategy. Frazier's explanation in terms of the AFS can only work if spec,TP is available for trace attachment before the verb has been encountered, as predicted by Theta Attachment.

The Active Filler Strategy, the crucial ingredient of Frazier's analysis, is not without problems. Frazier mentions some small problems herself; two major problems with the AFS were discovered by Mak, Vonk and Schriefers (1999) and Mak (2001). I will discuss these problems in the following subsection.

### **3.6.2 Problems with the Active Filler Strategy**

In a self-paced reading study and an eye-tracking study, Mak (2001) tested sentences like the following:

- (57) a. Vanwege het onderzoek moeten de inbrekers, die de  
because of the investigation should the burglars who the  
bewoner beroofd hebben, nog een tijdje op het bureau  
occupant robbed have still some time at the police office  
blijven.  
stay  
'Because of the investigation, the burglars who robbed the occupant will have to remain at the police office for some time'
- b. Vanwege het onderzoek moet de bewoner, die de  
because of the investigation should the occupant who the  
inbrekers beroofd hebben, nog een tijdje op het bureau  
burglars robbed have still some time at the police office  
blijven.  
stay  
'Because of the investigation, the occupant who the burglars robbed will have to remain at the police office for some time'
- c. Vanwege het onderzoek moeten de inbrekers, die de  
because of the investigation should the burglars who the  
computer gestolen hebben, nog een tijdje op het bureau  
computer stolen have still some time at the police office  
blijven.  
stay  
'Because of the investigation, the burglars who stole the computer will have to remain at the police office for some time'

- d. Vanwege het onderzoek moet de computer, die de  
because of the investigation should the computer that the  
inbrekers gestolen hebben, nog een tijdje op het bureau  
burglars stolen have still some time at the police office  
blijven.  
stay  
'Because of the investigation, the computer that the burglars  
stole will have to remain at the police office for some time' (Mak  
ch2, exp. 1 and 2, conditions A-D)

The results were as follows. Mak did find a difference between (57a) and (57b); sentences like (57b) turned out to be more difficult than sentences like (57a). In a sense, this is a replication of Frazier's results.<sup>8</sup>

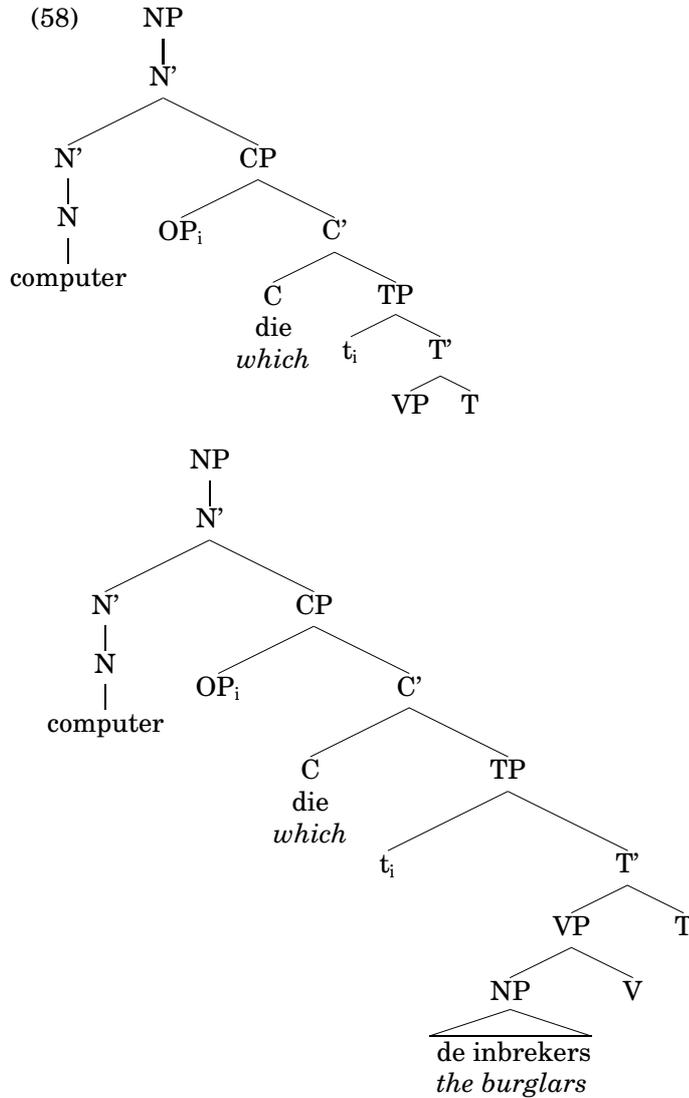
What is of interest here, is that Mak found *no* significant difference in reading time, nor in the number of mistakes in the interpretation, between sentences like (57c) and (57d). This is a problem for the Active Filler Strategy, since the AFS predicts a subject preference in all cases in (57), also in (57d); the AFS forces attachment of the relative trace in subject position as soon as the relative pronoun is encountered:

<sup>8</sup>Remember that Frazier in her experiment, as discussed in section 3.6.1, did not find longer reading times for the object relatives; she just found a large number of mistakes in the object relatives, where people mistook the relative pronoun to be the subject in 31% of the cases. Mak in his experiment did find longer reading times in the object relatives, whereas the number of mistakes was smaller than in Frazier's experiment. So it looks as if (one third of) the readers in Frazier's experiment ignored the agreement information all together, while the readers in Mak's experiment used the agreement information to initiate reanalysis.

One might seek an explanation for the differences between Frazier's and Mak's results in the difference between Mak's and Frazier's material: remember that where Frazier used inflected verbs, with thematic information and agreement information located on the same lexical item, Mak used materials where the thematic information is located on the participle, and the agreement information is located on the auxiliary following it.

However, Mak (p.50) reports that 'Mak, Vonk & Schriefers (unpublished data) showed that for sentences with two animate NPs, the results were similar for relative clauses with perfect tense and relative clauses with imperfect tense'. Mak (p.c.) suggests that we should probably look at the participle-auxiliary combination as being processed as one unit.

The difference between Frazier's results (interpretation errors in object relatives but no longer reading times) and Mak's results (longer reading times and less interpretation errors) then remains a mystery.



Integration of the verb *gestolen* should lead to problems here, since the verb *steal* selects for an animate subject. We would therefore expect reanalysis on *gestolen* under the AFS, but as we already saw, there is no difference in reading times between (57c) and (57d).

Mak concludes that the AFS does not work, and that the trace of the relative pronoun is not attached right away. So the lack of contrast between (57c) and (57d) constitutes an argument against Immediate Attachment.

Of course, the absence of an effect in (57c) versus (57d) in itself is not a compelling argument against the AFS; it may be that the effect found

by Mak just didn't reach significance. However, Mak found a more compelling problem for the Active Filler Strategy in the results of experiments involving case-ambiguous pronouns. Consider the following sentences:

- (59) a. Ongerust kijkt de hardloper, die jullie in het park gegroet  
 worried looks the jogger who you<sub>PL</sub> in the park greeted  
 heeft, naar de donkere lucht.  
 has<sub>SG</sub> at the dark sky  
 'Worriedly, the jogger, who greeted you in the park, looks at the  
 dark sky'
- b. Ongerust kijkt de hardloper die jullie in het park gegroet  
 worried looks the jogger who you<sub>PL</sub> in the park greeted  
 hebben, naar de donkere lucht.  
 have<sub>PL</sub> at the dark sky  
 'Worriedly, the jogger, who you greeted in the park, looks at the  
 dark sky' (Mak ch.4, exp. 1 and 2, conditions C and D)

In a self-paced reading experiment, Mak found longer reading times on the disambiguating auxiliary in (59a). This means that in relative clauses where the NP following the relative pronoun is a case-ambiguous pronoun, there is a preference for the *object* relative reading.<sup>9</sup> Clearly, this means that the AFS, which would force attachment of the trace of the relative operator in subject position as soon as the relative pronoun is encountered, i.e. before the discovery of *jullie*, is on the wrong track.

To summarize: while the expected subject preference seems to be confirmed in (58a)-(58b), closer investigation of the processing of Dutch relative clauses reveals two problems with the Active Filler Strategy; the absence of a subject preference in cases like (57d) versus (57c), and the object preference in cases like (59a) versus (59b).

This evidence leads Mak to reject the AFS, and to formulate a processing strategy that attaches material in relative clauses after the discovery of the NP following the relative pronoun. In the next subsection, I will discuss Mak's explanation of his data. Mak's theory is relevant to the discussion in this chapter, because he also claims that structure is built before the discovery of the verb (albeit not right at the relative pronoun, but slightly later); if his theory proves correct, this is a problem for head-

<sup>9</sup>A similar effect was found for embedded wh-clauses by Kaan (1997); while Kaan found a preference for the subject reading for the wh-element when the NP following it was a full NP, she found a preference for the object reading of the wh-element when the NP following the wh-phrase is a case-ambiguous pronoun:

- (i) Ik vroeg me af welke man jullie (bij de schuur achter de boerderij)  
 I wondered which man you-PL(NOM/ACC) at the barn behind the farm  
**heeft/hebben** gezien.  
 have-SG/PL seen

driven processing.

### 3.6.3 Attachment at the second NP: the Topichood Hypothesis

Mak (2001) conducted a series of experiments involving processing of Dutch relative clauses. He argues that the results of these experiments support the Topichood Hypothesis. My understanding of the Topichood Hypothesis is the following.

Mak argues that in relative clauses, structure is built as soon as the NP following the relative pronoun has been encountered. At that point, the reader tries to determine the relation between the two NPs, and assigns the two NPs to either subject or object position. Note that although this theory does not involve Immediate Attachment, it does involve attachment before the verb; I will label this concept Intermediate Attachment.

Now, in Mak's system, the NP that is most likely to be the topic is attached in subject position, and the other NP is attached in object position.

In determining which NP is more likely to be the topic, Mak uses two scales. One scale involves animacy. When one of the two NPs is animate and the other one is inanimate, the animate one is more likely to be the topic, and therefore has to be attached as the subject according to the Topichood Hypothesis.

The other scale that Mak uses to determine topichood involves whether the NP is pronominal or not. The more pronominal an NP is, the more likely it is to be the topic of the relative clause. This means that when the two NPs available are a pronoun and a relative pronoun, the pronoun has to be attached as the subject; and when the two NPs available are a full NP and a relative pronoun, the relative pronoun has to be interpreted as the subject under the Topichood Hypothesis.

The Topichood Hypothesis can be made explicit as follows:

- (60) **The Topichood Hypothesis:** when processing a relative clause in Dutch, the parser postpones attaching material until after discovery of the NP following the relative pronoun. Then, the element which is most likely to be the topic, is attached as the subject.
- (61) **Topic-likelihood scale:**  
 pronoun » relative pronoun » full NP  
 animate NP » inanimate NP

The following assumptions are needed to make this theory work:

- (62) **Assumption 1:** longer reading times are a reflection of reanalysis
- (63) **Assumption 2:** when the Topic-likelihood scale gives conflicting information, attachment is delayed.

The Topichood Hypothesis explains most of the processing effects that Mak found in his experiments. Below, I will discuss how the Topichood Hypothesis, combined with the assumptions formulated above, accounts for these effects.

The data fall into three basic categories: cases where Mak found a preference for the subject reading of the relative pronoun, cases with a preference for the object reading, and cases where no preference was found.

### Preference for the object reading

As we discussed above, when the NP following the relative pronoun is a case-ambiguous pronoun, a preference is found for the object reading (sentences in (59), repeated here as (64)).

- (64) a. Ongerust kijkt de hardloper, die jullie in het park gegroet  
 worried looks the jogger who you<sub>PL</sub> in the park greeted  
 heeft, naar de donkere lucht.  
 has<sub>SG</sub> at the dark sky  
 ‘Worriedly, the jogger, who greeted you in the park, looks at the dark sky’
- b. Ongerust kijkt de hardloper die jullie in het park gegroet  
 worried looks the jogger who you<sub>PL</sub> in the park greeted  
 hebben, naar de donkere lucht.  
 have<sub>PL</sub> at the dark sky  
 ‘Worriedly, the jogger, who you greeted in the park, looks at the dark sky’ (Mak ch.4, exp. 1 and 2, conditions C and D)

Recall that Mak found a longer reading time on the disambiguating auxiliary in sentences like (64a). The Topichood Hypothesis accounts for this effect in the following way.

An attachment decision for the relative pronoun and the case-ambiguous pronoun *jullie* can be made as soon as *jullie* is encountered. According to Mak, a pronoun is more pronominal than a relative pronoun, so *jullie* is more likely to be the topic, and hence more likely to be the subject, than *die*. Therefore *jullie* is analyzed as the subject, and *die* as the object (or rather, the trace of the relative operator associated with *die* is).

This initial analysis is correct for cases like (64b), but it has to be revised in (64a) at the disambiguating auxiliary; so the Topichood Hypothesis predicts the longer reading time there.

### No preference

The Topichood Hypothesis can also account for the absence of a preference for either the subject or the object reading in sentences like (57c) and (57d), repeated here in (65).

- (65) a. Vanwege het onderzoek moeten de inbrekers, die de  
because of the investigation should the burglars who the  
computer gestolen hebben, nog een tijdje op het bureau  
computer stolen have still some time at the police office  
blijven.  
stay  
'Because of the investigation, the burglars who stole the com-  
puter will have to remain at the police office for some time'
- b. Vanwege het onderzoek moet de computer, die de  
because of the investigation should the computer that the  
inbrekers gestolen hebben, nog een tijdje op het bureau  
burglars stolen have still some time at the police office  
blijven.  
stay  
'Because of the investigation, the computer that the burglars  
stole will have to remain at the police office for some time' (Mak  
ch2, exp. 1 and 2, conditions C and D)

In (65a), a decision can be made when *de computer* becomes available; both the animacy information and the pronominal information point towards the relative pronoun being the subject, which is the correct reading.

In (65b), on the other hand, the animacy information and the pronominal information give conflicting results with respect to topic likelihood. The relative pronoun is inanimate and the NP following it is animate, so the animacy information points to analyzing (65b) as an object relative. However, the relative pronoun is more pronominal than the full NP following it, which points to an analysis as a subject relative. Mak assumes that, therefore, no analysis is made until the verb is encountered. Since the verb contains all the information necessary to make the correct analysis, no particular difficulty is expected in (65b); there is no need for reanalysis.

### **Preference for the subject reading**

The Topichood Hypothesis also accounts for the general subject preference in some cases where the NP following the relative pronoun is a full NP. Such preferences have been robustly found by Mak. An overview of the data and the effects found is given below:

- (66) a. Vanwege het onderzoek moeten de inbrekers, die de  
because of the investigation should the burglars who the  
bewoner beroofd hebben, nog een tijdje op het bureau  
occupant robbed have still some time at the police office  
blijven.  
stay  
'Because of the investigation, the burglars who robbed the oc-  
cupant will have to remain at the police office for some time'
- b. Vanwege het onderzoek moet de bewoner, die de  
because of the investigation should the occupant who the  
inbrekers beroofd hebben, nog een tijdje op het bureau  
burglars robbed have still some time at the police office  
blijven.  
stay  
'Because of the investigation, the occupant who the burglars  
robbed will have to remain at the police office for some time'  
(Mak ch2, exp. 1 and 2, conditions A and B)
- exp 2.1 (self-paced reading): longer reading time in (66b) on the first word after the disambiguating auxiliary
  - exp 2.2 (eye-tracking): longer reading time in (66b) on the disambiguating auxiliary
- (67) a. Ongerust kijkt de hardloper, die de wandelaars in het  
worried looks the jogger who the strollers in the  
park gegroet heeft, naar de donkere lucht.  
park greeted has at the dark sky
- b. Ongerust kijkt de hardloper, die de wandelaars in het  
worried looks the jogger who the strollers in the  
park gegroet hebben, naar de donkere lucht.  
park greeted have at the dark sky.  
(Mak ch.4, exp. 1 and 2, conditions A and B)
- (68) a. Volgens de folder moet de gel, die de lekkages  
according to the brochure must the gel, that the leakages  
verhelpt, in één keer werken  
remedies, in one time work
- b. Volgens de folder moeten de lekkages, die de gel  
according to the brochure must the leakages, that the gel  
verhelpt, in één keer verdwenen zijn  
remedies, in one time disappeared be  
(Mak ch3, exp. 1)
- (self-paced reading): longer reading times in (68b) on the first two words after the disambiguating verb

In all the cases above, the relative pronoun and the NP following it are of the same type with respect to animacy. Therefore, only the pronominal status of the relative pronoun is relevant for subject attachment; since the relative pronoun is more pronominal than the full NP, it is more likely to be the topic, and hence it is attached as the subject of the relative clause, under the Topichood Hypothesis. This explains the longer reading times in the object relatives in the cases in (66b) through (68b) above.

Mak also found a preference for subject relatives with an inanimate relative pronoun and an animate NP following it (as in (69a)), compared with object relatives where the relative pronoun is animate, and the NP following it is inanimate, as in (69b).

- (69) a. In het dorp is de rots, die de wandelaars verpletterd heeft,  
 in the town is the rock, that the hikers crushed have,  
 het gesprek van de dag  
 the talk of the day
- b. In het dorp zijn de wandelaars, die de rots verpletterd  
 in the town are the hikers, that the rock crushed  
 heeft, het gesprek van de dag  
 has, the talk of the day  
 (Mak ch.3, exp. 2 and 3, conditions C and D)

In a self-paced reading study, Mak found longer reading times on the past participle, the auxiliary, and the first word after the auxiliary in sentences like (69b). In an eye-tracking experiment, he found longer reading times on the auxiliary and on the first word after the auxiliary in (69b).

These effects can also be accounted for under the Topichood Hypothesis. Let us first look at the subject relative in (69a).

In (69a), there is conflicting information. The relative pronoun is inanimate, and the NP following it is animate. So the animacy information points to a preference for the second NP to be attached as the subject, and the pronominality of the arguments points to a preference for the relative pronoun to be interpreted as the subject. Because of this conflict, the parser delays the decision and stores the arguments unattached. An attachment is made at the verb cluster; since the verb cluster provides all information that is necessary to make the correct attachment, the sentence is processed without any problems.

In the object relative in (69b), the situation is different. Here, the relative pronoun is animate, and the NP following it is inanimate. So according to both scales used to determine likelihood of topichood, the relative pronoun is most likely to be the topic: it is both more animate than the NP following it, and more pronominal.

This initial intermediate attachment is disproved in the verb cluster (by the agreement information on the auxiliary); and indeed, Mak finds longer reading times in and right after that region. It should be noted that

in these sentences, the effect is rather large.

There is one other point of interest with respect to the experiment in which Mak compared cases with inanimate subjects and animate objects. If we look at (69b), we see that the selection information on the participle does not force a decision for either the subject reading or the object reading; the disambiguating information is located solely on the auxiliary. However, in the same experiment Mak also tested sentences where the participle does disambiguate the sentence; these sentences use psych verbs, which select for an animate object.

- (70) a. In de gemeenteraad hebben de toespraken, die de  
 in the city council have the speeches, that the  
 burgemeester ontroerd hebben, niet veel reacties  
 mayor touched have, not many reactions  
 losgemaakt  
 stirred
- b. In de gemeenteraad heeft de burgemeester, die de  
 in the city council has the mayor, who the  
 toespraken ontroerd hebben, niet veel steun gekregen  
 speeches touched have, not much support received

Mak did not control for selection properties of the verb, since this is not a relevant factor for the hypothesis he was testing. However, there are interesting differences between the sentences in (69b) and (70b). Intuitively, (70b) is much more difficult to read than (69b). This intuition is robustly found among native speakers of Dutch: (70b) is very bad.

After we discussed this issue, Mak kindly carried out a post hoc analysis on his results in the reading time study, and found an interesting difference between the psych verbs and the verbs with no selectional restrictions: it turned out that the longer reading time on the participle was only found for the stimuli involving psych verbs, such as (70b). For these stimuli, there was no effect on the auxiliary. The other verbs, like the one in (69b), on the other hand, showed no effect on the participle, but did show an effect on the auxiliary; this makes sense under the Topichood Hypothesis, since the disambiguating information is located precisely on this auxiliary.

### 3.6.4 Some problems with Mak's account

In the previous subsection, we have seen how Mak's Topichood Hypothesis accounts for most of his data. Now, let us think about the implications of his theory.

What is striking about the approach is that structure-building is not immediate; attachment of constituents in subject or object position is made when two NPs have been encountered. Mak suggests that what happens

when the second NP is encountered, is that the parser tries to establish a relationship between the two NPs. We can conceptualize the process as follows: as soon as two NPs are available, a verb without features is postulated, and on the basis of this verb, a subject- and an object position can be created.<sup>10</sup>

To my mind, there are two conceptual problems with Intermediate Attachment. First of all, note that the operation that allows for the postulation of structure after the second NP in the relative clause has been encountered, has no counterpart in the grammar. As we saw in the introduction to this chapter, both Immediate Attachment and Theta Attachment have linguistic counterparts: Immediate Attachment is a transparent parsing implementation of a conception which uses rewrite rules, whereas Theta Attachment can be seen as implementing a lexicalist approach to grammar. The algorithm which builds structure after the second NP has been encountered, has no grammatical counterpart; therefore, it violates the transparency requirement we imposed on the parser.<sup>11</sup>

Another conceptual problem I have with the approach is the following. For Intermediate Attachment, the parser makes a decision with respect to the likelihood of subject- or objecthood of the two available NPs on the basis of tendencies like ‘topics tend to be realized as subjects’ and ‘animate

<sup>10</sup>This structural conceptualization of the predicted relationship between two NPs is reminiscent of an operation available in the work of Schneider (1999), which I briefly discussed in section 3.2. This featureless verb of course is not available as such in the lexicon (in Schneider’s work, it is the intersection of all verbs in the lexicon).

<sup>11</sup>A related problem, to my mind, is that the theory refers to a comparison of a specific number, namely two, NPs. Imagine what would happen under the Topichood Hypothesis, in a relative clause with three arguments, such as the following:

- (i) Ik zag de man die de jongen een boek gegeven had  
 I saw the man who the boy a book given had  
 ‘I saw the man who gave the boy a book’

The Topichood Hypothesis predicts a preference for subject attachment for the relative pronoun here. It also predicts that at that point, the NP following it, *de jongen*, is attached as the direct object. However, this is wrong; *de jongen* is the indirect object. We therefore expect to find an effect of reanalysis of *de jongen* from the direct object position to the indirect object position. Note that Mak has no theory about difficulty or ease of reanalysis; reanalysis in his view is just reflected in reading times. This means that Mak’s theory of Intermediate Attachment could be tested by comparing pairs like the following:

- (ii) a. Ik zag de man die de jongen een boek gegeven had  
 I saw the man who the boy a book given had  
 ‘I saw the man who gave the boy a book’  
 b. Ik zag de man die een boek gelezen had  
 I saw the man who a book read had  
 ‘I saw the man who read a book’

Intermediate Attachment predicts reanalysis (longer reading times) at *een boek* in (iia), and no reanalysis at *een boek* in (iib).

To my knowledge, there is no experimental material proving (or disproving) this.

NPs tend to be topics'. The problem is that it is not clear at all how this would actually benefit the interpretation process. The goal of the parser is to reach an interpretation for an incoming string as soon as possible. The assignment of available NPs to subject or object position does not help much in reaching this goal. 'Subject' and 'object' are grammatical functions, which do not straightforwardly correspond to specific interpretations for the NP occupying the subject or object position. The specific interpretation for an NP occupying a specific position (for instance as agent or theme), depends on the thematic roles which the verb assigns.

In addition to these conceptual problems, there are also three findings of Mak's that cannot be accounted for under Intermediate Attachment.

The first problem is that Intermediate Attachment cannot explain an effect that Mak found in relative clauses where the second NP is an accusative-marked pronoun.

- (71) a. Ongerust kijkt de hardloper, die ons in het park  
 worried looks the jogger, who us-ACC in the park  
 gegroet heeft, naar de regenwolken in de lucht  
 greeted has, at the rain clouds in the sky  
 'Worried, the jogger, who has greeted us in the park, looks at  
 the rain clouds in the sky'.  
 b. Ongerust kijkt de hardloper, die wij in het park  
 worried looks the jogger who we-NOM in the park  
 gegroet hebben, naar de regenwolken in de lucht  
 greeted have, at the rain clouds in the sky  
 (Mak's Conditions E and F, experiments 4.1 and 4.2)

Just like in the conditions with case-ambiguous pronouns, Mak found a preference for the object relative. However, the slow-down in the subject relative is already found right after the accusative pronoun is encountered, long before the verb has been found.

Mak argues that this effect accords with the Topichood Hypothesis, since the Topichood Hypothesis predicts difficulty with subject relatives when the second NP is a pronoun. However, there is an obvious difference between these cases and the cases with case-ambiguous pronouns. All the cases we discussed in section 3.6.3 are compatible with the theory that assignment of NPs to subject or object position is done after the second NP has been encountered. The longer reading time on (or right after) the verb or auxiliary can then be interpreted as a reflex of reanalysis. In this case, however, no such account is possible. Intermediate Attachment predicts that structure is built after the second NP has been encountered. The case on the pronoun in (71a) already shows that it must be the object, so the object reading for the relative pronoun cannot be built. And even if we would assume that the case on the pronoun is somehow ignored, it makes no sense to interpret the longer reading time in (71a) as a reflex

of reanalysis, since there is nothing at the point where the longer reading time occurs, that could trigger reanalysis (except for the case-marking on the pronoun, which is already available when the pronoun is encountered). All in all, there seems to be no way to interpret the longer reading time after the case-marked pronoun in (71a) as a reflex of reanalysis. This leaves us with the question what the longer reading time in (71a) does reflect; it also casts some serious doubt on the generality of the assumption that longer reading times in general reflect reanalysis (assumption (62)).

A similar question is raised by the cross-linguistic difficulty associated with object relative clauses; even in languages where there is no ambiguity at the point of discovery of the NP following the relative pronoun (such as English and French), object relative clauses are processed more slowly than subject relatives. Again, this slow-down cannot be due to reanalysis; there is no temporal ambiguity there to begin with.

A third point of interest is raised by the experiment in which Mak tested cases where the subject is inanimate and the object is animate. As we discussed in the previous section, there is an intuitive difference between the object relatives with psych verbs (such as (70b)) and the cases with verbs which do not select for an animate object (such as (69b)); the cases involving psych verbs are intuitively much more difficult to process.

Whereas Mak's theory does explain the difference in the timing of the effects (on the participle for psych verbs, on the auxiliary for the other cases), it does not explain why the cases with psych verbs are much more difficult intuitively; the effect is conscious in these cases.

Again, the very same effect is found in object relative clauses with psych verbs even in languages where the relative clause is *not* temporarily ambiguous. Consider the following example from Japanese<sup>12</sup>:

- (72)(?)?Otokonoko-ga [ tegami-ga otikomase-ta ] onnanoko-o mi-ta.  
 boy-NOM letter-NOM depress-PAST girl-ACC see-PAST  
 'The boy saw the girl who the letter depressed'
- (73) Otokonoko-ga [ onnanoko-o otikomase-ta ] tegami-o mi-ta.  
 boy-NOM girl-ACC depress-PAST letter-ACC see-PAST  
 'The boy saw the letter that depressed the girl'

We find the same effect as in (70): there is some problem, that can be detected by introspection, with the object relative. In Japanese, the explanation for this effect cannot possibly be that the parser initially makes the wrong analysis and has to revise later. In (72), the first two NPs encountered are both marked with nominative case; there is no way in which the parser can attach them that would be eligible for revision later: there is no temporary ambiguity. Still, the sentence is difficult to process.

Interestingly, the sentence in (73), which is easy to process compared

<sup>12</sup>I thank Taka Hara (p.c.) for providing these examples.

to (72), *does* involve a temporary ambiguity, and reanalysis. The initial analysis that will be made in (73) (under any processing theory), is one where *otokonoko-ga* ‘the boy’ will be attached as the subject of *otikomase-ta* ‘depressed’, and *onnanoko-o* ‘the girl’ as the object. This analysis has to be revised when the head of the relative clause, *tegami-o* ‘the letter’ is encountered. This reanalysis is performed without any conscious processing problems. The contrast with (72), where there is no temporary ambiguity, but still a problem in processing, is striking.

This is strong evidence that not every processing problem is caused by reanalysis of an initial analysis of a temporarily ambiguous string which turns out to be wrong later. It also emphasizes the need for a theory that distinguishes between permissible cases of reanalysis (such as in (73)), and impermissible reanalysis.

The same problem with the object relative is found in Hebrew; there is no temporary ambiguity in either the object or the subject relative in (74):

- (74) a. ??Ze ha-student [ she-ha-seret rigesh t ]  
           This the-student that-the-film moved/excited t  
           ‘This is the student that the film excited’  
       b. Ze ha-seret [ she-t-rigesh et ha-student ]  
           this the-film that that-t-moved/excited ACC the-student  
           ‘This is the film that excited the student’

Still, there is a conscious problem with the object relative.

If we try to think of a specific source for the processing problem in these object relatives, one possibility that comes to mind is the following. The subject in these cases seems to be the realization of a thematic role that originates VP-internally (it is the realization of the [-m]-role (subject matter) in the system of Reinhart (2001)).

There are some syntactic reasons for assuming that the argument realizing the subject matter role originates VP-internally. One such argument is that variable binding into a subject expressing the subject matter role is not as bad as binding into subjects that carry the agent role (which are merged outside the VP):

- (75) a. ??Zijn<sub>i</sub> boek ontmoert elke schrijver<sub>i</sub>  
           his book moves every author  
       b. \*De schrijver er<sub>i</sub> van leest elk boek<sub>i</sub>  
           the author of it reads every book

Another argument for the internal merging of subject matter may be that Dutch to a certain extent allows free word order between the subject and object with psych verbs (constrained by ‘animacy properties of the subject and pronominal characteristics of the object’, see Everaert (1986)).

- (76) a. ... dat dat boek hen heeft geërgerd  
 ... that that book them has annoyed  
 b. ... dat hen dat boek heeft geërgerd  
 ... that them that book has annoyed  
 ‘that that book has annoyed them’  
 (Everaert (1986)’s (140))
- (77) a. ... dat die boeken Karel hebben geërgerd  
 ... that those books Karel have annoyed  
 b. ??... dat Karel die boeken hebben geërgerd  
 ... that Karel those books have annoyed  
 ‘that those books have annoyed Karel’  
 (Everaert’s (141))
- (78) a. ... dat de kinderen ons hebben geërgerd  
 ... that the children us have annoyed  
 b. \*... dat ons de kinderen hebben geërgerd  
 ... that us the children have annoyed  
 ‘that the children have annoyed us’  
 (Everaert’s (142))

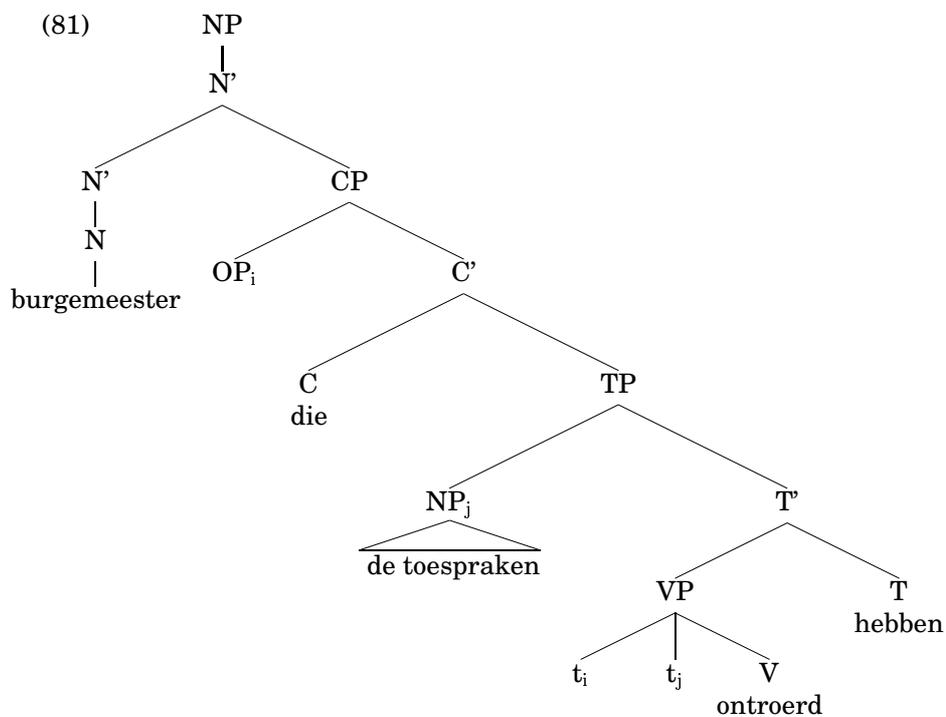
With verbs selecting for an agent in subject position, this is not possible:

- (79) \*... dat het boek Jan heeft gelezen  
 ... that the book Jan has read  
 ‘... that Jan read the book’

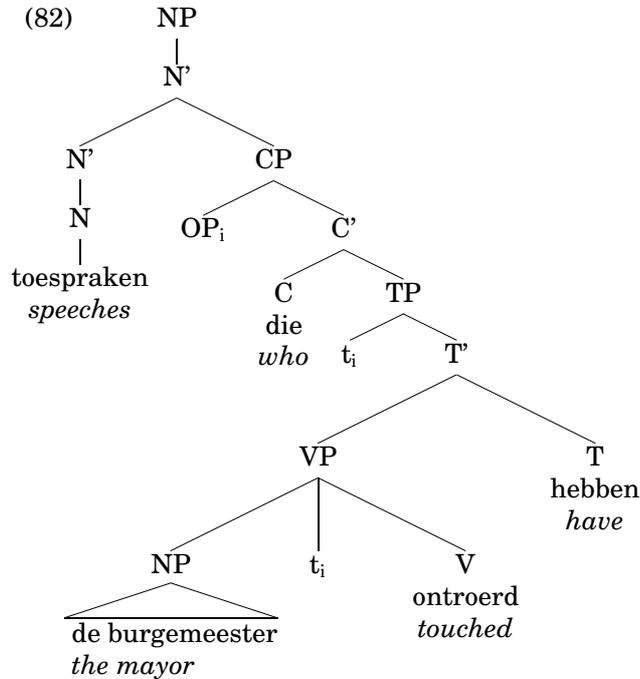
Let us see what this means for the parse of sentences like (70b), repeated here as (80):

- (80) In de gemeenteraad heeft de burgemeester, die de toespraken  
 in the city council has the mayor, who the speeches  
 ontroerd hebben, niet veel steun gekregen  
 touched have, not much support received

The structure that must be built for the relative clause, looks something like this:



In the structure in (81), the dependency between *de toespraken* ‘the speeches’ and its VP-internal trace crosses the trace of the relative operator. In the subject relative, there is no such crossing dependency:



The crossing dependency in (81) is present in the structure of object relatives with psych verbs in all languages; so it is a much better candidate for explaining the difficulty associated with this particular type of object relatives. It is not entirely clear whether this difficulty is a syntactic problem, or a processing problem. This is a topic for future research.

### 3.6.5 Longer reading times as a reflex of integration difficulty rather than reanalysis

In the previous subsection, I argued that the slow-down that Mak found in Dutch subject relatives with a case-marked NP following the relative pronoun cannot possibly be interpreted as a reflex of reanalysis. We also saw that the slow-down he found in Dutch object relatives with a full NP as the subject, is found in VO-languages as well; in these languages, the slow-down cannot be attributed to reanalysis either, since no temporary ambiguity exists in the relative clause.

I would like to take these findings as a starting point for developing an alternative account for Mak's results that is compatible with Theta Attachment.

Under Theta Attachment, we expect to find no misanalysis, since the parser does not build an analysis before the verb has been encountered.<sup>13</sup>

<sup>13</sup>I assume that the participle and the auxiliary are being processed as one unit (see foot-

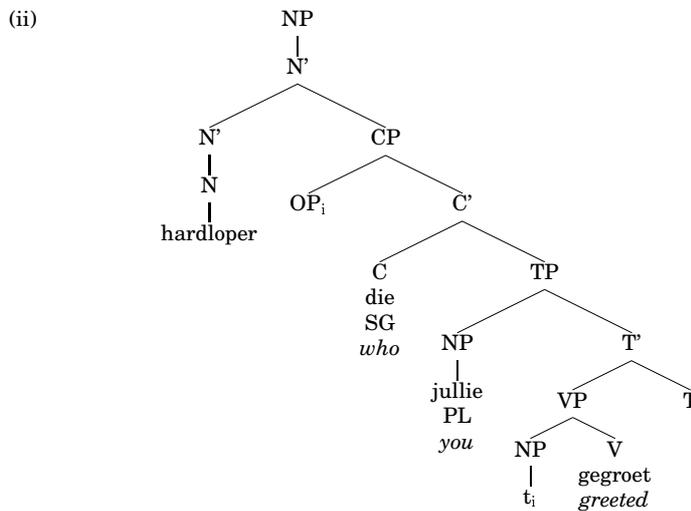
Since the source of the slow-downs that Mak found can't be an effect of *reanalysis* under Theta Attachment, the slow-downs must somehow occur at the first-pass *analysis*: somehow, integration of material must be faster in some cases than in others.

If we look closely at the effects that Mak found, we can establish that

note 8). It must be noted that in Pritchett's model, we cannot interpret any of the longer reading times that Mak found as a reflex of reanalysis. To see this, consider again the contrast in (64), repeated as (i):

- (i) a. Ongerust kijkt de hardloper, die jullie in het park gegroet heeft, naar de  
worried looks the jogger who you<sub>pl</sub> in the park greeted has at the  
donkere lucht.  
dark sky  
'Worriedly, the jogger, who greeted you in the park, looks at the dark sky'
- b. Ongerust kijkt de hardloper, die jullie in het park gegroet hebben, naar de  
worried looks the jogger who you<sub>pl</sub> in the park greeted have at the  
donkere lucht.  
dark sky  
'Worriedly, the jogger, who you greeted in the park, looks at the dark sky' (Mak  
ch.4, exp. 1 and 2, conditions C and D)

Mak finds a longer reading time on the disambiguating auxiliary in sentences like (ia). In principle, we could assume that Theta Attachment attaches material at the participle, and reanalysis occurs at the disambiguating auxiliary:



However, the reanalysis which would have to occur at the disambiguating auxiliary, violates the OLLC, since the source position (the subject position) neither governs nor dominates the target position (the object position):

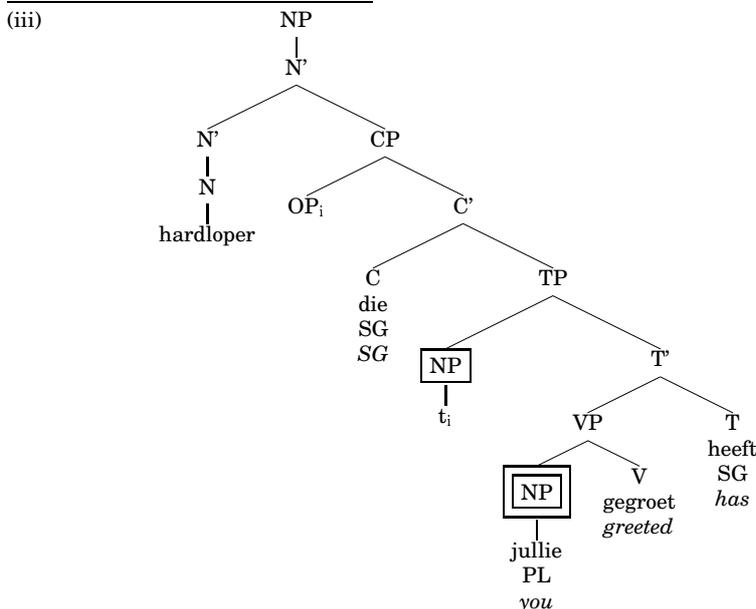
all the effects he found<sup>14</sup> can be accounted for under Theta Attachment by the following hypothesis:

- (83) **Ease of integration scale:** integration of a pronoun in subject position takes less time than integration of a relative trace in subject position; and integration of a relative trace in subject position takes less time than integration of a full NP in subject position

This hypothesis is very similar in spirit to the pronoun-part of the Topichood Hypothesis: the underlying intuition is simply that pronouns are better topics than relative traces, and relative traces are better topics than full NPs. The difference with Mak's approach as I understand it, is that (83) involves no structure building before the verb. This eliminates two of the empirical problems we found with Intermediate Attachment.

This hypothesis accounts for the subject preferences in cases where the NP following the relative pronoun is a full NP ((66) through (68), (69)), in the following way. When the relative trace turns out to be the object, the full NP has to be attached as the subject of the clause. According to (83), this integration of a full NP in subject position takes more time than integrating the relative trace in subject position.

Note that we can also account for the difficulty with object relatives in



In general, swapping between subject and object position of the same verb is not allowed under the OLLC. This means that an interpretation of the reading time effects as a reflex of reanalysis is impossible in Pritchett's framework, since we would always expect the dispreferred version to be a conscious garden path.

<sup>14</sup>Except for the null effect in (57c) versus (57d).

VO-languages in the same way. In object relatives, a full NP will have to be integrated in subject position, whereas in subject relatives the relative trace will be integrated in subject position. The latter integration is easier. The prediction is that object relatives will be easier than subject relatives if the subject is a pronoun, also in languages which display no temporary ambiguity in relative clauses.

The opposite preference, the object preference in sentences where the NP following the relative pronoun is a case-ambiguous pronoun (sentences like (64a) vs. (64b)), also follows. In the object relative (64b), the pronoun must be integrated in subject position. This takes less time than integration of the relative trace in subject position, which must take place in subject relatives like (64a).

The same holds for the object preference in sentences with case-marked pronouns ((71)). The timing of the effect is different here; it occurs preverbally. This suggests that the integration of a case-marked pronoun is done earlier than integration of a non-case-marked pronoun. This early integration of a morphologically case-marked element makes perfect sense if we extend Theta Attachment to Generalized Theta Attachment:

- (84) **Generalized Theta Attachment:** Every principle of the Syntax attempts to be maximally satisfied at every point during processing.  
(Pritchett's (336))

Under Generalized Theta Attachment, we expect that morphologically case-marked arguments are attached as soon as they are encountered, possibly before the theta-assigning verb has been encountered. The case-marking on the pronouns in (71) can license some structure-building before the verb (for instance of a small vP). The difficulty in (71a) is a reflex of the difficulty of integrating a trace in subject position.

### 3.7 Conclusions

In this chapter, we have seen that arguments for Immediate Attachment referring to temporary ambiguity of preverbal material in verb-final structures, do in fact not unequivocally show that head-final processing of such structures is on the wrong track; the effects can also be accounted for under a head-driven approach if we assume that building more complex structures is more complicated than building simpler structures. We have also seen that Immediate Attachment fails to account for the processing of Dutch relative clauses; and we have seen that a solution in terms of Intermediate Attachment cannot account for all the effects found by Mak (2001) either. In fact, a head-driven approach to structure-building combined with an ease of integration scale such as (83) does a better job of

accounting for the data, also cross-linguistically.

## Chapter 4

# Revising the OLLC: evidence from Japanese

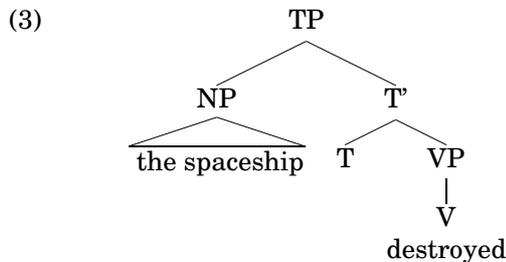
### 4.1 Introduction: some problems with the OLLC and with Pritchett's rebuffering mechanism

In chapter 2, I introduced Pritchett's rebuffering mechanism, which is needed to explain why some sentences that are predicted to induce a garden path effect under his theory, are in fact easily processed. Specifically, Pritchett notes that reduced relative clauses do not lead to a garden path effect if the verb in the relative clause is obligatorily transitive and is followed by an adjunct. This is exemplified by the contrast between the sentences in (67) and (68) of chapter 2, repeated here as (1) and (2):

- (1) a. ζ The horse raced past the barn fell  
b. ζ (Rex knows) the boy hurried out the door slipped
- (2) a. The spaceship destroyed in the battle disintegrated  
b. The bird bought in the store flew away  
c. The children found in the woods were frozen

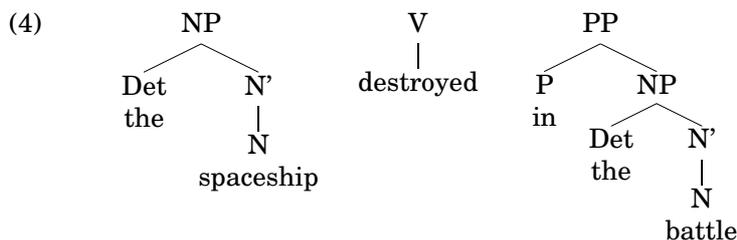
As we already saw in chapter 2, the fact that the sentences in (2) are processed without conscious effort is a problem for the OLLC: the OLLC correctly rules out the reanalysis in (1), and we would expect it to rule out the reanalysis in (2) in the same way.

We also saw that Pritchett saves the OLLC by introducing the mechanism of rebuffering. To recapitulate how this mechanism works, consider, for instance, (2a). Here, the parser first attaches *the spaceship* as the subject of *destroyed*:



Now, Pritchett proposes that when the parser encounters the PP *in the battle*, it becomes clear that this initial attachment was not correct; a direct object in English generally has to be adjacent to the verb, so the discovery of the PP directly following the verb shows that there is not going to be a direct object. Since the verb *destroyed* is obligatorily transitive, the parser ‘knows’ that the parse as a main clause is going to fail and that there is no point in pursuing it.

According to Pritchett, this ‘knowledge’ leads the parser to break up the structure in (3) and send the elements back to the buffer. The buffer then looks like this:



The move of breaking up the structure in (3) does not violate the OLLC, since the OLLC constrains the relation between the source and the target position:

- (5) **On-Line Locality Constraint (OLLC):** The target position (if any) assumed by a constituent must be *governed* or *dominated* by its source position (if any), otherwise attachment is impossible for the automatic Human Sentence Processor.  
Pritchett’s (286), p.101

When elements are sent back to store, there is no target position, so the OLLC does not apply when rebuffering occurs.

The parse of (2a) is completed when the verb *disintegrated* is encountered; the correct structure (with a reduced relative) can be built without problems using the material in the buffer.

Consider the difference with the reanalysis in (1a); in (1a), the discovery of the PP *past the barn* does not disprove the initial analysis as a main

clause. The main clause analysis only turns out to be wrong when the matrix verb *fell* appears. At this point, sending elements to storage is not an option: the verb forces immediate reattachment of the reanalyzed element *the horse*. Hence the OLLC does apply, and rules out the reanalysis.

So the crucial difference between (1a) and (2a), according to Pritchett, is that rebuffering is triggered in (2a) when the PP is encountered (which does not force reattachment of misanalyzed material), and reanalysis is triggered in (1a) when the matrix verb is encountered (which does force reattachment). The rebuffering mechanism can be summarized as follows:

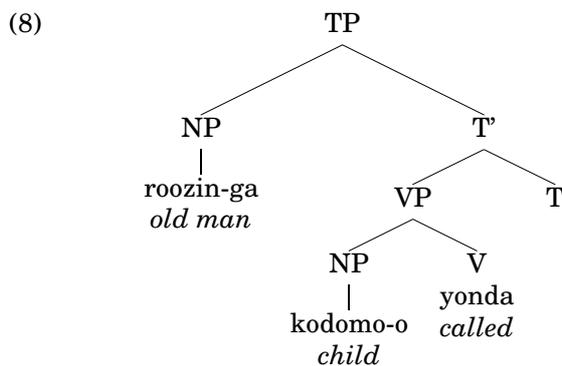
- (6) **Rebuffering:** When the Human Sentence Processor encounters a non-theta-assigning element that disproves the analysis made so far, the structure is broken up; the elements that cannot be attached, are put back in the buffer.

Pritchett provides independent support for the idea that the relevant factor in (2a) is that a non-theta-assigning element disproves the structure that is built initially. He notes the similarity between (2a) and Japanese relative clauses. In both cases, reanalysis is forced by a non-theta-assigner, and in both cases, the reanalysis does not lead to a garden path effect.

To see this for Japanese relative clauses, consider the following example:

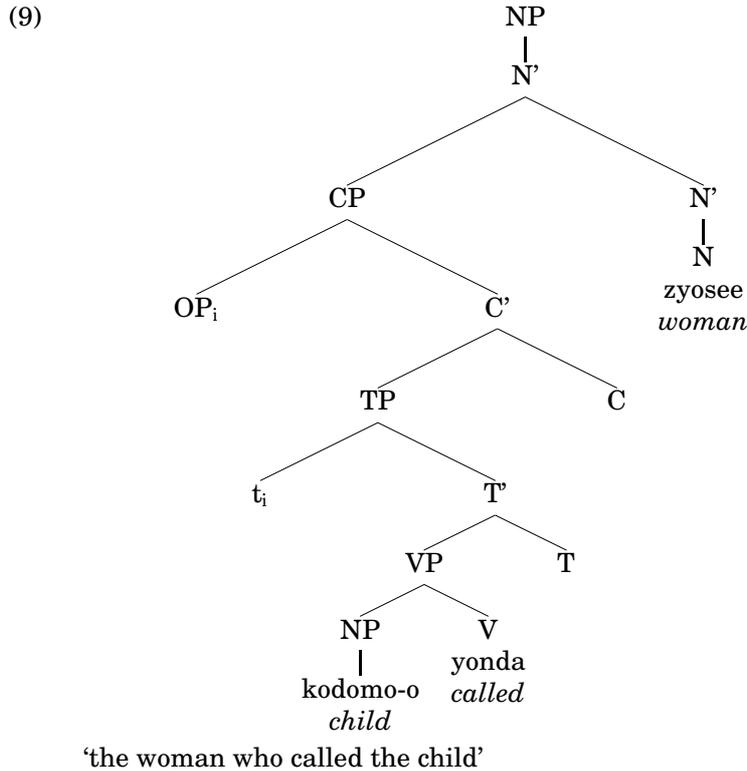
- (7) Roozin ga kodomo o yonda zyosee to hanasi o sita  
 old man NOM child ACC called woman with talk ACC did  
 ‘The old man talked with the woman who called the child’  
 (Pritchett’s (270))

Theta Attachment predicts initial analysis of the string *roozin-ga kodomo-o yonda* as a main clause, attaching the subject and the object as the verb *yonda* ‘called’ is found. The resulting structure looks like this:



When *zyosee-to* ‘woman’ is encountered, the analysis in (8) proves to be incorrect; *zyosee-to* ‘woman’ is the head of a relative clause, and its relative

operator gets the external theta role of *yonda* ‘called’:



This means that *roozin-ga* ‘old man’ has to be removed from the subject position of *yonda* ‘called’. As noted, this does not lead to any conscious processing problems.

Pritchett notes that in both cases, the element which has to be reanalyzed (*the spaceship* in (2a), and *roozin-ga* ‘old man’ in (7)), cannot be immediately reattached at the point where the initial analysis of the string is disproved. As we saw in the discussion of (2a), this means that the OLLC does not apply; there is a source position it can apply to, but there is no target position in the same structure.

To sum up what we have seen so far: the fact that reduced relative clauses with an obligatorily transitive verb, such as (2a), are processed without problems, is potentially problematic for the OLLC: the OLLC is too narrow, it rules out the reanalysis needed for those cases, while this type of reanalysis can actually be performed without conscious effort. Pritchett solves this problem by introducing a mechanism of rebuffering, which says that if a non-theta-assigning element disproves the structure built so far, the structure is broken up and the elements are sent back to store. Relative clauses in Japanese provide independent motivation for the idea that

sending back to store can be done without conscious effort.

However, there are a number of problems associated with the rebuffering mechanism as formulated in (6); these suggest that the line that Pritchett takes to account for the effortless processing of the sentences in (2) is not on the right track. In this chapter and the next, I will argue that these problems show that the OLLC is too narrow, i.e. it constrains the process of reanalysis too much, and that we need to relax the OLLC somewhat.

Let us first take a look at the problems with the OLLC and with the rebuffering mechanism.

Firstly, as Pritchett himself notes, it is not entirely true that there is no grammatical continuation for the main clause analysis of *the spaceship destroyed in the battle* (which is supposed to be the trigger for rebuffering). The main clause parse can be completed with a direct object that has undergone heavy NP shift:

- (10) The spaceship destroyed in the battle the giant Kzinti cruiser which had been pursuing it for weeks.  
(Pritchett's (273))

According to Pritchett, the possibility of sentences like (10) is not a problem for his theory, since the parse for it can still be assembled from the elements in the buffer after the whole sentence has been received.

However, it seems to me that the grammaticality of sentences like (10) proves that there is no reason for the parser to break up the structure upon the discovery of the PP in (2a). In other words, while Pritchett is right that sentences like (10) can still be parsed correctly under his theory, there is no real case for the strategy of breaking up structure that he ascribes to the parser: there *is* a grammatical continuation possible, so why would the parser decide to break up the structure?

This question aside, there are a number of empirical problems with the rebuffering mechanism. The general expectation under the rebuffering mechanism is that when reanalysis is triggered by a non-theta-assigner, the elements are put back into the buffer and no processing difficulty will arise; whereas when reanalysis is triggered by a theta-assigner, immediate reattachment of the reanalyzed constituent has to follow, potentially leading to a violation of the OLLC hence to a conscious processing difficulty.

As it turns out, this expectation is not borne out. On the one hand, we can find cases where the initial analysis is disproved by the discovery of a non-theta-assigner, but which are nevertheless not processed without effort. On the other hand, we can also find cases where reanalysis is triggered by a theta-assigner, and the reanalysis is not allowed by the OLLC, but which still do not give rise to a garden path effect.

These counterexamples will be discussed in detail in this chapter and the next. For now, let us just take a brief peek at them to get an indication of the scope of the problem.

One case where the initial analysis is disproved by a non-theta-assigner, but which nevertheless is not processed without effort, is provided by Mazuka and Itoh (1995). Consider the following Japanese relative clause:

- (11) ¿Yoko-ga kodomo-o koosaten-de mikaketa takusii-ni  
 Yoko-NOM child-ACC intersection-LOC saw taxi-DAT  
 noseta  
 put-on  
 'Yoko put the child on the taxi she saw at the intersection.'  
 (Mazuka and Itoh's (14a))

In (11), the non-theta-assigning element *takusii-ni* 'taxi' shows that the initial main clause analysis cannot be the right one. However, as noted, the sentence is difficult to process.

Another instance of the same phenomenon is found in Dutch:

- (12) ¿De gemeente had de straat opgebroken in verband met  
 The city council had the street broken up in connection with  
 rioleringswerkzaamheden na het ongeluk onmiddellijk  
 sewerage activities after the accident immediately  
 dichtgegooid.  
 filled up  
 'After the accident, the city council immediately filled up the street,  
 broken up because of sewerage activities'  
 (Koorwinder, Mulders and Schuytplot's (1996) (37))

Here, the non-theta-assigning element which disproves the initial main clause analysis, is the adverb *onmiddellijk* 'immediately'. This adverb cannot occur after a direct object:

- (13) \*De gemeente had de straat opgebroken in verband met  
 the city council had the street broken up in connection with  
 rioleringswerkzaamheden na het ongeluk onmiddellijk.  
 sewerage activities after the accident immediately

Hence, the parser should 'know' when it encounters *onmiddellijk*, that its initial analysis is not right, and it should break up the structure. However, the sentence is a severe garden path.

On the other hand, there are also cases where reanalysis is triggered by a theta-assigning element, forcing immediate reattachment of the reanalyzed constituent in a way which violates the OLLC, which are processed without conscious effort.

One instance is provided by Mazuka and Itoh (1995):

- (14) Nakamura-ga tyuuko-no pasokon-o katta toki  
 Nakamura-NOM second-hand PC-ACC bought when  
 syuuri-site-kureta  
 repaired (for me)  
 ‘When I/(he/she) bought a second-hand computer, Nakamura re-  
 paired it for me.’  
 (Mazuka and Itoh’s (9)=(37))

The element triggering reanalysis here, is the matrix verb; the reanalysis from the subject position of the embedded clause to the main clause is not permitted by the OLLC; but nevertheless, the sentence is processed without effort.

Another case can be found in Dutch:

- (15) Ik zag haar kinderen optillen  
 I saw her children lift  
 ‘I saw her lift children’

Here, *haar kinderen* ‘her children’ is initially analyzed as the direct object of *zag* ‘saw’. The constituent *haar kinderen* has to be split up when the embedded verb *optillen* ‘lift’ is encountered, attaching *haar* as its subject and *kinderen* as its object. This is not allowed by the OLLC, but the reanalysis can be performed without conscious effort.

These examples show that there are some problems with the OLLC that cannot be solved by the rebuffering mechanism. We also saw that the rebuffering mechanism in itself predicts ease of processing in cases which are in fact not easily processed. All in all, it seems that the OLLC is not the right formulation of the restrictions on reanalysis. In this chapter, I will revise the OLLC in such a way that it can account for the facts that were introduced above.

We will arrive at this revision of the OLLC by carefully examining the Japanese counterexamples provided by Mazuka and Itoh (1995). The structure of the argumentation is the following. In section 4.2, I will first try to stick as closely as possible to Pritchett’s formulation of the OLLC and his rebuffering mechanism; I will argue that the data provide evidence for a constraint on the rebuffering mechanism: not more than one element can be put back in store.

Then, in section 4.3, we will see that the OLLC still bars certain types of reanalysis that are in fact possible in Japanese, even if we add the revised rebuffering mechanism. As we will see, these types of uncostly reanalysis are also limited to one argument at a time. Careful examination of the data will lead to the formulation of a reanalysis constraint replacing the OLLC, in section 4.4. This revised version of the OLLC will subsume the constraint on the rebuffering mechanism that is proposed in section 4.2.

## 4.2 Permitted/unpermitted reanalysis forced by a non-theta-assigner in Japanese relative clauses

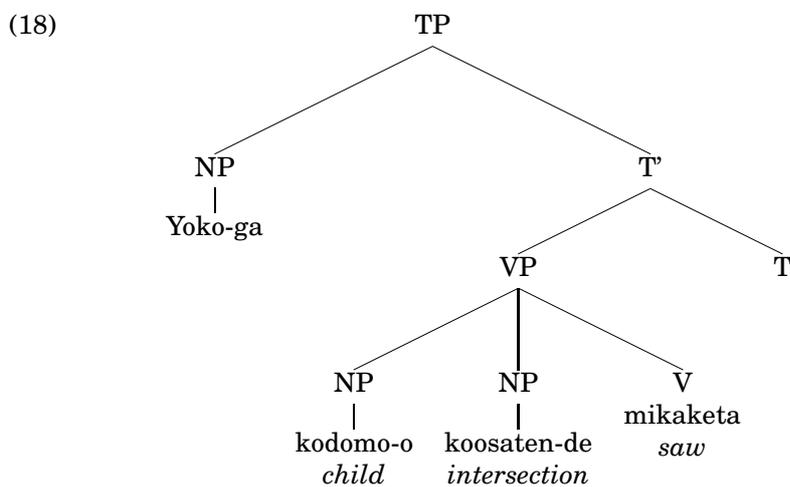
### 4.2.1 The basic contrast

Mazuka and Itoh (1995) reject Pritchett's model on the basis of counterexamples from Japanese, and propose an alternative theory, the Tentative Attachment strategy, which will be discussed below (see (78)). Mazuka and Itoh present the following contrast as an argument against Pritchett's model:

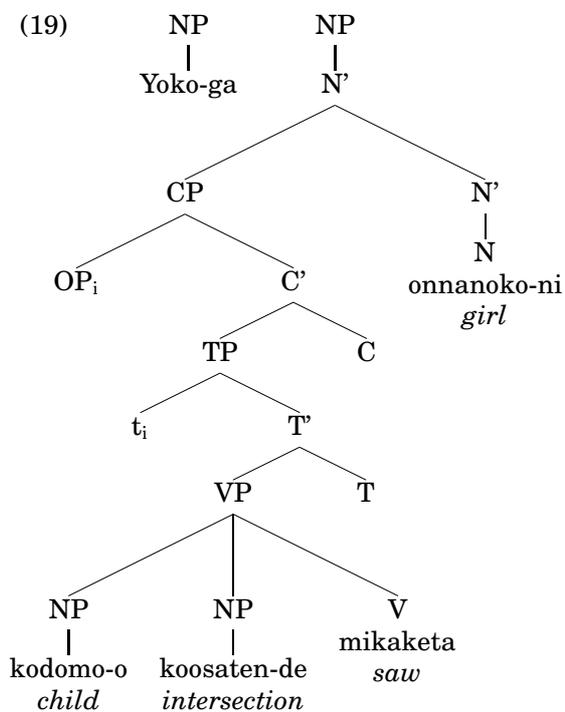
- (16) <sub>OK</sub>Yoko-ga kodomo-o koosaten-de mikaketa onnanoko-ni  
 Yoko-NOM child-ACC intersection-LOC saw girl-DAT  
 koe-o kaketa  
 called  
 'Yoko called the girl who saw the child at the intersection'  
 (Mazuka and Itoh's (8b))
- (17) <sub>¿</sub>Yoko-ga kodomo-o koosaten-de mikaketa takusii-ni  
 Yoko-NOM child-ACC intersection-LOC saw taxi-DAT  
 noseta  
 put-on  
 'Yoko put the child on the taxi she saw at the intersection.'  
 (Mazuka and Itoh's (14a))

Both sentences are initially analyzed as main clauses. In (16), reanalysis is forced by a non-theta-assigner (*onnanoko-ni* 'girl'), and there is no garden path effect. In (17), reanalysis is also forced by a non-theta-assigner (*takusii-ni* 'taxi'), and here we do find a garden path effect. This is a problem for Pritchett's model because, as we saw, Pritchett assumes that reanalysis is always unproblematic when it is forced by a non-theta-assigning element.

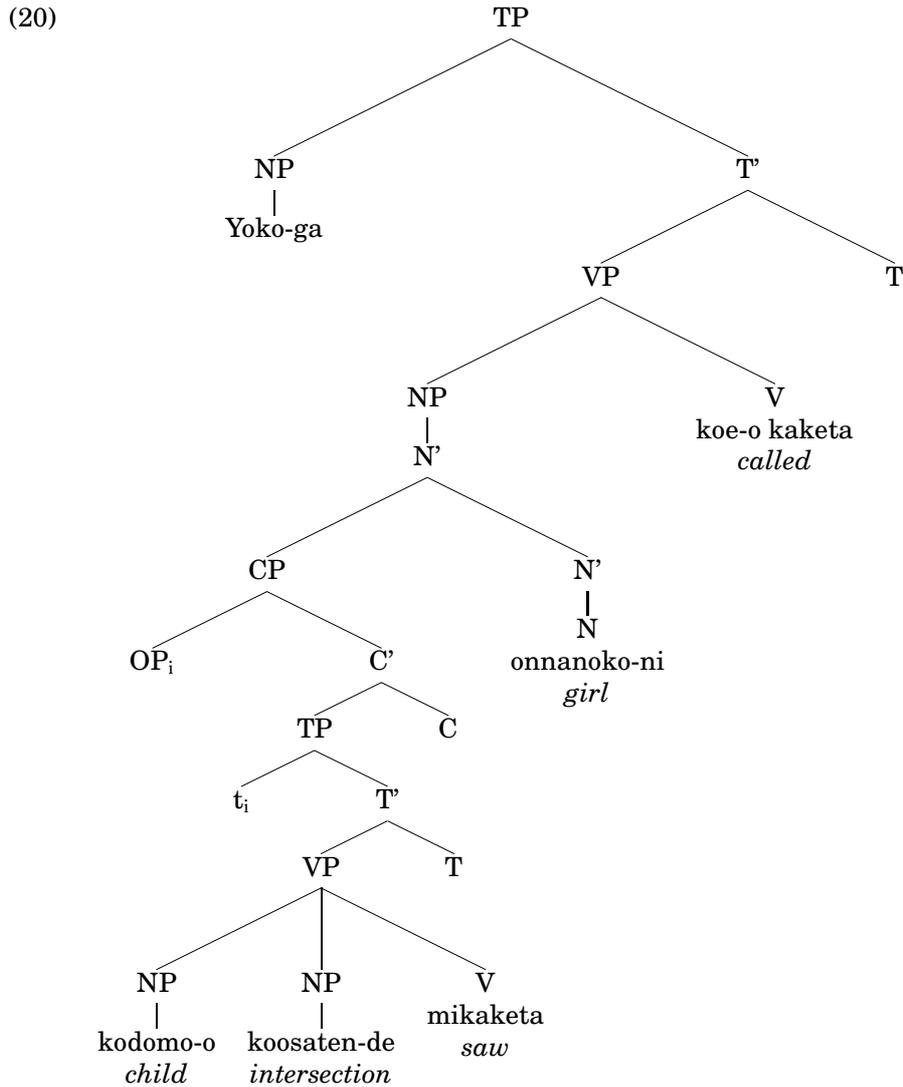
Let us first see how the rebuffering mechanism in (6) accounts for the unconscious reanalysis in (16). The parse goes as follows. When the verb *mikaketa* 'saw' is encountered, the first three NPs can be theta-attached in a single clause, as follows:



This main clause analysis has to be revised when *onnanoko-ni* 'girl' is encountered. *Yoko* has to be taken out of the structure, and then a relative clause can be built, where the relative operator associated with *onnanoko-ni* 'girl' can occupy the subject position, as in (19):



The two NPs thus constructed can be theta-attached when the matrix "verb" *koe-o kaketa* 'called' is encountered:



We see that the OLLC does not come into play, since the element that has to be reanalyzed, *Yoko-ga*, is not immediately reattached into the structure; it is sent back to the buffer.

We may wonder what exactly triggers the reanalysis at the point where *onnanoko-ni* 'girl' is encountered. Let us for the time being assume that the reanalysis leading to the situation in (19) has to occur because it comprises a step forward towards the right analysis, whereas maintaining the

main clause analysis will certainly not lead to a well-formed analysis of the string.

Now, let us look at the contrast with (17), repeated here as (21):

- (21) ¿Yoko-ga kodomo-o koosaten-de mikaketa takusii-ni  
 Yoko-NOM child-ACC intersection-LOC saw taxi-DAT  
 noseta  
 put-on  
 ‘Yoko put the child on the taxi she saw at the intersection.’  
 (Mazuka and Itoh’s (14a))

As noted, (21) is a problem for Pritchett’s rebuffering mechanism, since the sentence is a garden path, even though reanalysis is triggered by a non-theta-assigner and should thus be allowed by the rebuffering mechanism in (6).

As Mazuka and Itoh point out, the difference with the sentence in (16), which is not a garden path, is that in (21) both the initial subject and object need to be reanalyzed<sup>1</sup>, whereas in (16) only the initial subject is reanalyzed.

We can use Mazuka and Itoh’s insight to constrain the rebuffering mechanism in the following way: rebuffering is limited to one argument.

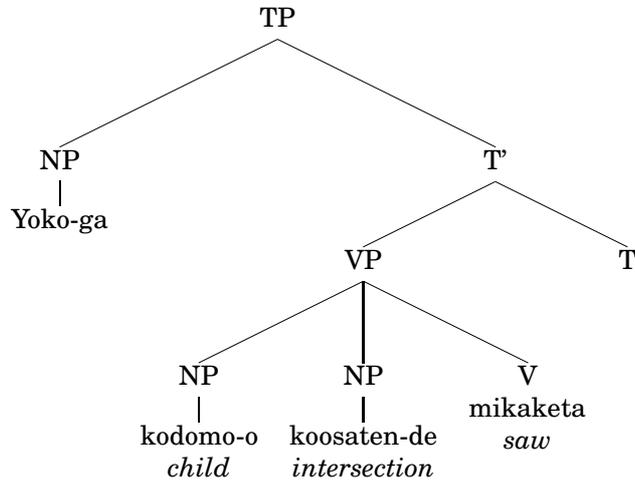
- (22) **Rebuffering mechanism (revision):** When the Human Sentence Processor encounters a non-theta-assigning element that disproves the analysis made so far, the structure is broken up; the elements that cannot be attached, are put back in the buffer. The rebuffering mechanism can only send one argument back to store.

With this constraint in mind, let us go over the parse of (21) in detail. The initial analysis is, again, a main clause analysis:

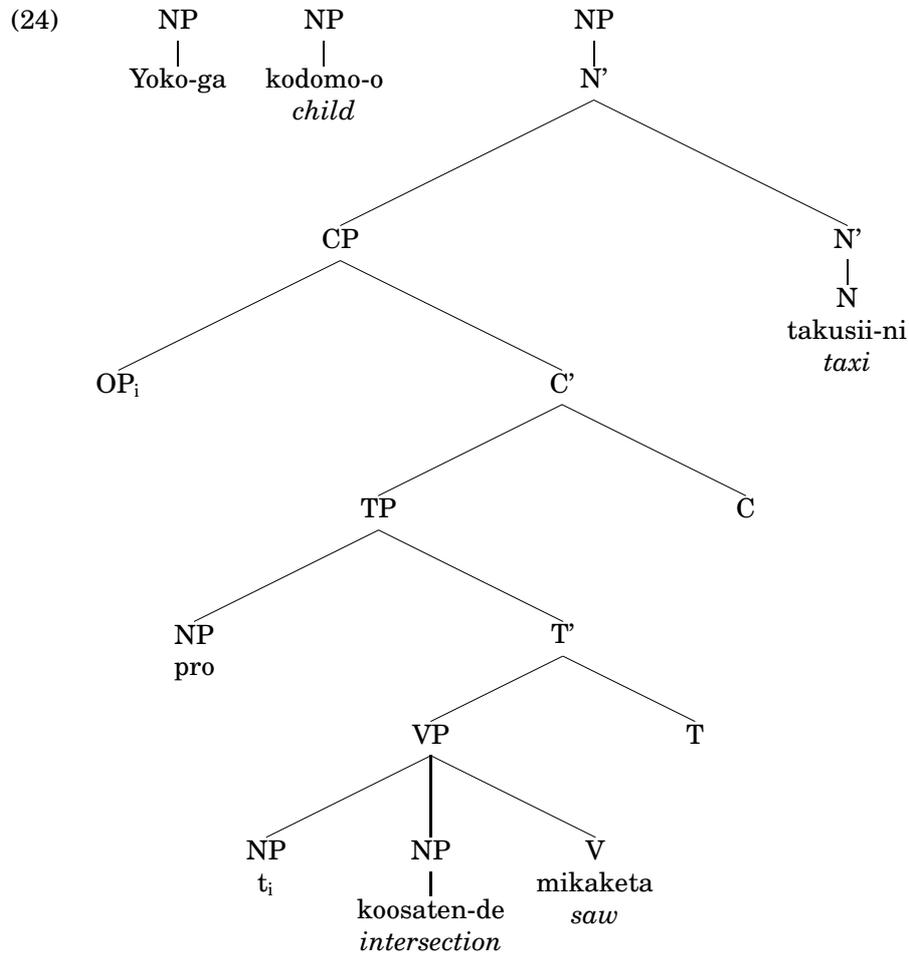
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<sup>1</sup>It should be noted that Mazuka and Itoh report that (21) is not as severe a garden path as most English cases are, but that it does induce conscious processing problems. I will come back to this in chapter 5.

(23)



When *takusii-ni* is encountered, the initial main clause analysis has to be revised to a relative clause analysis. Note that the selectional restrictions on *mikaketa* ‘saw’ are such that the trace of the relative operator associated with *takusii-ni* can only be attached as the direct object of *mikaketa*. This means that the direct object of the initial main clause analysis has to be taken out and sent back to store, and it also means that there is no subject available for the relative clause, so we have to insert a *pro* there. The resulting situation is as follows:



But by the rebuffering mechanism as constrained in (22) we are allowed to take out only one argument; this means that the situation in (24) cannot arise.

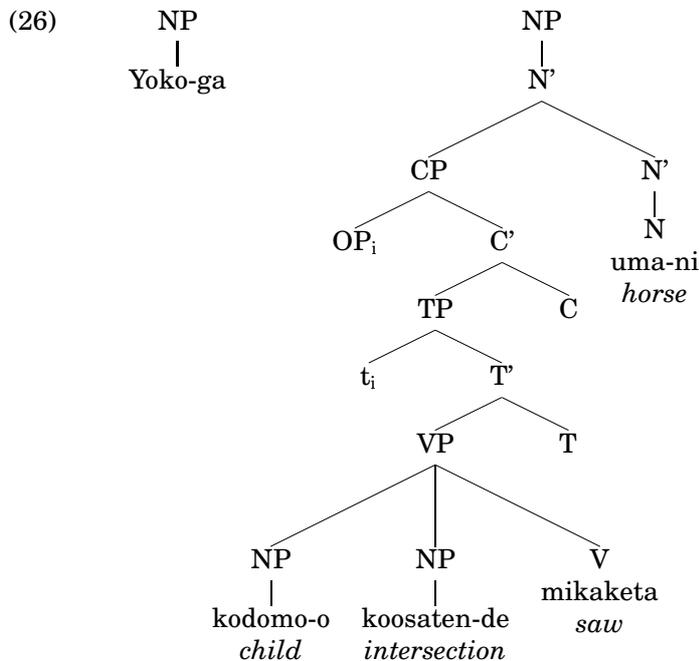
Note that the crucial difference between (16) and (17) is that the head noun which forces the reanalysis can be construed as the subject of the relative clause which it heads in (16), whereas it cannot in (17). The reason for this is that *girl* is a possible subject for *saw*; *taxi* is not, since it is inanimate. This means that *taxi* can only be construed as the direct object of *saw* in the relative clause it heads, which means that both the subject and the object have to be taken out and sent back to store. And it is this move which violates the constrained rebuffering mechanism (22).

We therefore expect that if we replace *taxi* in (17) with an animate NP which can be the subject of *saw*, the sentence is not a garden path. This

prediction is borne out.<sup>2</sup>

- (25) <sub>OK</sub>Yoko-ga kodomo-o koosaten-de mikaketa uma-ni  
 Yoko-NOM child-ACC intersection-LOC saw horse-DAT  
 noseta  
 put-on  
 'Yoko put him/her on the horse that saw the child at the intersection.'

At the relevant point in the parse, the discovery of *uma-ni* 'horse', the following structure can be built:

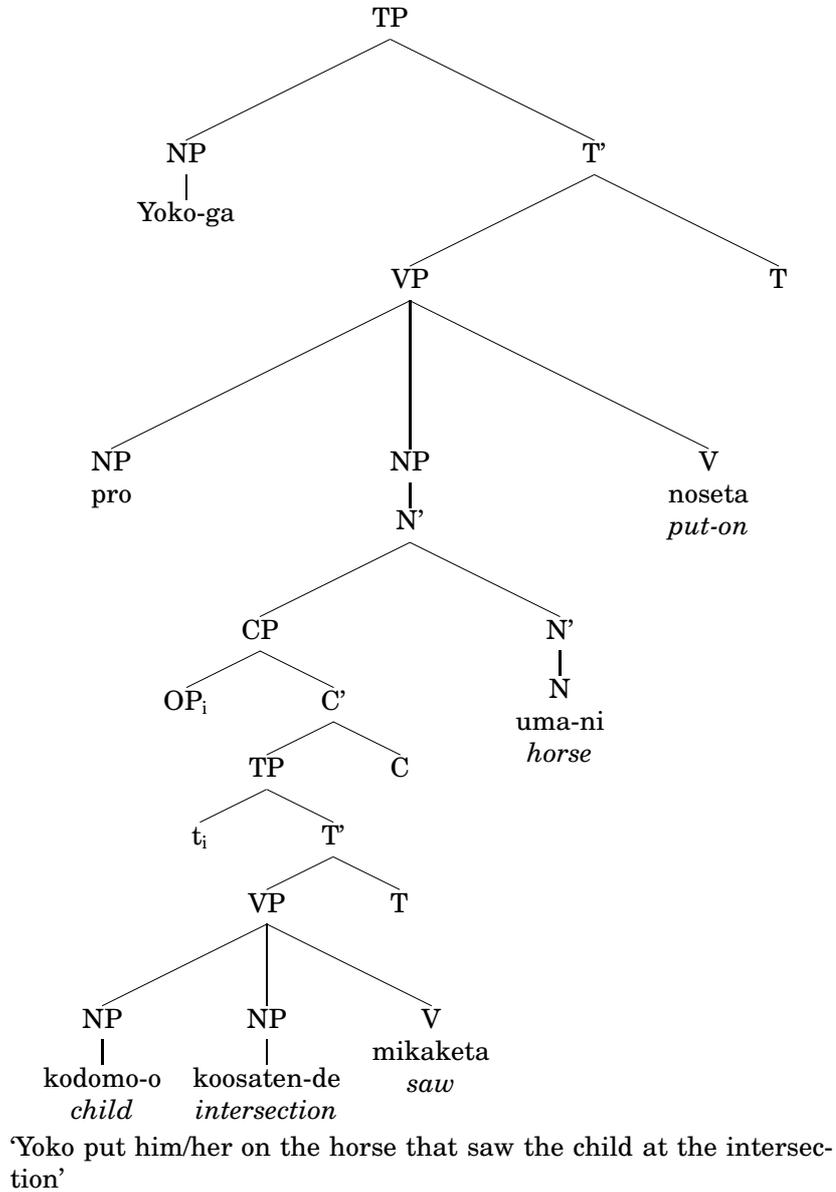


The reanalysis from the initial main clause analysis to the analysis in (26) is possible because it involves taking out only one argument, *Yoko*, from the initial analysis; the reanalysis thus satisfies constraint (22).

When the matrix verb is discovered, the two NPs formed in (26) can be integrated. Since *noseta* 'put on' requires three arguments, a *pro* argument is inserted at this point to fill the direct object position in the main clause. The resulting structure is the following:

<sup>2</sup>Example from Taka Hara (p.c.).

(27)



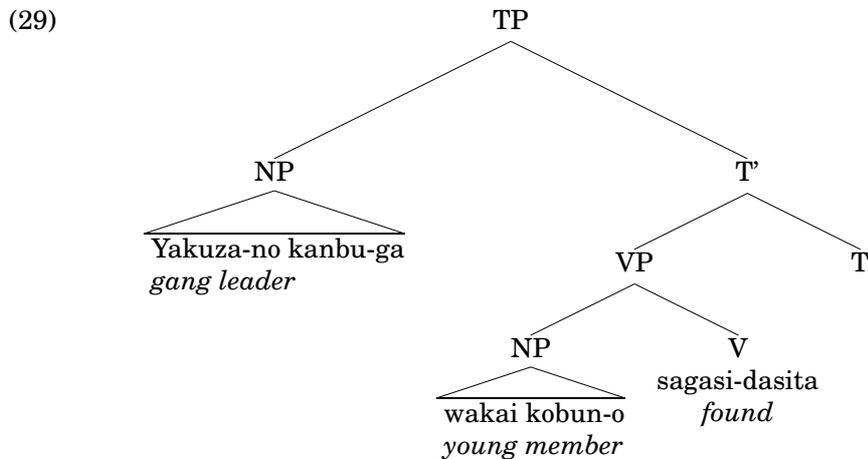
#### 4.2.2 Similar cases

Mazuka and Itoh (1995) provide some more contrasts in possible versus impossible reanalysis triggered by a non-theta-assigner. These contrasts are very similar structurally to the contrast between (16) and (17); they can also be accounted for with the constrained rebuffering mechanism in

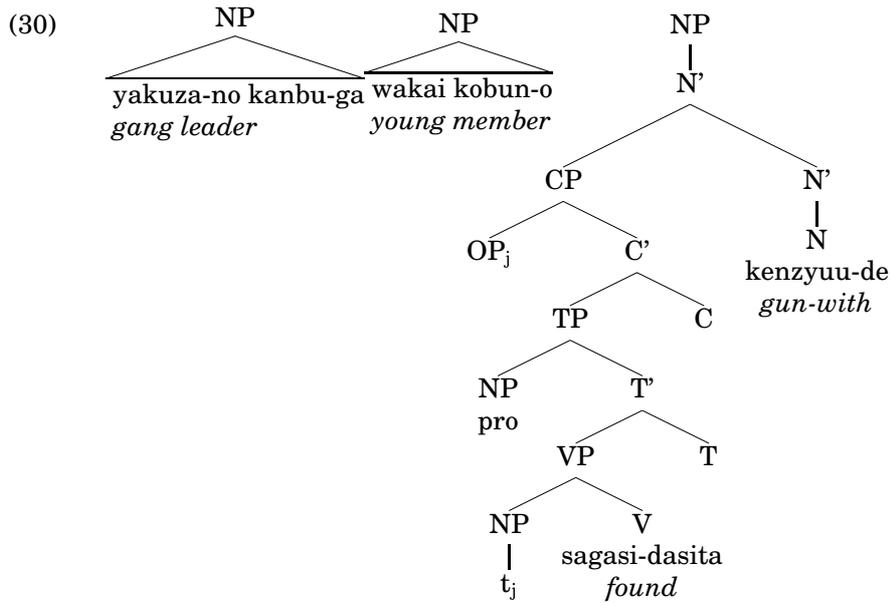
(22). Consider, for instance, the following sentences:

- (28) a. ¿Yakuza-no kanbu-ga wakai kobun-o sagasi-dasita  
 gang-GEN leader-NOM young member-ACC found  
 kenzyuu-de utikorosite simatta  
 gun-with shot to death  
 ‘The leader of the gang [shot; IM] the young member to death  
 with the gun he found.’
- b. <sub>OR</sub>Yakuza-no kanbu-ga wakai kobun-o sagasi-dasita  
 gang-GEN leader-NOM young member-ACC found  
 otoko-ni rei-o itta  
 man-DAT thanked  
 ‘The leader of the gang thanked the man who found the young  
 member of the gang’  
 (Mazuka and Itoh’s (15))

The parse of (28a), which is a garden path, goes as follows. The initial analysis is a main clause analysis:

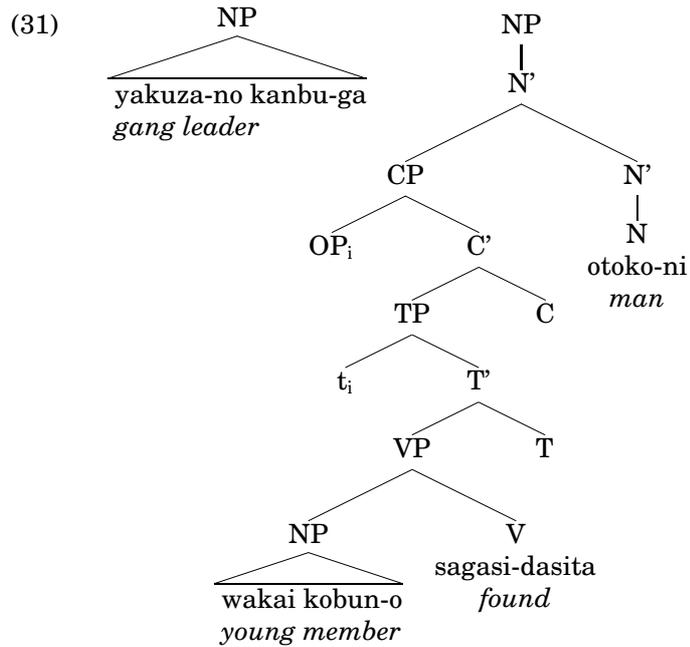


This analysis must be revised to a relative clause analysis when the head noun *kenzyuu-de* ‘gun’ is encountered. Since the trace of the relative operator associated with it can only be attached as the direct object of the verb *sagasi-dasita* ‘found’, both the subject and the object have to be taken out of the initial structure and sent back to store:



This move is not permitted by (22), so the parse breaks down.

Let us now look at the permitted reanalysis in (28b). The initial main clause analysis in (29) has to be revised when the head noun *otoko-ni* 'man' is encountered. The trace of the relative operator associated with it can be attached as the subject of the relative clause, so we get the following structure:

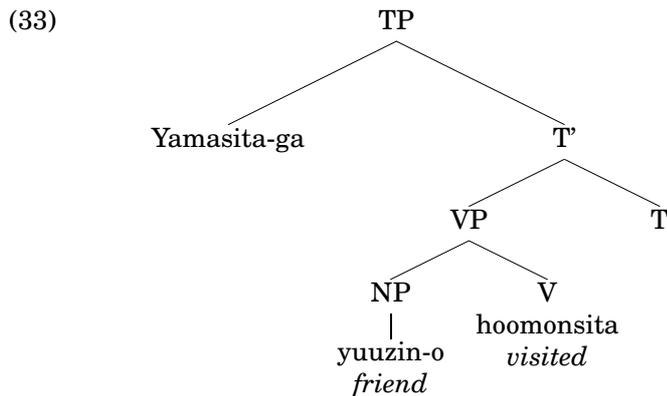


The only element we need to send back to store in order to build this structure is the original subject of the main clause analysis, *yakuza-no kanbu-ga* 'gang leader'. This is permitted by (22), and the sentence is easily processed. The two NPs thus constructed in (31) can be integrated without problems when *rei-o itta* 'thanked' is discovered.

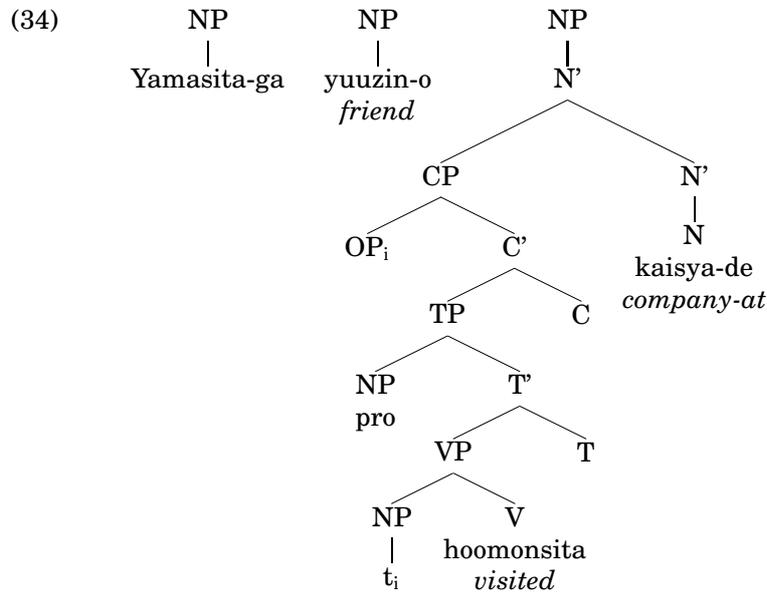
The other contrast similar to the contrast between (16) and (17) mentioned by Mazuka and Itoh is the following:

- (32) a. ĵHati-gatu-ni natte kara, Yamasita-ga yuuzin-o  
 August-to became after Yamasita-NOM friend-ACC  
 hoomonsita kaisya-de mikaketa  
 visited company-at saw  
 ‘After it turned into August, Yamasita saw his friend at the  
 company he visited.’
- b. <sub>OK</sub> ĵHati-gatu-ni natte kara, Yamasita-ga yuuzin-o  
 August-to became after Yamasita-NOM friend-ACC  
 hoomonsita siriai-ni tegami-o kaita  
 visited acquaintance-to letter-ACC wrote  
 ‘After it turned into August, Yamasita wrote a letter to an ac-  
 quaintance who visited his friend.’  
 (Mazuka and Itoh’s (16))

The breakdown in (32a) is basically the same as in (28a). The initial analysis is a main clause analysis:

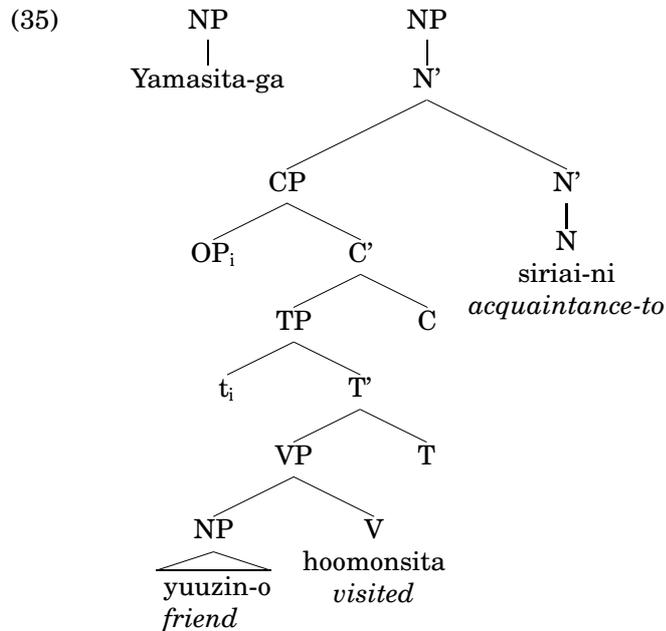


Discovery of the head noun *kaisya-de* ‘company’ leads to reanalysis:



This reanalysis is not permitted by (22), since it involves sending two NPs back to store.

However, the reanalysis in (32b) *is* permitted by (22), since it involves sending only one argument back to store:



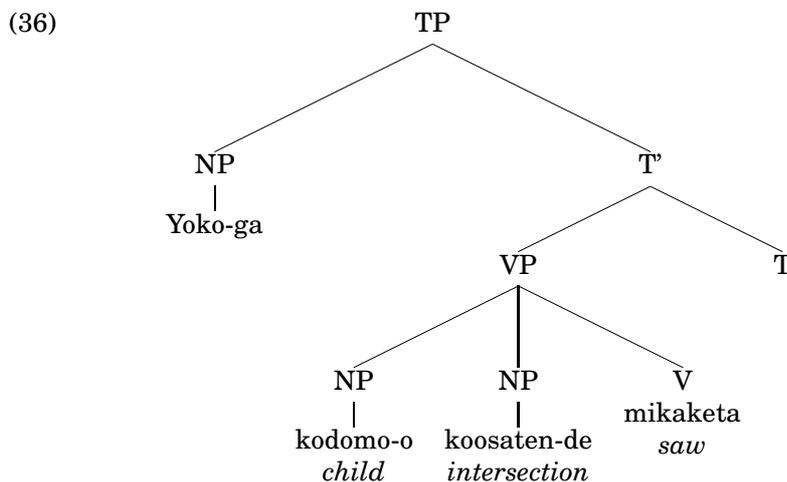
The next input consists of *tegamio* ‘letter’, which added to the store. When the matrix verb *kaita* ‘wrote’ is encountered, the three NPs in store can be integrated to form a main clause.

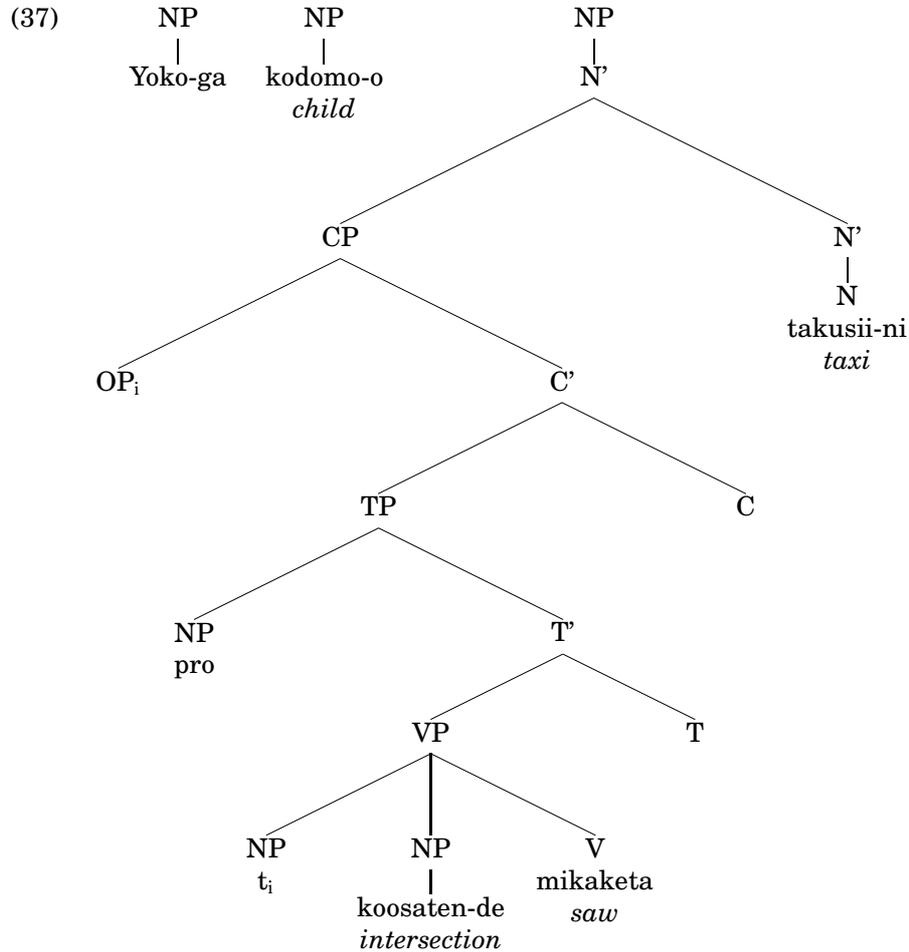
### 4.2.3 Why would rebuffering be restricted to one argument?

We have seen in the previous section that if we constrain the mechanism of sending back to store as in (22), we can account for the contrasts in processing difficulty between cases where the head noun forces reanalysis of one element, and cases where the head noun forces reanalysis of two elements. The question is, of course, why the rebuffering mechanism would be so constrained that it is able to send only one argument back to store. I have no clear understanding of why this should be so; in this section I will discuss some evidence that at least provides us with some information as to what is *not* the true nature of the constraint.

#### Additional violation of the Theta Criterion is not the reason

Let us take a step back, and look again at the exact point in the parse that we are constraining. The step in the parse that is constrained by (22) is the reanalysis from (23), repeated here as (36), to (24), repeated here as (37):





A potential reason why the move in (37) is not allowed could be that the situation in (37) is a deterioration with respect to Theta Attachment, if we compare it to the situation where we leave the new input, *takusii-ni*, unattached. If we choose to do that and maintain the main clause analysis in (36), we get one theta criterion violation (*takusii-ni* needs a theta role). If we reanalyze to the situation in (37), however, we end up with three violations of the theta criterion: *Yoko*, *kodomo*, and the NP headed by *takusii-ni* need a theta role.

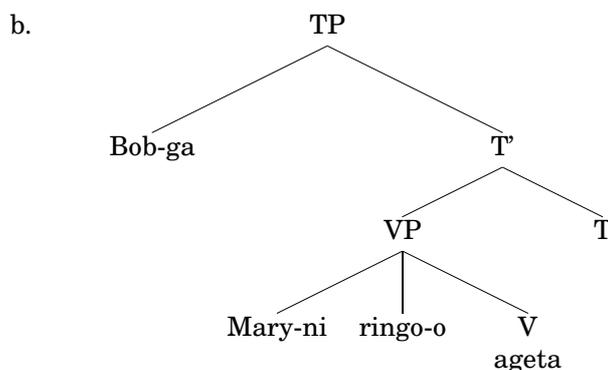
However, note that a similar deterioration arises in cases of permitted reanalysis induced by a head noun. Reconsider for instance the reanalysis from (33) to (35). If we take out one element from the initial main clause analysis in (33), we move to a situation where the rebuffed NP violates the theta criterion, as well as the NP that contains the relative clause (in the buffer displayed in (35)). Since the alternative, not reanalyzing and

storing the head noun, involves only one violation of the theta criterion, it seems that this option would be preferable for Theta Attachment.

So a desire for minimization of the number of theta criterion violations does not seem to be the factor which rules out the reanalysis in (37).

Note that in principle, it is perfectly fine to store three case-marked NPs, as in (37). Consider for instance (3a) from chapter 3, repeated here as (38a):

- (38) a. Bob-ga Mary-ni ringo-o ageta.  
 Bob-NOM Mary-DAT apple-ACC gave  
 'Bob gave Mary the apple'  
 (Schneider's (1999) (97))



The structure in (38b) can only be built when the verb *ageta* 'ate' is encountered; until then, the three preceding NPs have to be stored. This storage of three arguments is fine.

We have to conclude that the fact that the reanalysis to (37) results in a situation where the buffer contains three NPs, cannot be the reason why the reanalysis is disallowed.

### It is not a subject phenomenon

From the data we have looked at so far, one might get the impression that only subjects can be put back in store, and that the factor that disallows the reanalysis to (37) is that it involves taking out a direct object. This is not true, however; direct objects can also be reanalyzed.

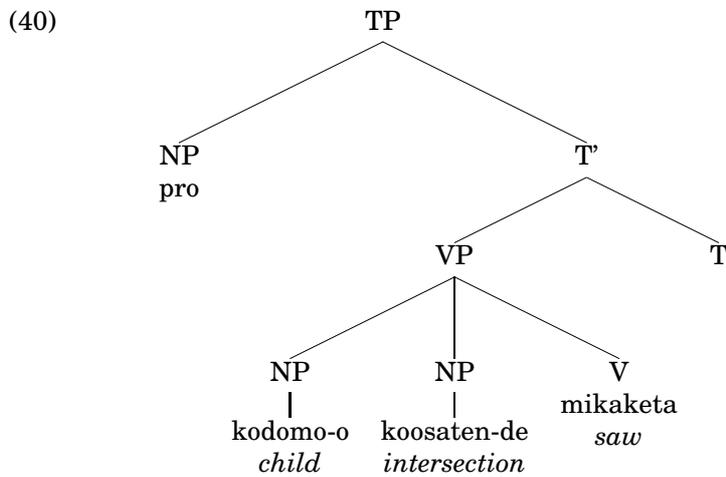
To see this, consider the following. Mazuka and Itoh point out that (21) is not a garden path if the subject NP is dropped<sup>3</sup>:

<sup>3</sup>It is possible in Japanese to drop arguments; it is generally assumed that the argument position is then filled with a phonologically empty pronoun.

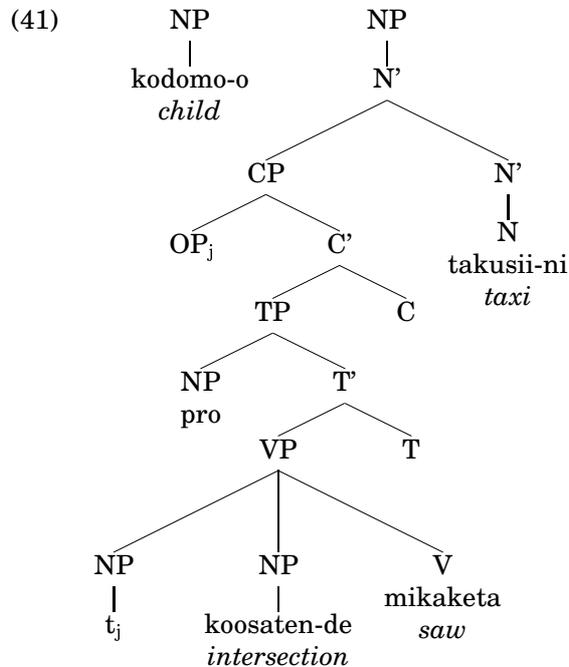
- (39)  $_{\text{OK}} \emptyset$  kodomo-o koosaten-de mikaketa takusii-ni noseta  
 child-ACC intersection-LOC saw taxi-DAT put-on  
 ‘ $\emptyset$  put the child on the taxi she saw at the intersection’  
 (Mazuka and Itoh’s (18a))

To see what is going on here, let us go over the parse for (39).

The initial analysis for the first part of the string is a simple main clause; since there is no NP that could function as the subject of the sentence, a *pro* subject is inserted:

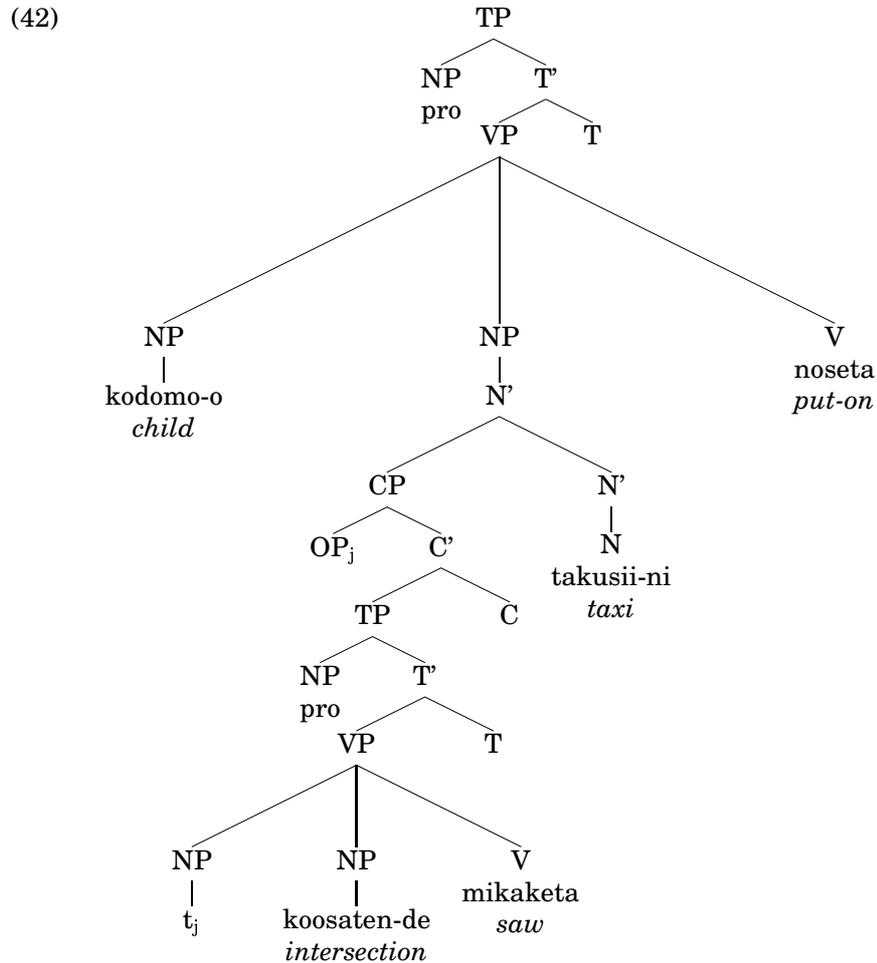


When *takusii-ni* is encountered, this structure has to be reanalyzed. *Kodomo-o* ‘child’ has to be taken out, and the trace of the relative operator is put in its place:



Note that the *pro* in subject position can stay there, since it is a phonologically empty element, which can occur anywhere in the string. Since *kodomo-o* is the only element that needs to be put back in store, the reanalysis satisfies constraint (22). Note that the element which is taken out is the direct object of the initial main clause analysis.

The parse is completed when *noseta* 'put on' is encountered. The two NPs that are in store at this point can be integrated into a single structure without problems. Since there is no NP available that could be inserted as the matrix subject, a *pro* is inserted in the matrix subject position. The resulting structure is as follows:



We see that in cases with a *pro* subject in the main clause, the constrained rebuffing mechanism in (22) makes the right predictions; and that it is perfectly fine to send a direct object back to store.

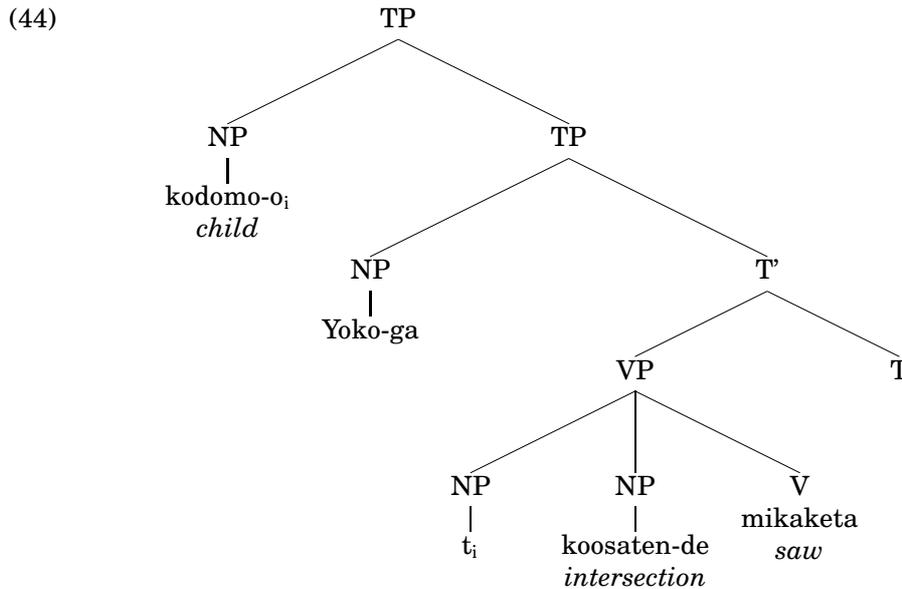
Reanalysis is also permitted when the element which is taken out is a scrambled direct object, as in (43):

- (43) <sub>OK</sub> Kodomo-o [Yoko<sub>i</sub>-ga [ $\emptyset_i$   $\emptyset_j$  koosaten-de mikaketa]  
 child-ACC Yoko-NOM intersection-LOC saw  
 takusii<sub>j</sub>-ni noseta]  
 taxi-DAT put-on  
 'Yoko placed the child on the taxi she saw at the intersection'  
 (Mazuka and Itoh's (46c))

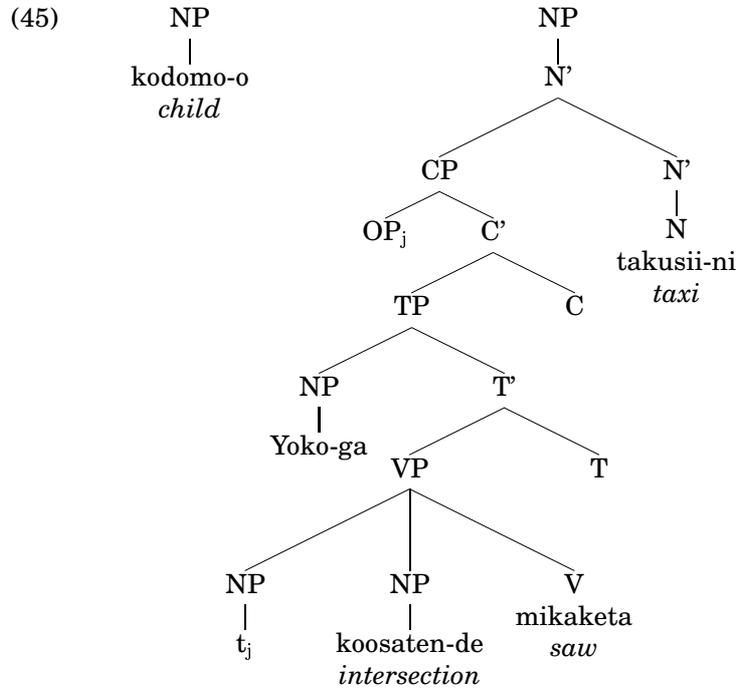
This sentence differs from the garden path sentence in (21) in only one

way: the direct object *kodomo-o* ‘child’ is scrambled to sentence-initial position. But, strikingly, where (21) is a garden path, (43) is not.

Let us see how (22) would deal with this. The analysis at the point of discovery of the first verb *mikaketa* looks roughly like this:

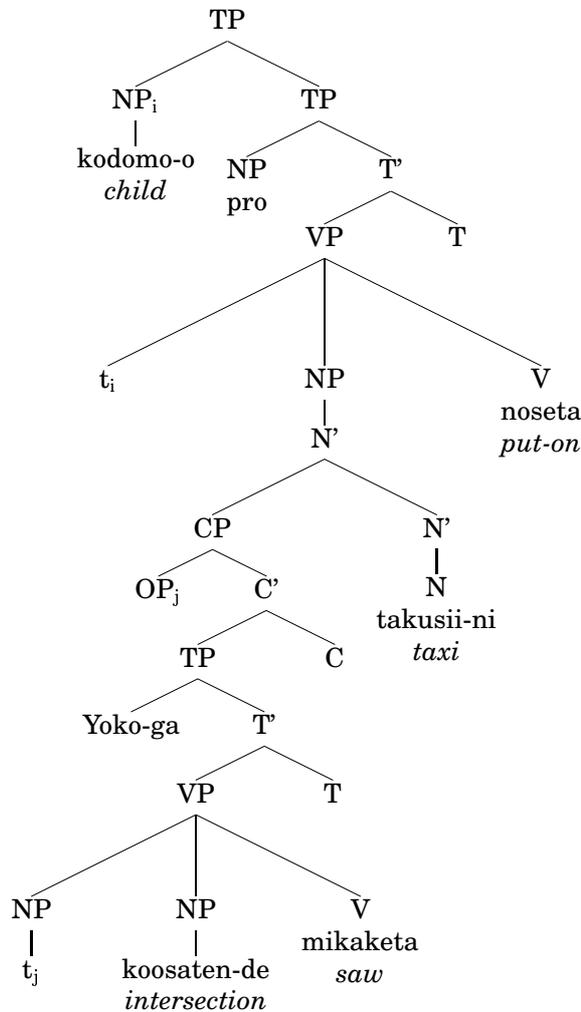


Next, *takusii-ni* is encountered. The initial analysis now needs to be revised. By (22), we can only take out one argument. This argument has to be *kodomo-o* ‘child’; its position is replaced by the trace of the relative operator in the final structure. We then get the following structure:



When the matrix verb *noseta* 'put on' is encountered, the NP headed by *takusii-ni* and the NP *kodomo-o* 'child' can be attached as arguments of the matrix verb. There is no subject available for the matrix verb, so a *pro* has to be inserted in the matrix subject position. The resulting structure is the following:

(46)



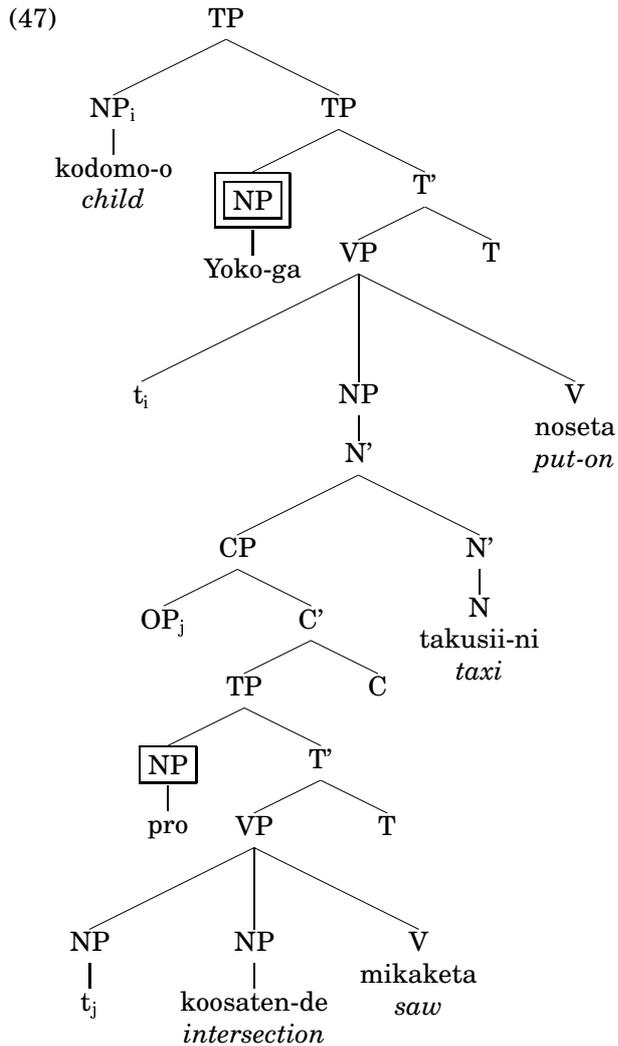
(Mazuka and Itoh's (46d))

Again, we see that a scrambled direct object can be sent back to store, if the original subject of the main clause analysis can stay in the relative clause.

However, the resulting structure actually is not the one we are looking for; the resulting structure has *Yoko* in the subject position of the relative clause, not in matrix subject position. According to Mazuka and Itoh, this is also a possible interpretation for the string in (43), but it is not the preferred interpretation.

I prefer to look upon this as a separate problem, however. It looks as though in order to get the preferred interpretation of (43), with *Yoko* in the matrix subject position, we have to reanalyze *Yoko* as soon as the matrix

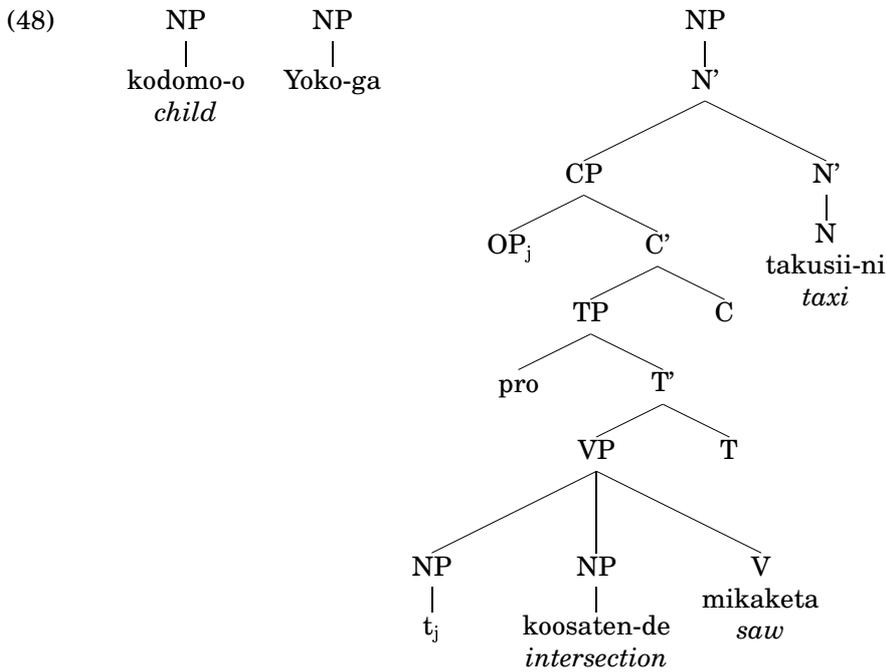
verb *noseta* ‘put on’ is encountered, and put a *pro* in its original position. This reanalysis is not triggered by the head noun, but by the matrix verb. It is a problem for Pritchett’s model, because this move is not permitted by the OLLC:



It is clear that the source position does not govern or dominate the target position in (47).

The problem arises in this form in case the reanalysis of *Yoko* takes place when the matrix verb is encountered. I'm assuming that the parse of the string in (43) involves two instances of reanalysis: reanalysis of the scrambled direct object when *takusii-ni* ‘taxi’ is encountered, and reanaly-

sis of *Yoko* when the matrix verb is encountered. It is the latter step which violates the OLLC. We might try to find a solution to this problem along the following lines; the point in time where *Yoko* is reanalyzed, is actually before the matrix verb is discovered; it also takes place when *takusii-ni* is encountered. That would mean that at that point, the buffer would come to look like this:



However, this analysis not only violates our constraint (22), it also violates Theta Attachment. *Yoko* can receive a theta role from *mikaketa* 'saw' if it is placed in the subject position in the relative clause (as it does in the buffer represented in (45)), and so it should.

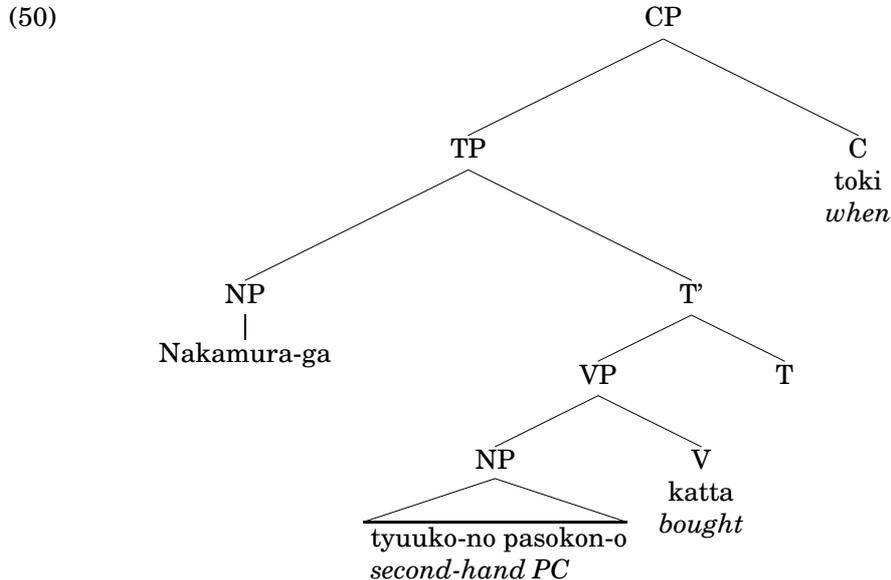
So the question remains, Why can the overt subject of the relative clause be reanalyzed as the subject of the higher clause, and the relative clause subject be replaced by *pro*? Interestingly, exactly this situation arises in the other counterexamples that Mazuka and Itoh provide against Pritchett's model. These counterexamples involve exactly this type of reanalysis at the point of discovery of the matrix verb, and this reanalysis does not lead to any conscious processing difficulty. We will look at these cases in the next section.

### 4.3 Permitted reanalysis forced by the matrix verb

In the previous section, we looked at cases of reanalysis forced by a non-theta-assigner; we also saw one case, (43), which involved one instance of reanalysis forced by a non-theta-assigner, and one instance of reanalysis forced by a theta-assigner. Another instance of the latter phenomenon, where reanalysis is forced by a theta-assigner but does not lead to a garden path effect, is the following (=14):

- (49) Nakamura-ga  $\emptyset$  tyuuko-no pasokon-o katta toki  
 Nakamura-NOM second-hand PC-ACC bought when  
 syuuri-site-kureta  
 repaired (for me)  
 ‘When I/(he/she) bought a second-hand computer, Nakamura re-  
 paired it for me.’  
 (Mazuka and Itoh’s (9)=(37))

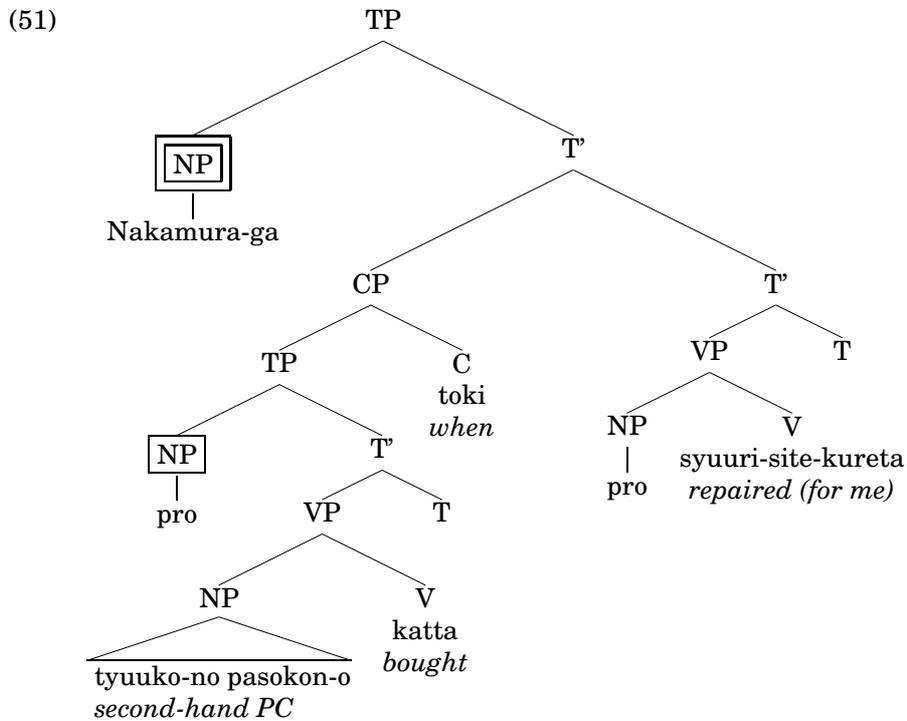
Up until the point of *toki* ‘when’, the string is straightforwardly analyzed as an adverbial clause:



Now, when the matrix verb *syuuri-site-kureta* ‘repaired for me’ is encountered, it becomes clear that this is not the right analysis. As Mazuka and Itoh explain, the verb *syuuri-site-kureta* is a special verb form that is used when the speaker is the beneficiary of the action expressed by the verb – *site kureta* means something like ‘someone did – for my benefit’. Because

of this meaning, the verb *syuuri-site-kureta* ‘repaired for me’ cannot take a *pro* as its subject which is interpreted as the speaker.<sup>4</sup> Mazuka and Itoh report that it is possible to interpret the string in (49) with a *pro* in matrix subject position referring to a third person, but according to them this reading is difficult to obtain without a proper context.

This means that at the point of discovery of the matrix verb, the subject inside the embedded clause has to be reanalyzed as the subject of the matrix clause, and the subject position inside the embedded clause has to be filled with a *pro*.



<sup>4</sup>Mazuka and Itoh contrast (49) with the following example:

- (i) Nakamura-ga tyuuko-no pasokon-o katta toki  $\emptyset$  syuuri-site-yatta  
 Nakamura-NOM second-hand PC-ACC bought when repaired  
 ‘When Nakamura<sub>i</sub> bought a second-hand personal computer, (I<sub>j</sub>) repaired (it) for him<sub>i</sub>,’  
 (Mazuka and Itoh’s (10))

In this case, because a different verb form is used which does not mean that the speaker is the beneficiary, a *pro* referring to the speaker can be inserted in its subject position, and no reanalysis is necessary when the matrix verb is encountered; *Nakamura* therefore stays in the subject position of the embedded clause. According to Mazuka and Itoh, (49) and (i) ‘are alike in their ease of comprehension’ (p.303).

This case is similar to the case in (47), in that it involves reanalyzing a subject from an embedded clause to a higher clause, and filling its original position with a *pro* argument.

The reanalysis we see here dramatically violates the OLLC. The source position does not dominate the target position, nor does the source position govern the target position; it doesn't even m-command it. Also intuitively, the reanalysis seems rather drastic: an argument is removed from the licensing domain of its original theta-assigner (*katta* 'bought'), to the domain of a theta-assigner in a higher clause (*syuuri-site-kureta* 'repaired for me'). Intuitively, this is all the more strange, because under reasonable assumptions we would expect the domain of the original theta-assigner to have been closed already by the time of discovery of the theta-assigner that forces the reanalysis.

Let us not worry now about the oddness of the phenomenon observed here, and simply state the observation as follows.

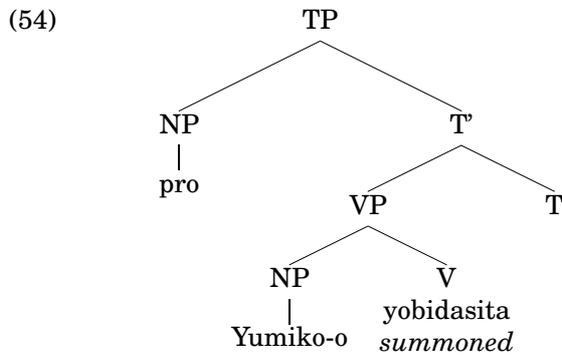
- (52) Observation: the human sentence processor is able to perform reanalysis of an argument from an embedded clause to a position outside the embedded clause

As noted, we have seen instances of this phenomenon in (47) and (51). In these cases, the element reanalyzed from the embedded clause was the subject. We may wonder if the direct object can also undergo the same type of reanalysis.

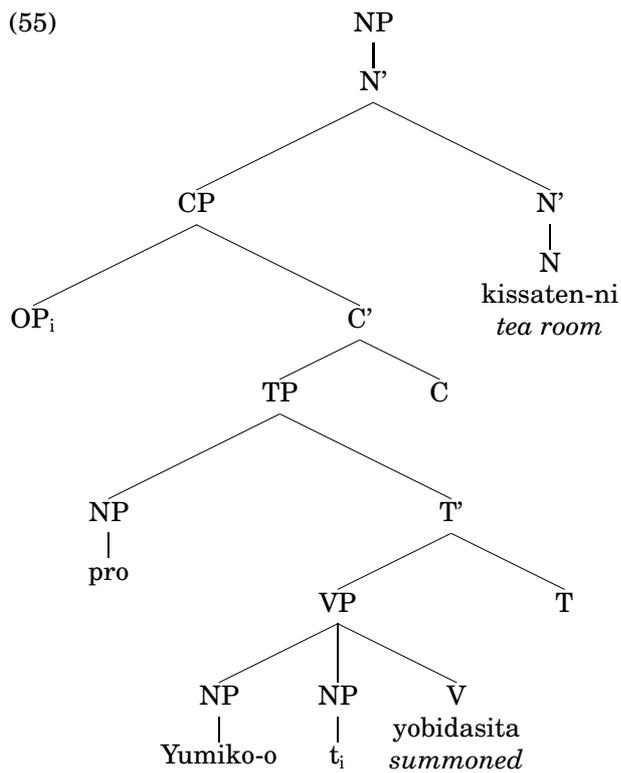
Indeed, it can, when the subject of the main clause is a *pro*. Consider the following sentence:

- (53)  $\text{OK } \emptyset$  Yumiko-o yobidasita kissaten-ni nagai koto mata-seta  
 Yumiko-ACC summoned tea room-LOC long time wait-made  
 ' $\emptyset$  made Yumiko wait for a long time at the tea room to which he  
 summoned her'  
 (Mazuka and Itoh's (18b))

This sentence is parsed as follows. First, a main clause is built with a *pro* in subject position:

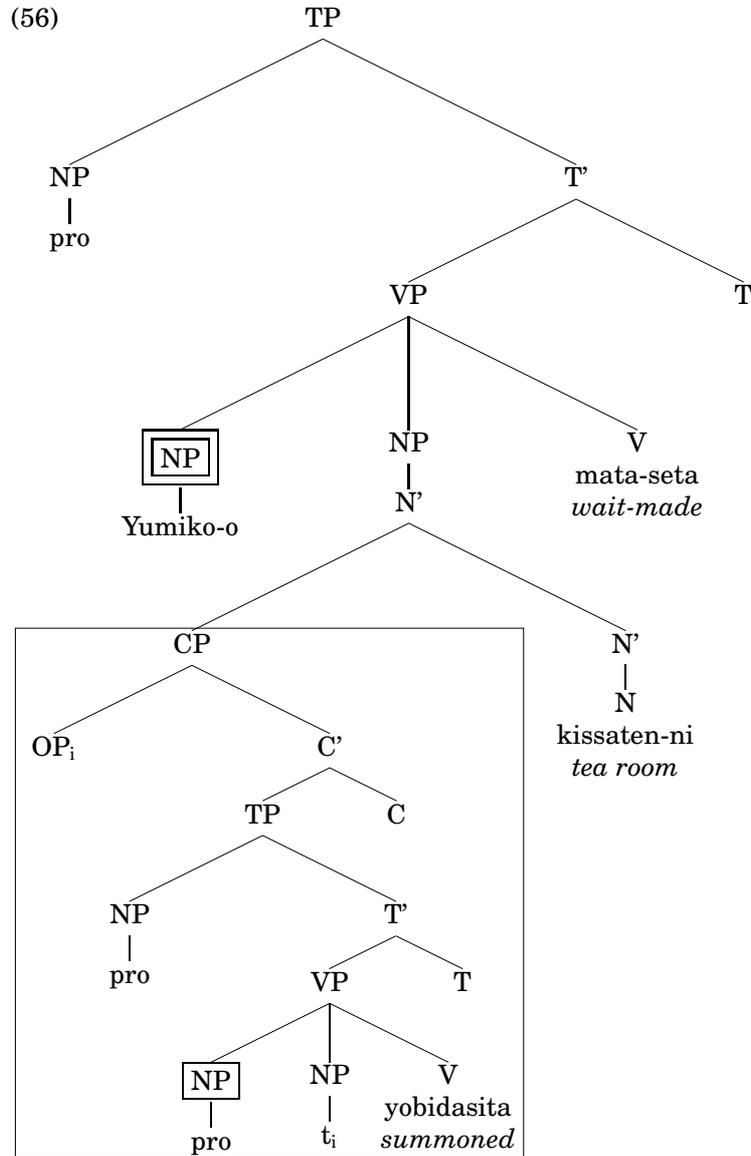


When *kissaten* ‘tea room’ is encountered, this main clause is attached as an adverbial relative clause to this NP.



‘The tea room where I/he summoned Yumiko.’

Now, when the matrix verb *mata-seta* ‘made wait’ is encountered, *Yumiko* has to be reanalyzed. The *pro* in the subject position inside the relative clause headed by *kissaten-ni* ‘tea room’ can be maintained, and a *pro* is inserted in the subject position in the main clause.

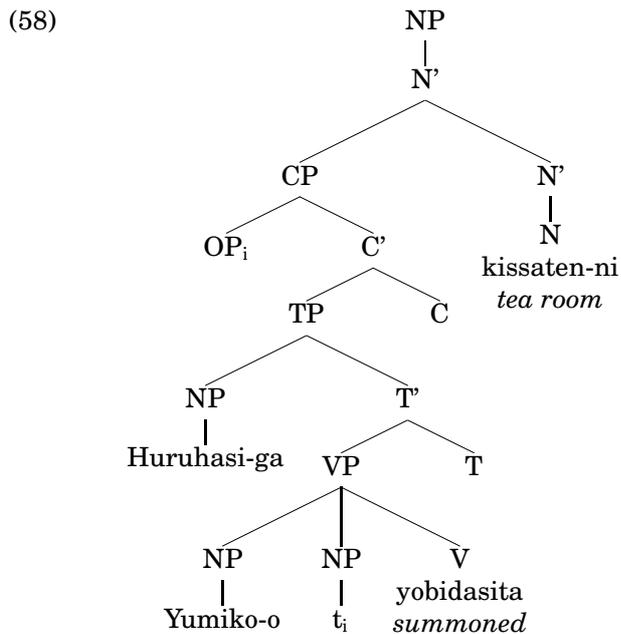


In the structure above, I boxed the embedded clause from which the reanalysis takes place, to make it clearer that the phenomenon we are dealing with, is similar to the phenomenon we saw in (47) and (51): reanalysis of an argument from an embedded clause to a higher clause. As noted, this reanalysis of the direct object does not lead to conscious processing problems.

However, when the embedded clause has an overt subject, it is not possible to reanalyze both the subject and the object to the main clause:

- (57) ¿Huruhasi-ga Yumiko-o ∅ ∅ yobidasita kissaten-ni  
 Huruhashi-NOM Yumiko-ACC pro pro summoned tea room-LOC  
 nagai koto mata-seta  
 long time wait-made  
 ‘Huruhasi made Yumiko wait for a long time at the tea room to  
 which he summoned her.’  
 (Mazuka and Itoh’s (17c)=(37))

Let us look at the parse of the string in (57). Again, the initial analysis of the first part of the string is a straightforward main clause analysis. When the head noun *kissaten* ‘tea room’ is encountered, the main clause in (57) is attached as a relative clause to this NP.

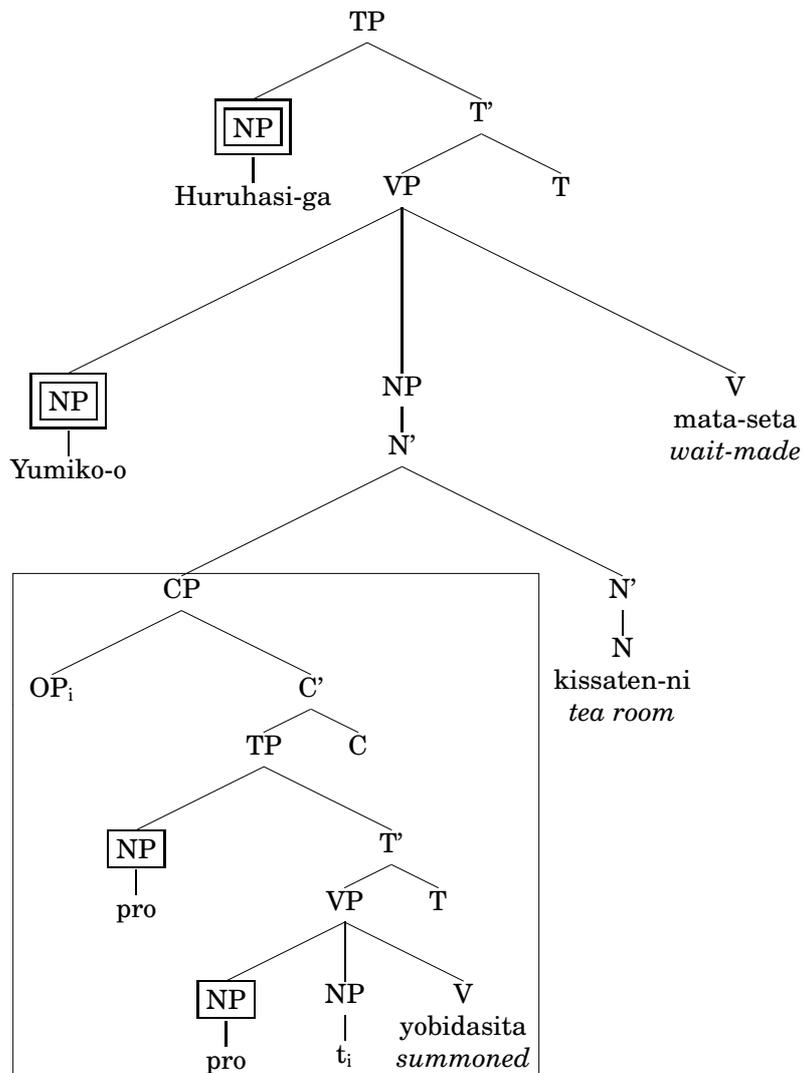


‘The tea room where Huruhasi summoned Yumiko.’

This analysis has to be revised when the matrix verb *mata-seta* ‘made-wait’ is encountered. The verb requires two arguments, a subject and an object. In order to satisfy these requirements, the subject and the object inside the relative clause (the initial main clause) would have to be removed, and replaced with *pro*. Consider the resulting structure (where I omitted the

adverb *nagai koto* 'long time' for simplicity):

(59)

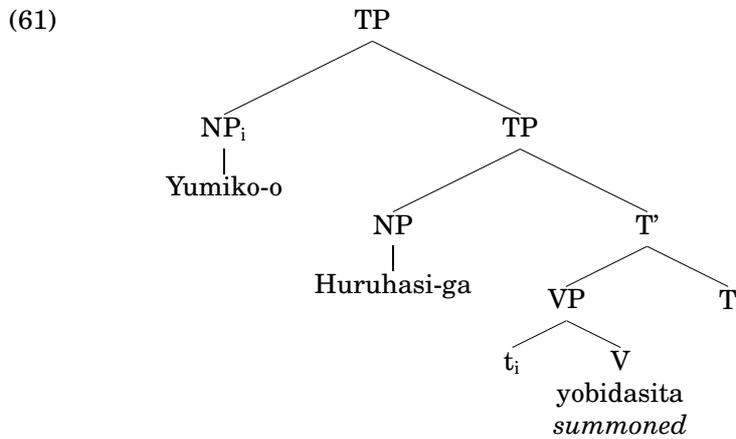


As noted, this reanalysis leads to conscious processing problems.

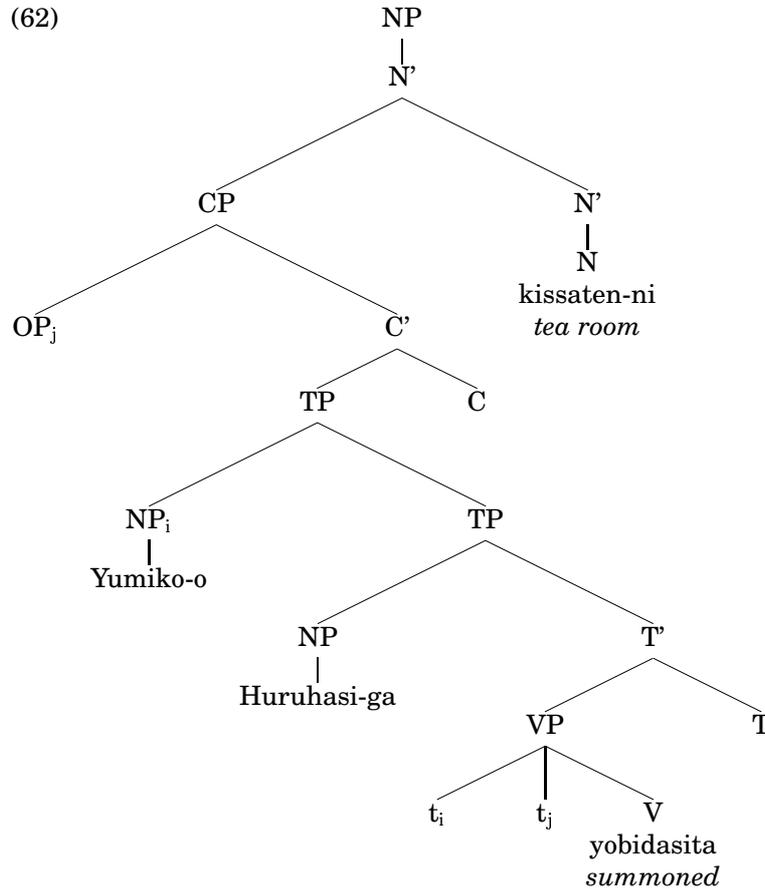
However, and quite spectacularly, it *is* possible to reanalyze both the subject and the object to satisfy the requirements of the matrix verb, if the object is in a scrambled position:

- (60) <sub>OK</sub> Yumiko-o Hurahasi-ga yobidasita kissaten-ni  
 Yumiko-ACC Hurahasi-NOM summoned tea room-LOC  
 nagai koto mata-seta  
 long time wait-made  
 ‘Hurahasi made Yumiko wait for a long time at the tea room  
 to which he summoned her.’  
 (Mazuko and Itoh’s (19b))

This sentence is parsed as follows. First, a main clause analysis is built with the direct object *Yumiko-o* in scrambled position:

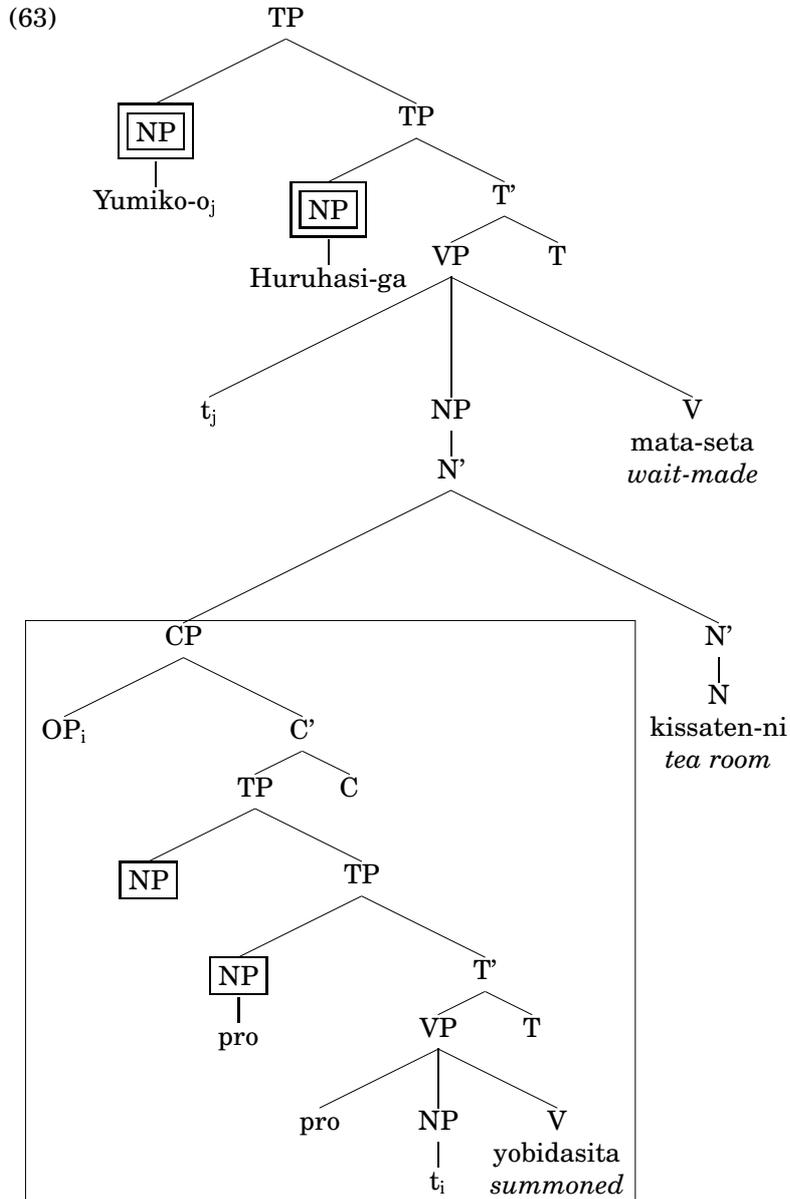


When *kissaten-ni* ‘tea room’ is encountered, the main clause in (61) is revised to a relative clause.



'The tea room where Huruhasi summoned Yumiko.'

This analysis has to be revised when the matrix verb *mata-seta* 'made-wait' is encountered. The verb requires two arguments, a subject and an object. In this case, the subject and object inside the relative clause apparently *can* be removed. The resulting structure is the following:



We have now seen four examples of unproblematic reanalysis of arguments from an embedded clause to the main clause, triggered by the matrix verb. Such reanalysis can be performed automatically when the subject is the only element removed (as in (47) and (51)), or when the object is the only element removed (as in (56)), or when both the subject and the object are removed if the object has been scrambled over the subject (as in (63)).

Reanalysis of both subject and object cannot be performed automatically, however, when the object is inside the VP (as in (59)).

These cases of reanalysis are all disallowed by the OLLC: the OLLC is too restrictive. The cases discussed in this section cannot be solved by resorting to our (revised) rebuffering mechanism in (22). The OLLC will have to be reformulated in such a way that it will allow for the cases of automatic reanalysis discussed in this section. In the next section, we will see how the OLLC can be extended to accommodate the cases of reanalysis triggered by the matrix verb that we discussed in this section; as we will see, this revised OLLC also subsumes the constraint on the rebuffering mechanism that was proposed in (22), so we no longer need to state that constraint separately.

#### 4.4 Revising the OLLC: phases

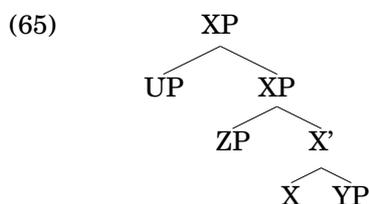
In the discussion of (49), we observed that apparently, the Human Sentence Processor is able to remove an element from an embedded clause. This seems surprising, since under reasonable assumptions, the embedded clause is a ‘closed’ domain, which we would not expect the parser to be able to target for reanalysis.

In order to get a better understanding of what is going on, let us first define the notion of ‘closed’ domain, a term which is used rather loosely here. Since we want the parser to be transparent, i.e. only use notions that are linguistically relevant, we are looking for a notion of ‘closed domain’ that is independently motivated in the linguistic (competence) literature. An obvious candidate that comes to mind, is the notion of *phase*.

The concept of phase was introduced in Chomsky (1998) and further developed in Chomsky (1999). Phases are constituents (CP and vP, possibly also NP and PP) that are closed for syntactic operations relating their elements to a position outside that phase: material inside a phase cannot be moved to a position outside that phase. There is one exception: material that is located in the *edge* of a phase, is accessible:

- (64) **Phase Impenetrability Condition (PIC):** The domain of H is not accessible to operations outside HP, but only H and its *edge*.  
(Chomsky (1999), p.10)

The edge of a head H is basically its specifier(s) and everything adjoined to its maximal projection. (For definitions, see Chomsky (1995), pp.177-178). So in an abstract structure like (65), the edge of X is the set {UP, ZP}.



The edge of a phase is basically an escape hatch. The intuition goes back to Chomsky (1973) and plays a dominant role in Chomsky (1986). In syntactic theory, it plays an important part in the description of extraction phenomena (extraction is only possible if an escape hatch is available), and there is quite a bit of morphosyntactic evidence for the existence of successive-cyclic movement through intermediate specifier positions (see for instance Torrego (1984), McCloskey (1990), Chung (1994), Kayne and Pollock (1978), Clements (1984), Haik (1990), Georgopoulos (1985), Collins (1993), Collins (1994)).

The structural intuition underlying the accessibility of the edge of the phase to outside operations, seems to be that the edge of a phase is somehow rather loosely attached to the phase; it's 'wiggly'.

With the concept of phase as a closed constituent in mind, where the edge is an escape hatch, we expect the following hypothesis to be true:

- (66) Hypothesis: the human sentence processor is able to reanalyze material from the edge of a phase

To see if this hypothesis can help us to understand the odd observation that reanalysis from an embedded sentence is possible (observation (52)), we have to see if the arguments which can be reanalyzed from an embedded clause, are indeed located in the edge of a phase. We have seen above that:

- (67) the reanalyzed argument can be either
- a. a subject (see (47), (51))
  - b. an object if the subject is *pro* (see (56))
  - c. both subject and object if the object has undergone scrambling (see (63))

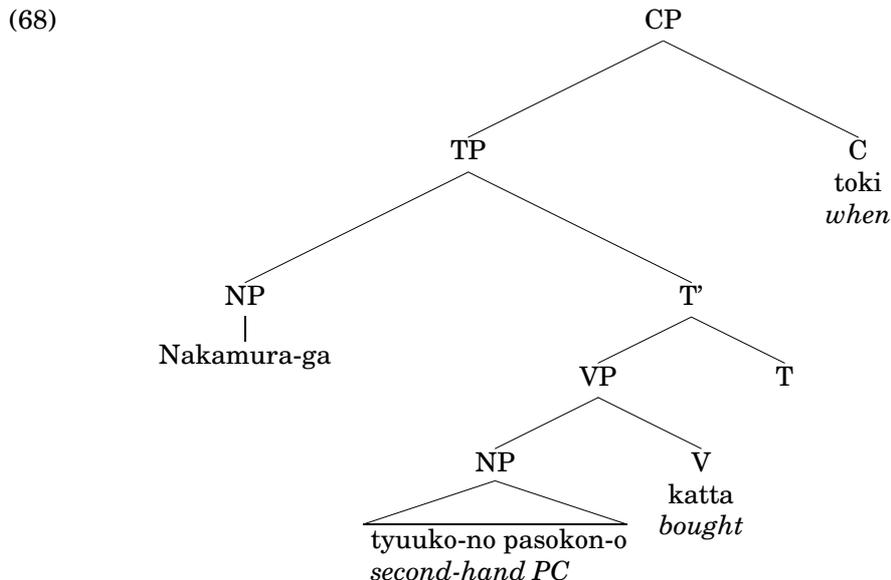
(67b) falls into place without any problems under hypothesis (66): the standard assumption in the Minimalist Program is that direct objects in OV-languages are indeed located in the edge of a phase, namely in the specifier of *vP*; so it is not surprising, from the perspective we are taking here, that a direct object can be reanalyzed from that position.<sup>5</sup>

<sup>5</sup>As noted in chapter 2, I am abstracting away from VP-internal structure throughout this dissertation, expecting that the insights formulated will be translatable without too much effort into a more sophisticated view of VP-internal structure. As noted, it is generally assumed in the Minimalist Program that the first argument in a verb-final VP is located in its edge, so let us just work with that. For more discussion, see chapter 5.

As for (67a) and (67c), the reanalyzed elements there are located in the CP-phase, but they are not actually located in the CP-edge in its strict sense (i.e. spec,CP): in (67a), the reanalyzed element is in spec,TP, and in (67c), the reanalyzed elements are also in the edge of TP: the scrambled direct object is adjoined to TP, and the subject is in spec,TP.

These positions do constitute the edge of the CP-phase, however, in the sense that they are the first edge-positions within the CP-phase that are filled with overt material.<sup>6</sup>

My way of understanding what is going on here is the following. Let us look in detail at what happens when the parser receives the matrix verb in, for instance, (51). The element that the parser has in store at this point is the structure in (50), repeated here as (68):



The incoming matrix verb, *syuuri-site-kureta* ‘repaired (for me)’, requires an overt argument. The verb has the information that this argument should be animate, and it has the information that the argument should be to a position to the left of it, so the argument should have been received already: it should be in store. It is clear that the element that is in store at that point, (68), cannot be integrated as an argument of *syuuri-site-kureta*: so the parser ‘knows’ there is a problem here; it ‘knows’ it made a mistake.

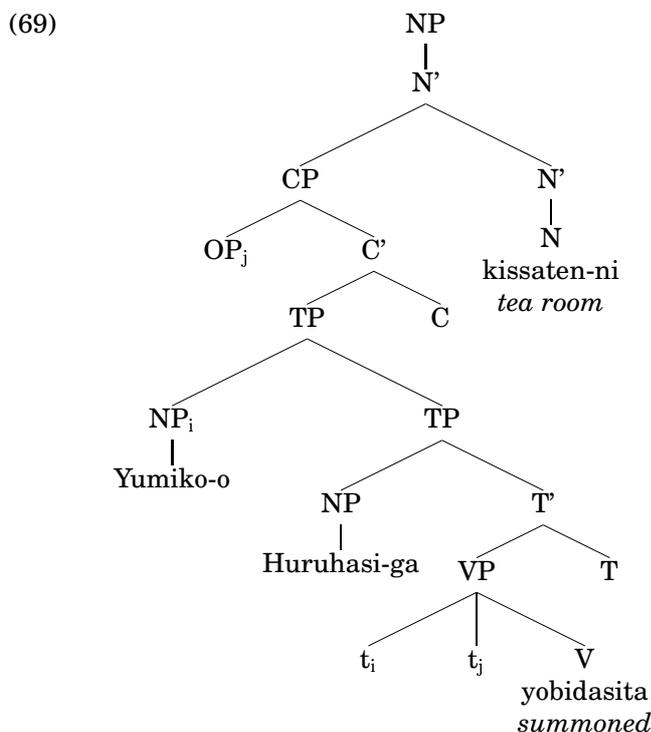
In order to fix the problem, the parser has to look for material that can satisfy the requirement of the matrix verb, inside the structure that it has

<sup>6</sup>A similar mix-up of a phonological notion of edge versus a purely structural notion of edge plays a role in the discussion of object shift in Scandinavian in Chomsky (1999); in order to solve it, Chomsky introduces the notion of *phonological border*, which refers to the leftmost phonologically overt constituent inside the vP.

built so far. It ‘knows’ that accessible material can be found in the edges of phases, so it inspects the edges of the phases of structure in store.

The structure in (68) has two phases: the VP and the CP. Let us assume that the parser inspects the CP-phase first. It now has to find the edge of CP, where the available material should be. But what is the edge of CP? The CP does not contain any overt element in spec,CP (there is no spec,CP). The first material that is in an edge in the CP, is located in the specifier of TP. Apparently, this material in the edge of the CP-phase in some sense; in any case, it is available for reanalysis.

The situation is similar for (63). When the matrix verb *mata-seta* ‘made-wait’ is encountered, the structure in the buffer looks like (62), repeated here as (69):



In (69), the available material happens to involve two constituents, the subject and the scrambled object; these are both located in specifier positions of the same head, i.e. in the same edge. Note that in (59), where reanalysis is not possible, the situation is different: there, the two arguments which should be reanalyzed, are not located in specifiers of the same head; they are not even in the same phase. So apparently, the parser can access only one phase in the reanalysis process.

Let us, with this understanding, reformulate the OLLC so that it can

accommodate the cases of automatic reanalysis in (67). The OLLC in Pritchett's formulation is repeated below:

- (70) **On-Line Locality Constraint (OLLC):** The target position (if any) assumed by a constituent must be *governed* or *dominated* by its source position (if any), otherwise attachment is impossible for the automatic Human Sentence Processor.  
(286), p.101

Note that the OLLC is formulated in terms of attachment; it states that attachment cannot be performed by the Human Sentence Processor, unless the source position governs or dominates the target position. An equivalent formulation of the OLLC would be the following:

- (71) The Human Sentence Processor can automatically perform reanalysis, iff:
- a. the source position dominates the target position; or
  - b. the source position governs the target position

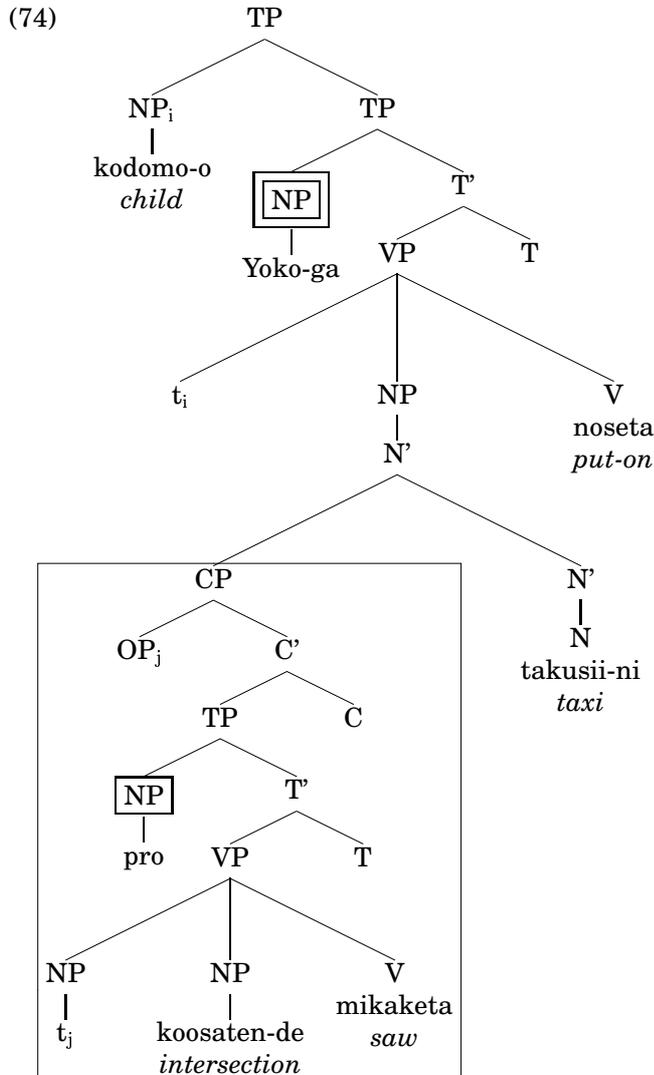
The condition we have found in this chapter, is a constraint on reanalysis from a position inside a phase to a position outside that phase: we found that only material from a single edge can be reanalyzed. I propose to reformulate the OLLC as follows:

- (72) **Revised On-Line Locality Constraint (ROLLC):** The Human Sentence Processor can automatically perform reanalysis, iff:
- a. the source position dominates the target position; or
  - b. the source position governs the target position; or
  - c. it can locate material to be reanalyzed in the first edge of a single phase, and the target position is located outside that phase

Where *first edge* is understood as follows:

- (73) The first edge of a phase is its leftmost edge containing overt material

A couple of remarks about this formulation are in order. First, the addition 'containing overt material' in (73) is vacuous in most instances of reanalysis from TP-specifiers, since the dominating CP usually has no specifier, so spec,TP is the first edge in the CP-phase anyway. However, there is one case where there is an edge in the CP-phase filled with a phonologically empty operator, that precedes the first overt specifier in the phase. That case is (47), repeated here as (74) with a box indicating the relevant phase:

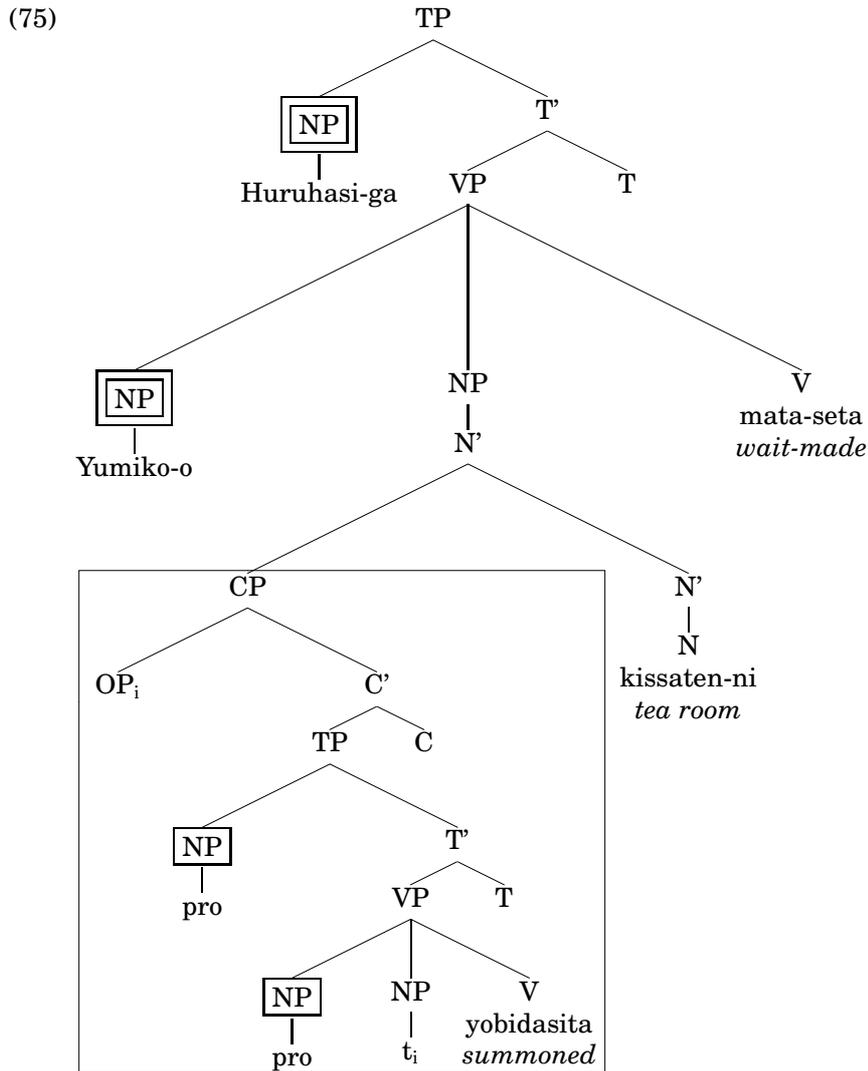


The phase that *Yoko-ga* is reanalyzed from, is the embedded CP. As noted, the specifier of CP contains an empty operator. Apparently, this specifier can be skipped by the parser in its search for material that it can use to satisfy the requirements of *noseta* 'put-on'. The assumption that the parser looks for overt material does not seem unreasonable; after all, overt material is the only material it is certain of; elements like empty operators, traces and *pro* arguments are postulated by the parser itself, do not appear as such in the input, and may turn out to be wrong.

The second thing to note about (72c) is that it differs from (72a) and (72b) in that it is derivational in nature, whereas (72a) and (72b) are for-

mulated as constraints on representations. In the next chapter, I will propose an alternative formulation of (73) which reconciles these different natures of the three clauses of the ROLLC. For now, let us see why (72c) has to be derivational in nature.

Consider (59), repeated here as (75):



The reanalysis in (75) cannot be performed automatically by the parser. The reason for this is that the parser in its search for available material, can only look at a single phase. In (75), there are two phases it could in principle look at. The VP-phase has the direct object in its edge, so the

direct object is available, in principle, for reanalysis under (72c). However, if the parser chooses to reanalyze the direct object in (75), it has nowhere to put it, since the eventual analysis of course does have to respect the linear order of the input.

The other phase that the parser can look at, is the CP-phase. This phase has the subject in its first edge, so the subject is in principle available for reanalysis. Suppose the parser reanalyzes the subject to the matrix clause subject position. Can it now access the VP-phase and reanalyze the object (which reanalysis at this point, now that the subject is out of the way, would be respecting the linear order of the input)? The answer is no; the parser can only look at one phase per reanalysis. In the case of (75), this is the CP.

Consider now a representational formulation of (72c), such as (76):

- (76) The parser can perform reanalysis if the source position is located in the first edge of a single phase

This formulation would not work to exclude the reanalysis in (75): both source positions are by themselves located in the edge of a single phase, be it the CP-phase for the subject *Huruhasi-ga*, and the VP-phase for the object *Yumiko-o*. The point of the derivational formulation of (72c) is to restrict the reanalysis process to access one phase per step in the parse.

The discussion above should give some idea of how (72c) works. Let us now consider how it relates to the mechanism of rebuffering. Since (72c) is formulated in such a way that it constrains the material which can be taken out to amount to no more than the material located in the first edge, the ROLLC allows us to dispense with the constraint on sending back to storage formulated in (22). We did not find any constraint on the target position in reanalysis from a phase to a position outside that phase; it seems that it is not relevant whether or not the reanalyzed element(s) originating in the edge of a single phase, is/are immediately reattached (as in (47), (51), (56), and (63)), or sent back to storage (as in (9), (19), (31), (35), (41), and (45)). This is captured by the formulation of (75c), since obviously, an element that is put back in store is also ‘outside the phase’ when it is in store.

#### **Application to a Japanese puzzle**

The ROLLC can also account for the unproblematic processing of the following example, which is presented as a puzzle by Mazuka and Itoh:

- (77) <sub>OK</sub>Hiroshi-ga aidoru kashu-o kakusita kamera-de  
 Hiroshi-NOM popular singer-ACC hid camera-with  
 totta  
 photographed  
 'Hiroshi photographed the popular singer with the camera he was  
 hiding'  
 (Mazuka and Itoh's (20))

Mazuka and Itoh's processing theory for Japanese is also head-driven, just like Pritchett's. They furthermore assume the following:

- (78) *The Tentative Attachment Strategy:*  
 In Japanese, a parsing decision is tentative until the sentence is finished. By tentative, we mean that reanalysis of each decision will have a psychologically measurable cost (i.e., it is not cost-free), but any single reanalysis will not be costly enough to cause conscious processing difficulty. When reanalysis is combined with other complexities (e.g., lexical ambiguities, multiple reanalyses, pragmatic naturalness, etc.), it becomes increasingly costly and may become conscious.  
 (Mazuka and Itoh's (45))

In Mazuka and Itoh's view, the conscious processing difficulty that is found in sentences like (17), (28a) and (32a), arises because in those cases, two arguments have to be reanalyzed. The ease with which (77) is processed, is a problem for this theory, since this case also involves reanalysis of two arguments, but is nevertheless processed without any conscious effort. In order to account for the difference in processing difficulty between (77) on the one hand (their (20)), and (17), (28a) and (32a) on the other hand (their (14), (15), (16), and (17)), they say:

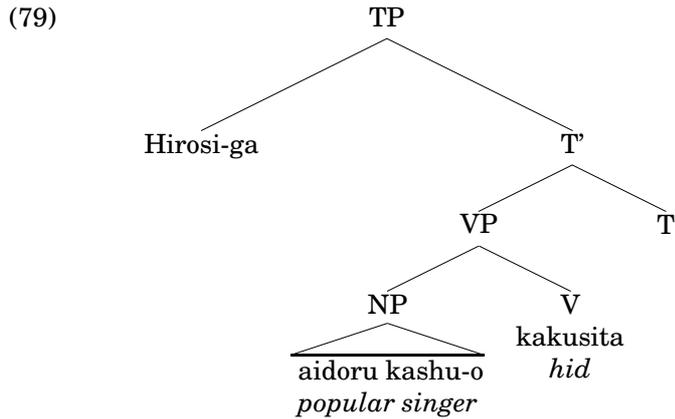
'The difference between the garden-path sentences and (20) can probably be accounted for by factors including the meaning of an individual verb, the strength of the relation between the NP and the verb, and other pragmatic knowledge. For example, hiding a popular singer in (20) is not as likely an event as seeing a child in (14), finding a gang member in (15), visiting a friend in (16), or summoning a person in (17).'

(Mazuka and Itoh, p.308)

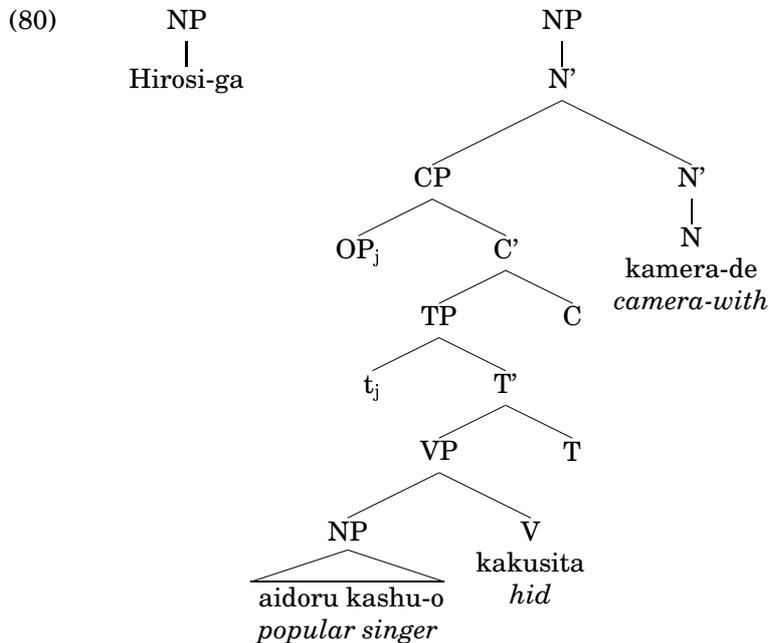
To my mind, it makes no sense at all to suppose that hiding a popular singer is less likely an event than finding a gang member, so I don't believe that this is the right explanation.

But when we look at the parse carefully, it turns out that under the assumptions we have been making here, the difference between (78) on the

one hand, and (17), (28a), and (32a) on the other hand, is not surprising at all. The initial analysis is a main clause:

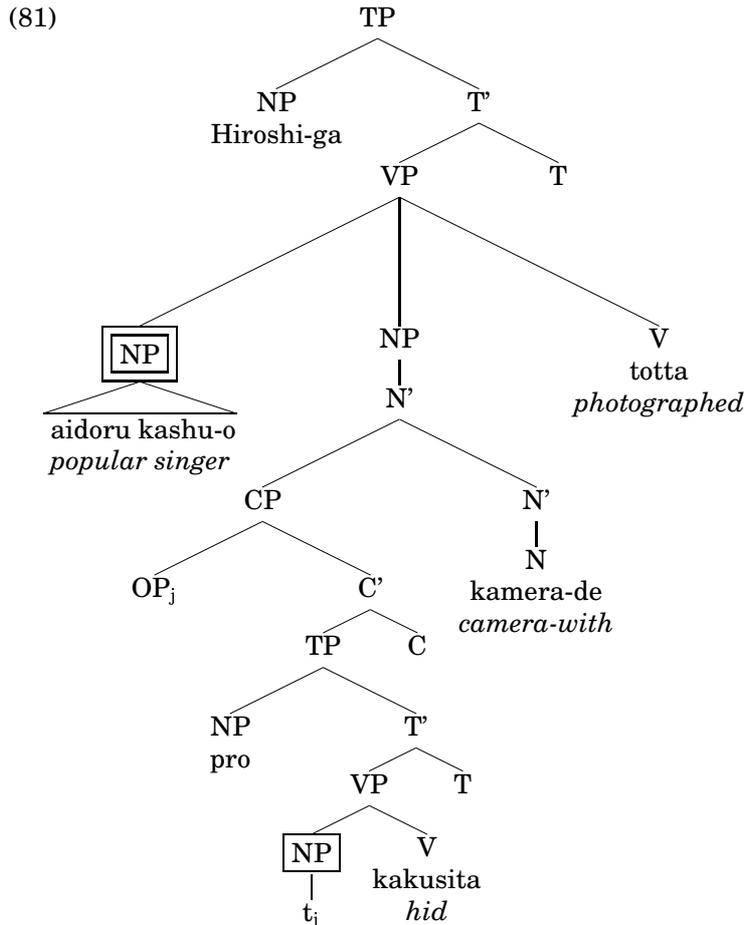


When the head noun *kamera-de* is discovered, only one NP needs to be sent back to store, since *kamera* can in principle be the subject of *kakusita* 'hide'; *kakusita* does not select for an animate subject.



'Hiroshi' 'with the camera that hid the popular singer'

However, *aidoru kashu-o* ‘popular singer’ has to be taken out of the relative clause when the matrix verb is discovered:



The revisions are slightly more complex than in cases like (47) and (51); the trace of the relative operator is put in the object position in the relative clause, and the subject position in the relative clause, which was occupied by the trace of the relative operator in the first relative clause analysis, is filled with a *pro* argument. Still, the only reanalysis of an overt argument in this step is reanalysis of *aidoru kashu-o* ‘popular singer’; this argument can be taken out under the ROLLC, because it is located in the first edge of the phase.

The main point of difference between this case and problematic cases of reanalysis of two arguments such as (17), (28a) and (32a) under the current approach, is that in this case, the reanalysis of the two arguments takes place at two different points in the parse and is permitted at each

of those points because the reanalysis takes only one argument at a time, which is allowed by (72). In (17), (28a) and (32a), the reanalysis of the two arguments has to take place at a single point in the parse. This is disallowed by our constraint (72).

### ECM-verbs in Dutch

With the ROLLC as formulated in (72) we can also tackle a case of (virtually) uncostly reanalysis in Dutch that is problematic for the OLLC in Pritchett's formulation. This case was introduced in (15) above.

In Dutch, ECM-verbs can take bare infinitival complements. The parse of these infinitival complements involves reanalysis. Consider first (82):

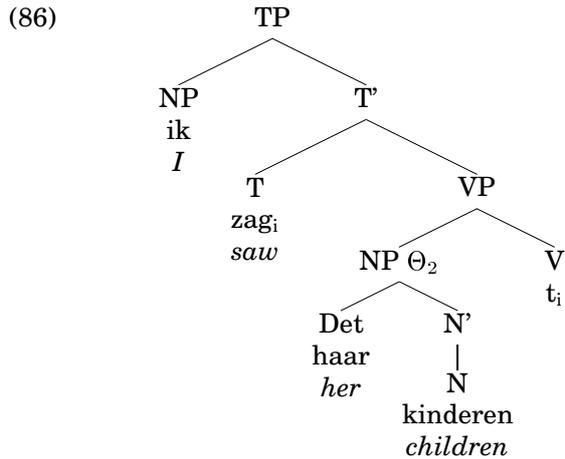
- (82) <sub>OK</sub>Jan zag haar struikelen  
 Jan saw her trip

Initially, *haar* will be analyzed as the direct object of *zag* 'saw'. This analysis has to be revised when the embedded verb is encountered. Since the source position (the maximal projection of the infinitival clause) dominates the target position (the subject position of the infinitival clause), this reanalysis is unproblematic for both the OLLC and the ROLLC.

However, the reanalysis can also involve two arguments. Consider (83), (84), and (85):

- (83) a. Ik zag Saskia d'r moeder  
 I saw Saskia her mother  
 'I saw Saskia's mother'  
 b. Ik zag Saskia d'r moeder vermoorden  
 I saw Saskia her mother murder  
 'I saw Saskia murder her mother'
- (84) a. Jan hoorde Sabine  
 Jan heard Sabine  
 b. Jan hoorde Sabine d'r moeder  
 Jan heard Sabine her mother  
 'Jan heard Sabine's mother'  
 c. Jan hoorde Sabine d'r moeder uitschelden  
 Jan heard Sabine her mother call-names  
 'Jan heard Sabine call her mother names'
- (85) a. Ik zag haar kinderen  
 I saw her children  
 b. Ik zag haar kinderen optillen  
 I saw her children lift  
 'I saw her lift children'

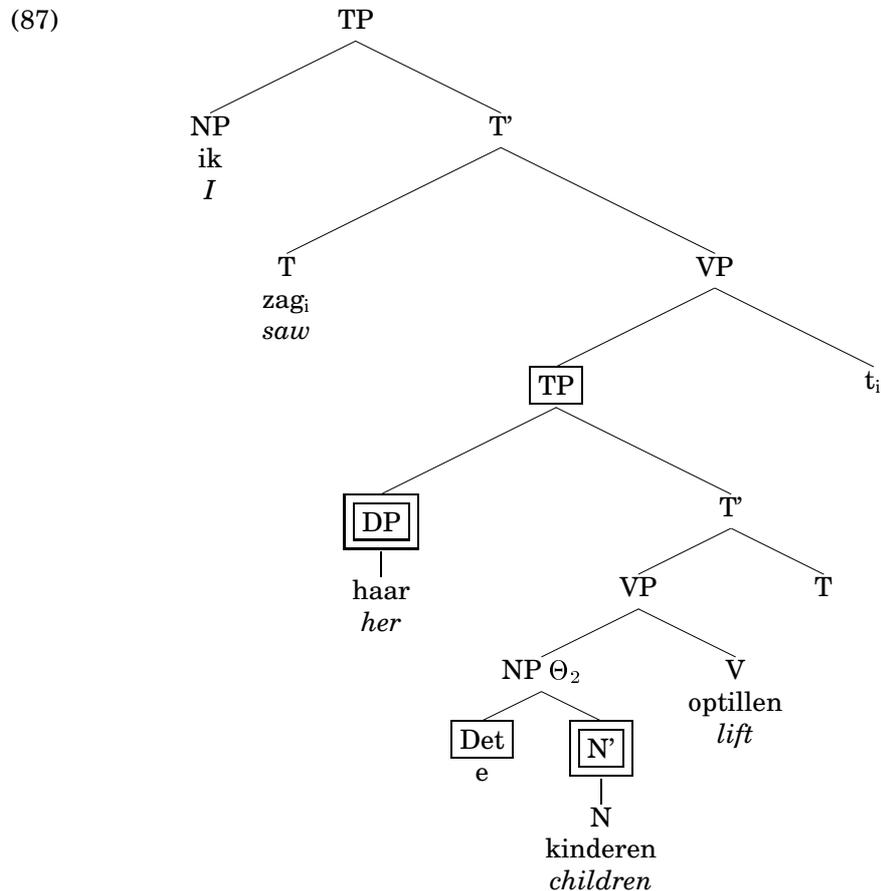
Consider (85b) (which we already saw in the introduction as (15)). Here, the phrase *haar kinderen* ‘her children’ is initially attached as the direct object of *zag* ‘saw’.



The constituent *haar kinderen* has to be split up when the transitive embedded verb is encountered. It is rather difficult to represent in a single tree what happens, because there are actually two processes taking place at the same time: the NP *haar kinderen* is split up, its specifier *her* is attached as the subject of *optillen*, and *kinderen* ‘children’ is attached as its object.

The reanalysis undergone by *kinderen* can be viewed as falling under the dominance clause of the OLLC; but the removal of *haar* from its specifier position is not allowed by the OLLC. It is, however, by the ROLLC: *haar* is located in the left edge of the NP-phase, so it can be taken out.<sup>7</sup>

<sup>7</sup>Under a DP-analysis, the element *haar* would be more like a combination of a D-head and its possessor-specifier; note that the head of a phase is also accessible under PIC.



Two things must be noted about the reanalysis in cases like (85b). First, it is not exactly right to say that this type of reanalysis is performed without any effort; native speakers of Dutch do report a slight effort associated with processing it, although the effect is definitely not a strong garden path effect. I suggest that we interpret this 'slight effort' as a reflex of the fact that the reanalysis that is needed to arrive at the correct interpretation, actually involves two (permitted) reanalysis processes, as indicated above. I will come back to this issue in the next chapter.

Second, it should be noted that the position originally occupied by *haar* in (85b) is not replaced with a *pro* argument, as was the case with the cases of reanalysis of arguments from specifiers in the Japanese examples we've been discussing in this chapter. This suggests that the availability of *pro* arguments is not the relevant factor that makes the Japanese cases easy to process. It is important to see this, because at first sight it would not be unreasonable to suspect that this property of Japanese syntax would play a role in the ease of reanalysis.

## **4.5 Conclusions**

In this chapter, I have shown that Pritchett's OLLC rules out certain cases of reanalysis in Japanese that are in fact not costly. These cases of reanalysis involve reanalysis from edge positions to positions higher in the structure. I have added a clause to the OLLC which specifies that reanalysis is permitted if the source position can be found in the first edge of a single phase. I have also shown that this stretching up of the OLLC correctly allows for certain cases of reanalysis in Dutch involving bare infinitival complements of ECM-verbs. Furthermore, we have seen that it follows that the rebuffering mechanism can only send one argument at a time back to store.

## Chapter 5

# Exploring the Revised OLLC

### 5.1 Introduction

In this chapter, I will give an overview of the system that was developed in the previous chapters by showing how it accounts for the various garden path effects we encountered throughout this dissertation.

The model consists now of two ingredients. One is Pritchett's structure-building mechanism of Theta Attachment:

- (1) **Theta Attachment:** The theta criterion attempts to be satisfied at every point during processing given the maximal theta grid.

The other ingredient is a mechanism of reanalysis. In the previous chapter, I extended Pritchett's OLLC by adding a clause that states that the Human Sentence Processor can automatically perform reanalysis from the first edge of a phase. The resulting formulation is the following:

- (2) **Revised On-Line Locality Constraint (ROLLC):** The Human Sentence Processor can automatically perform reanalysis, iff:
  - a. the source position dominates the target position; or
  - b. the source position governs the target position; or
  - c. it can locate material to be reanalyzed in the first edge of a single phase, and the target position is located outside that phase

Where *first edge* is understood as follows:

- (3) The first edge of a phase is its leftmost edge containing overt material

Obviously, the addition of (2c) is a significant addition to Pritchett's system as described in chapter 2; it allows for a whole new class of reanalyses. It seems to me that it would therefore be a good idea to take a step back and look at the resulting system as a whole, to see which kinds of reanalysis it allows, which kinds it excludes, and to observe in detail its mode of operation. In doing so, I will also pay some more attention to the intuitions underlying the three clauses of the ROLLC, and point out some topics for future research. In addition, I will present some Dutch cases that have not been discussed so far.

The addition of the edge-clause to the ROLLC has the effect that we can distinguish two types of reanalysis: reanalysis within a phase, which is potentially allowed by the government-clause or by the dominance-clause, but never by the edge-clause; and reanalysis to a position outside a phase, which can potentially be allowed by the edge-clause. I will first discuss the cases of phase-internal reanalysis we have seen so far. In section 5.2 and 5.3 I will briefly recapitulate which kinds of reanalysis are permitted by the dominance clause and the government clause of the (R)OLLC, respectively. In this discussion, I will also point out some details of Pritchett's system that were ignored in chapter 2.

In section 5.4, I will briefly recapitulate the motivation for the edge-clause. I will then provide some additional cases of uncostly reanalysis in Dutch that support the edge-clause in section 5.4.1. In section 5.4.2, I will look at the English cases that involve reanalysis from a phase to a position outside the phase, and check if the ROLLC makes the right predictions. We will see that indeed, in almost all the English cases of reanalysis from a phase that we saw in chapter 2, the source position is not located in the first edge, so the reanalysis there is still correctly ruled out by the ROLLC.

In section 5.5, I will suggest a more elegant formulation of the ROLLC.

Finally, in section 5.6, I will discuss the predictions that the current model makes for the processing of relative clauses. We will see that the ROLLC, contrary to the OLLC, allows for reanalysis from an initial main clause analysis to a reduced relative clause analysis. We will also see that the formulation of the reanalysis constraint that I propose in section 5.5, does rule out this type of reanalysis, just like the OLLC, which can be viewed as an empirical argument for this reformulation. I will show that it is actually difficult to take a position here because the data are very murky. I will furthermore show that Theta Attachment entails many interesting predictions about the initial analysis of reduced relatives.

## **5.2 The dominance clause of the ROLLC**

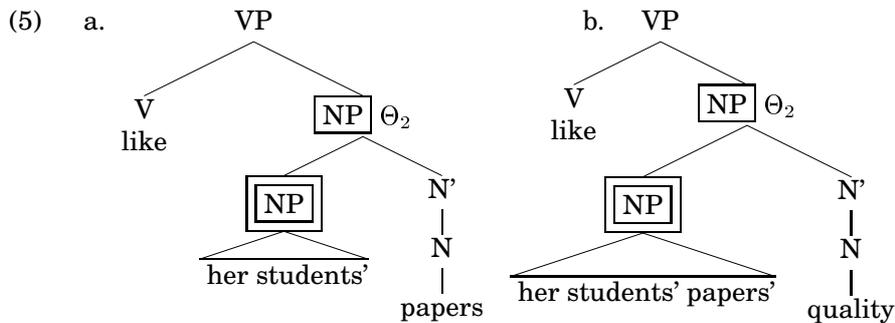
The dominance clause of the (R)OLLC says that reanalysis is possible if the source position dominates the target position. The underlying intuition

seems to be that reanalysis is possible if the Human Sentence Processor continues to work on the most recently attached constituent.

As we saw in chapter 2, the dominance clause of the (R)OLLC allows for reanalysis to the specifier position of the original attachment site. This type of reanalysis never leads to a garden path effect, and it can occur recursively:

- (4) a. I like her  
 b. I like her students  
 c. I like her students' papers  
 d. I like her students' paper's quality

Consider for instance the steps from (4b) to (4c), and from (4c) to (4d):

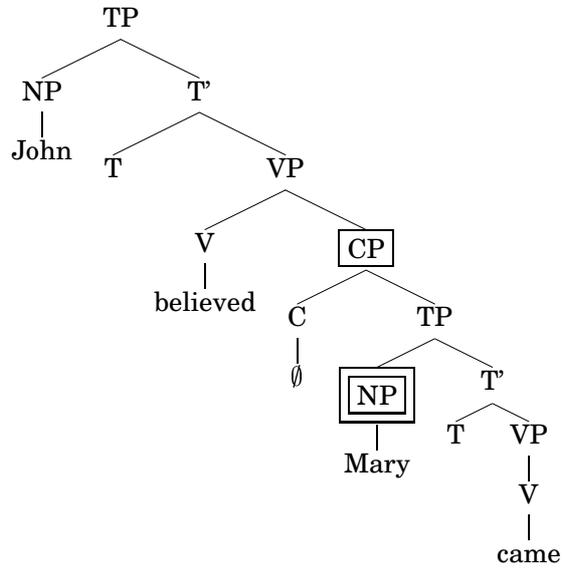


A similar case of reanalysis where the source position dominates the target position arises when a nominal direct object is reanalyzed to the subject position of a verbal complement, as in (6):

- (6) John believed Mary came

When *Mary* is encountered, it is theta-attached as the direct object of *believed*. The necessary reanalysis when *came* appears is depicted below:

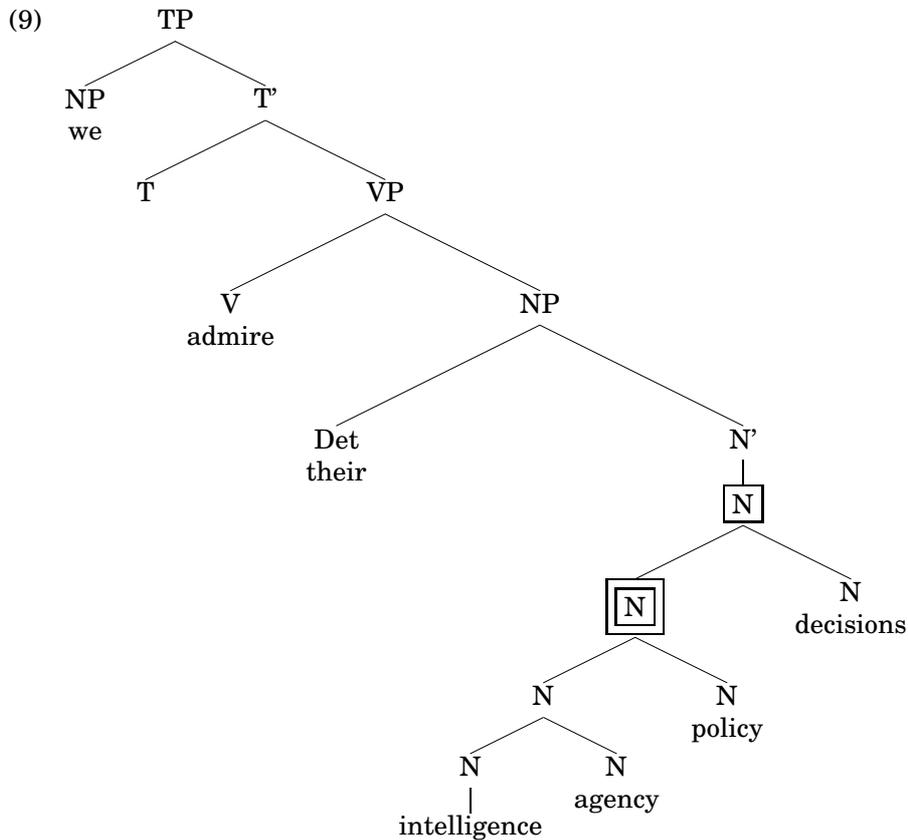
(7)



The dominance clause of the (R)OLLC also allows for recursive compounding. Consider (8):

- (8) We admire their intelligence agency policy decisions  
(Pritchett's (238))

Consider for instance the reanalysis from *We admire their intelligence agency policy* to *We admire their intelligence agency policy decisions*:



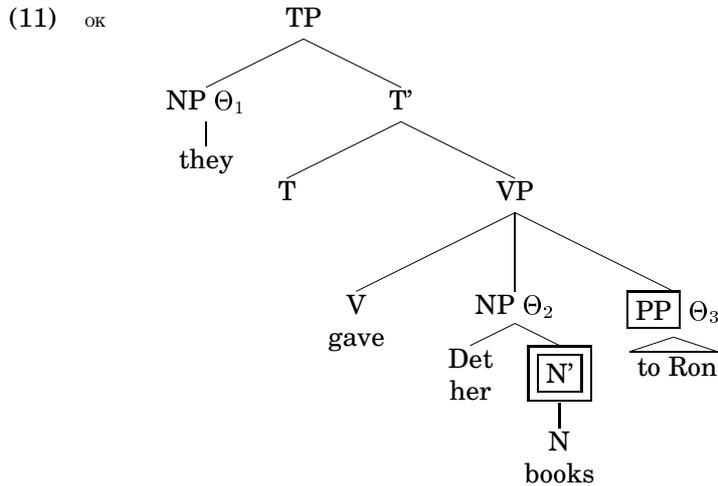
Since the source position dominates the target position, this type of reanalysis is also freely allowed by the (R)OLLC.

### 5.3 The government clause of the ROLLC

In the discussion of the OLLC in chapter 2, we saw that the government clause of the OLLC is needed to account for only one case of uncostly reanalysis in English:

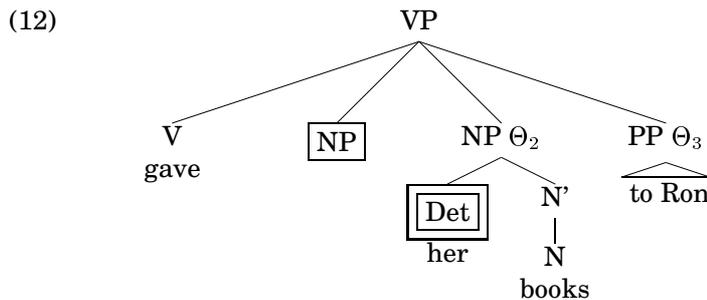
(10) <sub>OK</sub>They gave her books to Ron

During the parsing of (10), *her* is initially attached as the indirect object of *gave*; this analysis has to be revised when the actual indirect object, *to Ron* is encountered. In chapter 2, we already saw that this reanalysis is allowed by the OLLC because the source position governs the target position. The relevant structure was given in (47), and is repeated below:



A couple of things must be noted about Pritchett's analysis. First, observe that two elements are reanalyzed here: *her* and *books*. The reanalysis of *her* is unproblematic: its source position dominates its target position. The other element that is reanalyzed here is *books*; *books* is removed from its original theta position, and is merged in the position containing *her*, with reanalysis of *her* to the specifier of that position.

Second, if the reanalysis process would be a reanalysis of *her* to the specifier position of *books*, the reanalysis would not be permitted by the OLLC. To see this, take a look at the structure below, which depicts reanalysis of *her* rather than *books*:



The reanalysis in (12) is not allowed by the OLLC, because the source position does not govern the target position: there is a maximal projection (the maximal projection of *books*) intervening.<sup>1</sup>

The reason that this problem does not arise if we assume the reanalysis in (10) to be reanalysis of *books* rather than *her*, as depicted in (11), is

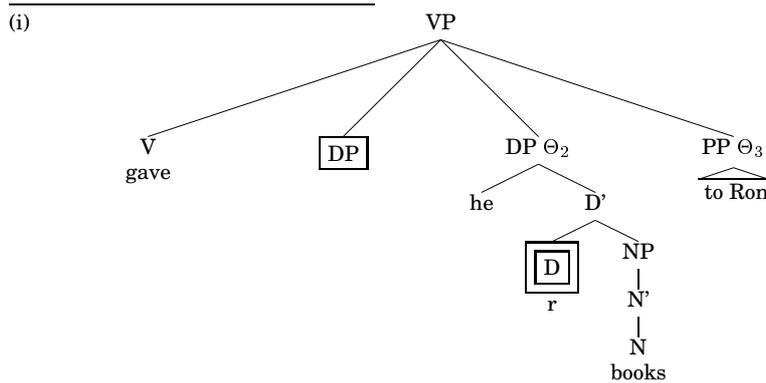
<sup>1</sup>However, there is in fact a government relation between the source position of *her* and its target position if we assume a DP-analysis for *her books*:

that the target position there is the head position of the newly formed constituent *her books*; the source position governs the maximal projection of the target position, hence the reanalysis is allowed according to Pritchett.

As discussed in chapter 2, Pritchett makes a point of explaining that there is no problem with taking the reanalysis in (10) to be reanalysis of *books* to a position in which a different theta role was assigned before the reanalysis.<sup>2</sup>

One way of looking at what the government clause of the (R)OLLC does, is to say that it distinguishes between (uncostly) reanalysis of a VP-internal argument to a different argument position within the same VP, and (costly) reanalysis of a VP-internal argument to a position adjoined inside a VP-internal argument. The basic contrast is the contrast between (13) and (14):

(13) <sub>OK</sub>They gave her books to Ron

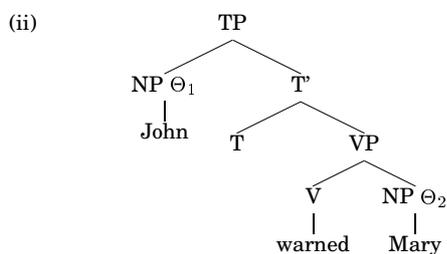


This analysis also allows us to maintain the original source position; see footnote 2.

<sup>2</sup>Note that there is another construction in which Pritchett *does* maintain the original theta position as the target position. The relevant case is the following:

(i) <sub>!</sub> John warned Mary left

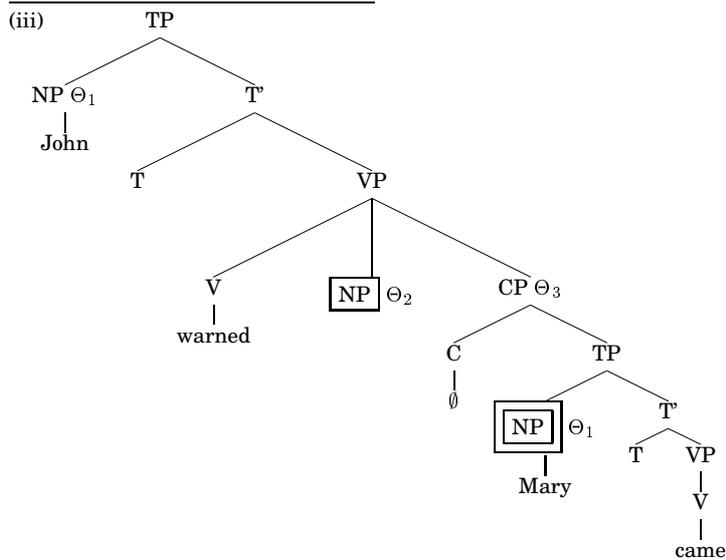
In the initial parse, *Mary* is attached as an argument of *warned*:



This analysis has to be revised when *came* is encountered: *Mary* must be reanalyzed as the subject of the clause expressing the content of the warning.

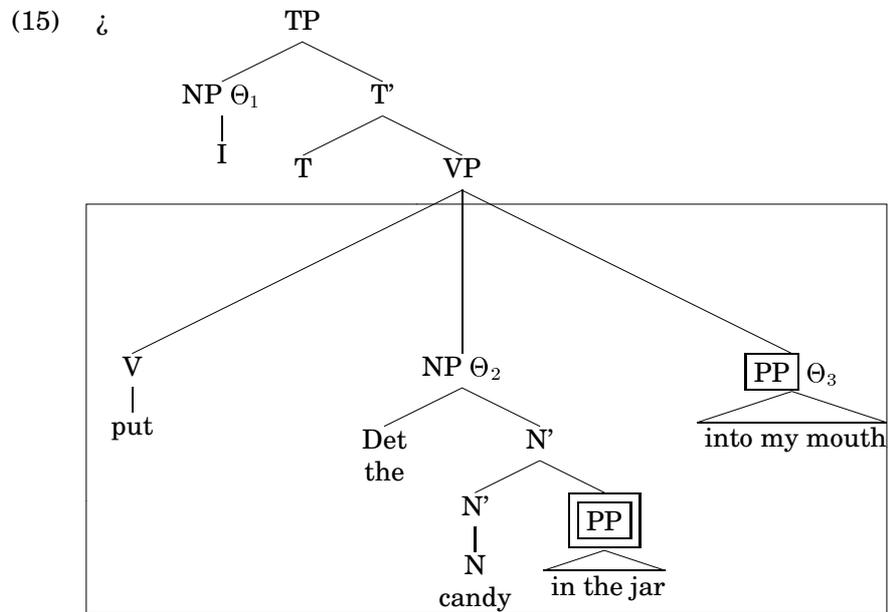
(14) ¿ I put the candy in the jar into my mouth

Let us consider again how the reanalysis in (14) is barred under the (R)OLLC:



Note that in the structure in (iii), the original theta position of *Mary* is maintained as the source position (which neither governs nor dominates the target position). If the original theta position would not be maintained, the source position would be the maximal projection of the complement clause; and then, the reanalysis would be permitted by the OLLC, since the source position would then dominate the target position.

It does seem reasonable to maintain the source position in (iii), since the embedded CP does indeed satisfy a different theta role than *Mary* did in its source position. However, there is some tension between retaining the original position here, but not in the double object cases. A more sophisticated VP-structure might shed some light on this issue.



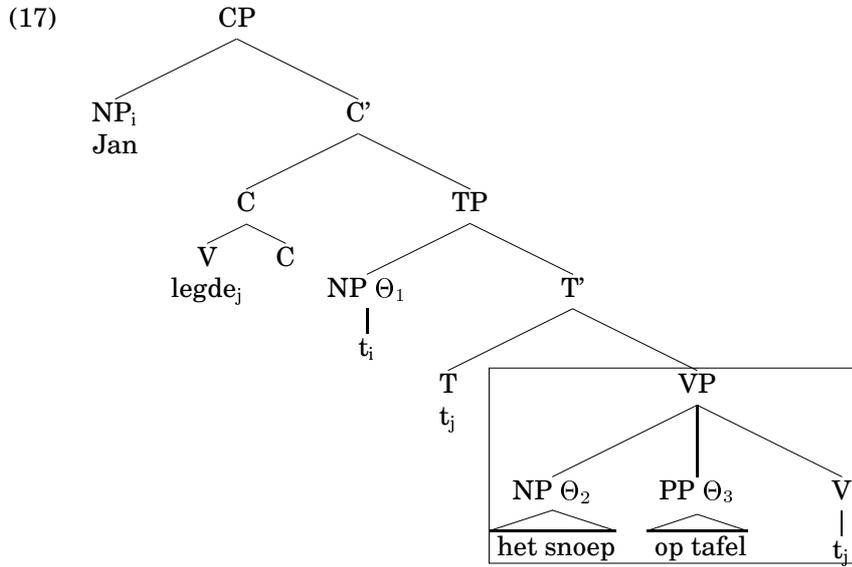
The crucial factor distinguishing (15) from (11) is that in (15), the reanalyzed element is reanalyzed to an adjoined position inside the complement. The maximal projection of *candy* constitutes an intervening barrier, and this excludes government of the target position by the source position.

It may seem as if the government clause of the (R)OLLC is a rather sophisticated technical device which excludes cases of reanalysis on the basis of rather *unsophisticated* (flat) VP-structures. However, the underlying intuition seems pretty clear: reanalysis from one argument position to another argument position inside the VP is allowed, and reanalysis from an argument position to an embedded adjoined position is not. It should be possible to reconstruct this notion in a syntactic framework with more VP-internal structure, and without the notion of government, such as the Minimalist Program. The exact formulation is a topic for future research.

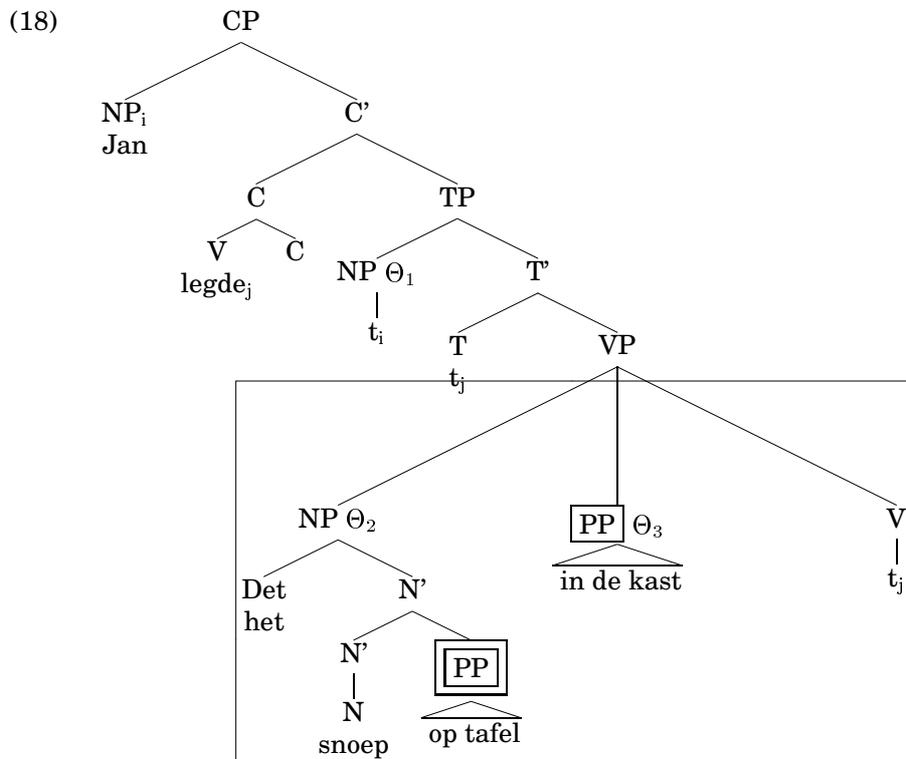
Let us for now proceed with the government clause of the (R)OLLC as formulated. The same phenomenon as in (14) is found in Dutch:

- (16) (i) Jan legde het snoep op tafel in de kast  
 Jan put the candy on table in the cupboard

The initial parse is the following:



This analysis must be revised when *in de kast* 'in the cupboard' is encountered:



This analysis is not allowed by the (R)OLLC, because there is no government between the source position and the target position.

The garden path effect disappears when (16) is embedded:

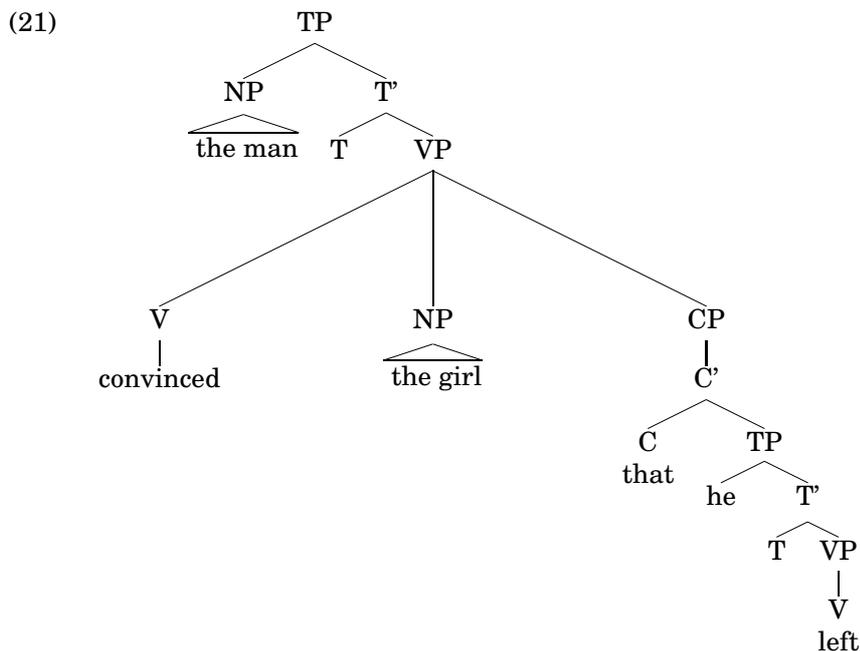
- (19) *oɪk denk dat Jan het snoep op tafel in de kast legde*  
 I think that Jan the candy on table in the cupboard put  
 'I think that Jan put the candy on the table in the cupboard'

This is exactly what we expect under Theta Attachment: attachment of the PPs will be postponed until the verb is encountered. Since the verb appears at the end of the clause, there is no misattachment and no reanalysis.

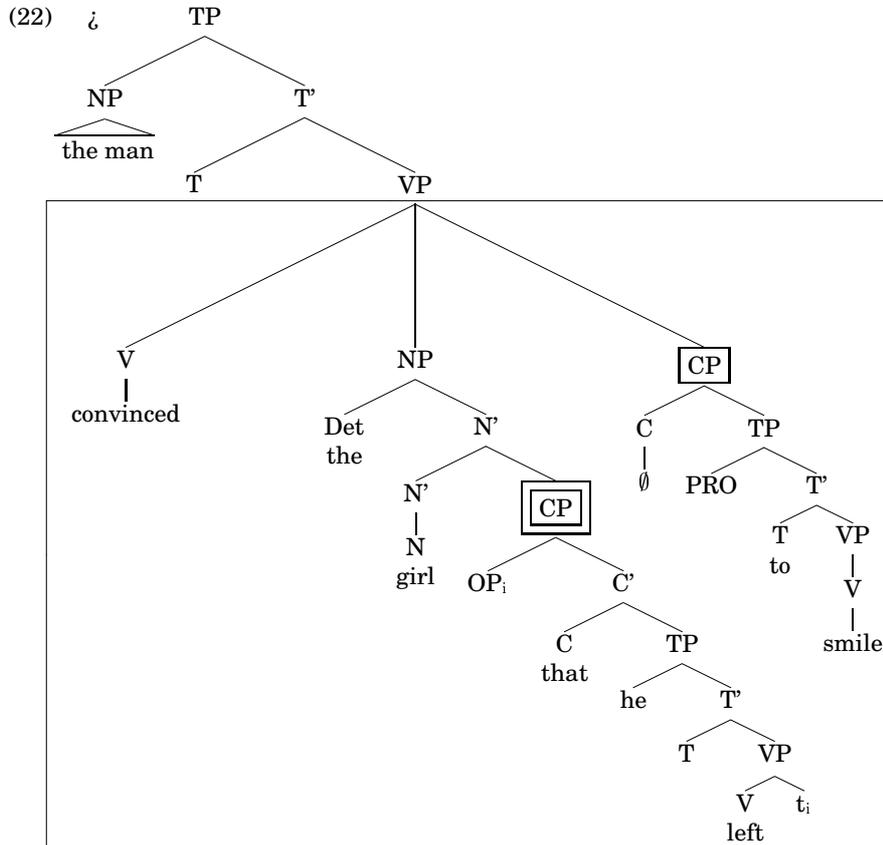
The cases we discussed above all involve PPs that are locally ambiguous between an argument attachment and attachment as an adjunct. We can find a similar type of local ambiguity with CPs. Recall (13) from chapter 2, repeated here as (20):

- (20) *ɿ The man convinced the girl that he left to smile.*

The initial analysis is depicted below:

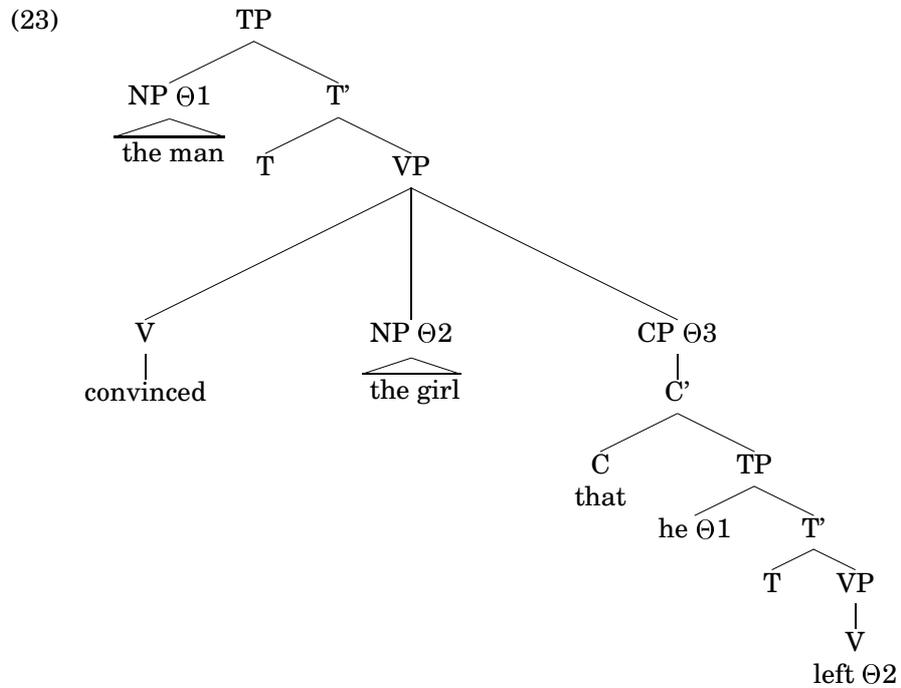


And the necessary reanalysis looks like this:



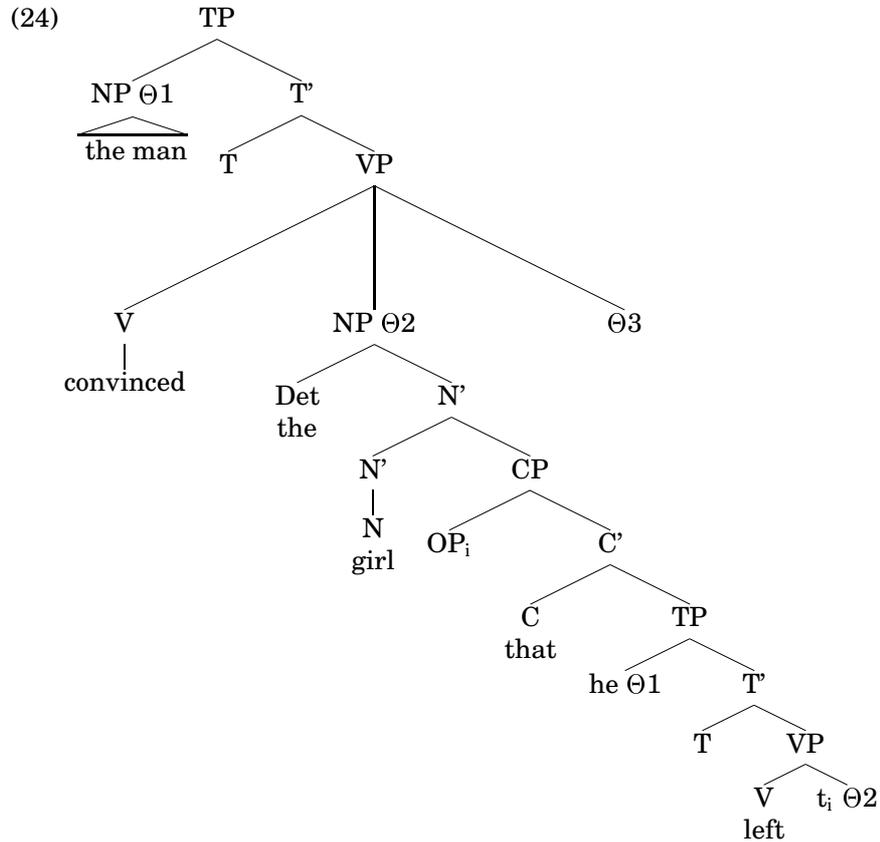
What the cases in (15), (16), and (22) have in common is that the target position of the reanalysis is an embedded adjoined position; this means that the source position does not govern the target position.

In chapter 2, we stated Pritchett's account of (20) without further comment. On closer inspection, however, it turns out that Theta Attachment actually predicts optionality between attachment of the first CP as an argument of *convinced*, and attachment as a relative clause. The reason for this is that the resulting structures each have one theta role left to assign. Consider first the argument analysis in (23):



In this analysis, the internal theta role of *left* is not assigned. This theta role is optional, but it does count for Theta Attachment because Theta Attachment refers to the maximal theta grid.

In the relative clause analysis (24), we also find one violation of the theta criterion:



Here, the unassigned theta role is the third theta role of *convinced*, which is also optional. The initial analysis in (24) is the correct analysis for the string in (20); so (20) is actually predicted to give rise to only a 50% garden path effect.

In order to determine whether Theta Attachment makes the right prediction here, more research involving a sufficiently large number of subjects is necessary.

A Dutch equivalent is given below:

- (25)  $\frac{1}{2}$  Jan vertelde het meisje dat de hond beet dat hij naar huis ging  
 Jan told the girl that the dog bit that he home went

Theta Attachment predicts optionality here, for the same reason. The way to test whether this prediction is borne out, is to present a sufficient number of subjects with sentences like these, and see if the judgments really fall into two groups of roughly the same size, one group reporting no par-

ticular difficulty, the other group reporting a garden path effect.<sup>3</sup>

The same prediction is made for the following case:

- (26)  $\frac{1}{2}$  Volgens de meneer die ik aan de telefoon kreeg, betekent  
 According to the mister REL I on the phone got, means  
 de uitspraak van de kantonrechter dat wij een  
 the verdict of the cantonal judge that we an  
 arbeidsovereenkomst hebben dat we in loondienst  
 employment contract have, that we in salaried employment  
 zijn.  
 are

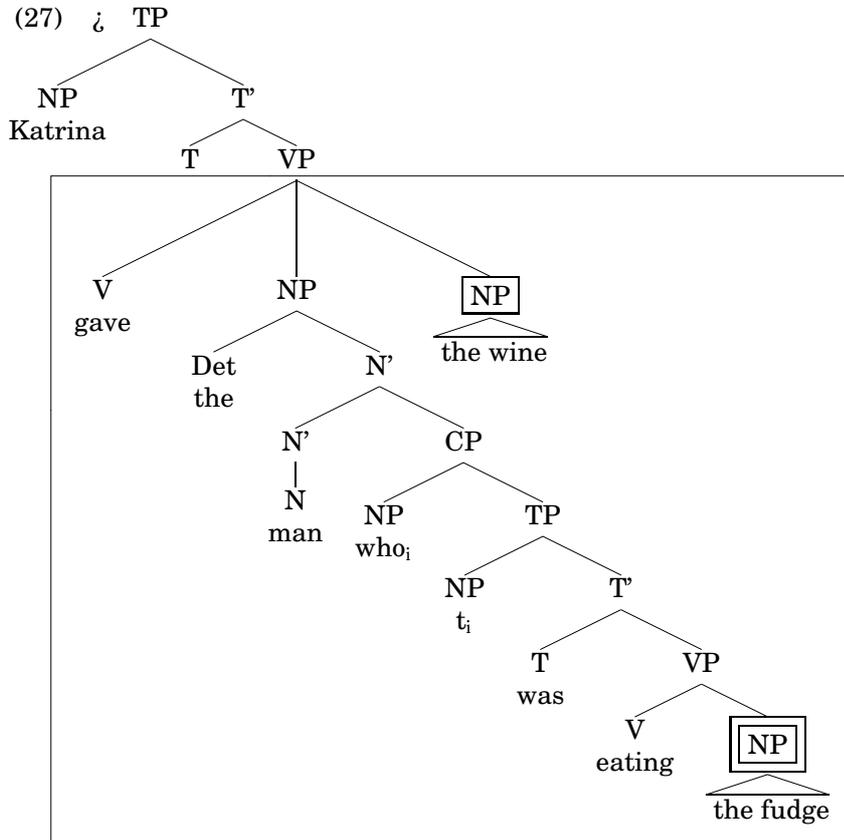
‘According to the person I talked to on the phone, the cantonal judge’s verdict that we have an employment contract, means that we are in salaried employment.’

(source: personal email, dd.21-3-’00.)

In this case, Theta Attachment predicts optionality because the CP *dat wij een arbeidsovereenkomst hebben* can be either attached as a complement of *uitspraak* ‘verdict’ (in which case no reanalysis needs to occur), or as a complement of *betekent* ‘means’, in which case reanalysis does have to occur. This reanalysis violates the (R)OLLC.

In chapter 2, we also saw the following case of phase-internal reanalysis, excluded by the (R)OLLC. For completeness’ sake, it is repeated below.

<sup>3</sup>I tested this sentence with six native speakers of Dutch, and indeed received mixed judgments, but that is hardly significant since the group was too small.



The reanalysis in (27) is excluded by the (R)OLLC because the source position of *the fudge* neither dominates nor governs the target position, and because the source position does not appear in the first edge of a phase.

## 5.4 The edge clause of the ROLLC

The edge clause of the ROLLC was motivated by the possibility of reanalysis in Japanese of elements originating in the edge of a phase (see the discussion of (47), (51), (56), (63), (9), (19), (31), (35), (41), and (45) in the previous chapter). We saw that a similar type of reanalysis can take place in Dutch ((85b) in chapter 4).

In this section, I will discuss cases of reanalysis from a phase to a position outside the phase in English and Dutch. In section 5.4.1, I will discuss an environment in Dutch that provides some additional support for supplementing the OLLC with the edge-clause (2c). In section 5.4.2, we will see that the edge-clause added to the OLLC does not affect the English

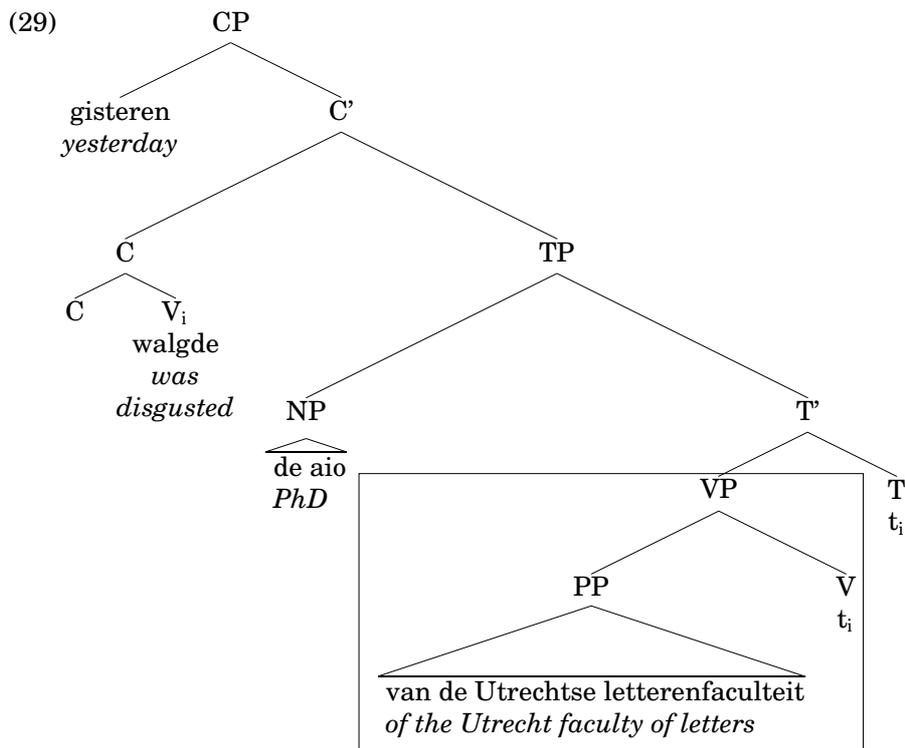
garden paths we discussed in chapter 2, which involve reanalysis from a complement position.

### 5.4.1 Permitted reanalysis from the edge of a phase

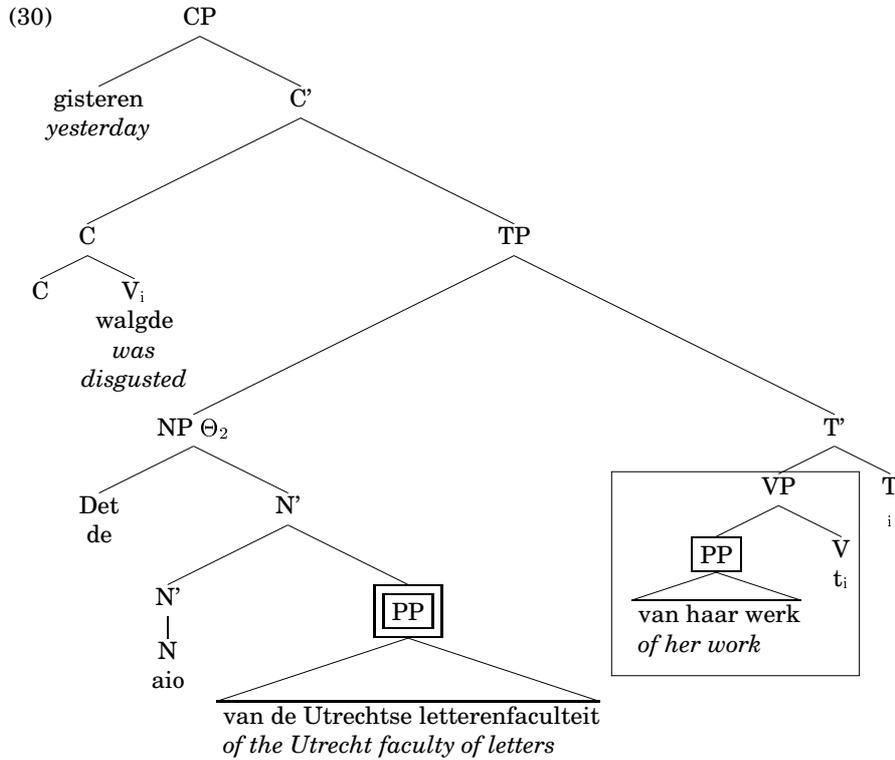
Consider the following Dutch case:

- (28) Gisteren walgde de aio van de Utrechtse  
 yesterday was disgusted the PhD-student of the Utrecht  
 letterenfaculteit van haar werk.  
 faculty of letters of her work  
 ‘Yesterday, the PhD-student of the Utrecht faculty of Arts was dis-  
 gusted with her work’

The PP *van de Utrechtse letterenfaculteit* is locally ambiguous; it can be attached to the subject, or as an argument of the verb *walgde* ‘was disgusted’. By Theta Attachment, it is initially attached as an argument of the main verb:



This analysis must be revised when *van haar werk* ‘of her work’ is encountered:



This reanalysis can be performed without conscious processing difficulty. It is permitted by the ROLLC because it takes place from the first edge of the VP-phase. It is not, however, permitted by the OLLC, because the source position neither governs nor dominates the target position; so the lack of processing difficulty in this case is an additional argument for the ROLLC as opposed to the OLLC. Note the contrast in acceptability with the reanalysis in (18), which is more difficult to process, and which *is* barred by the ROLLC. The crucial structural difference between (18) and (30) is that in (18), the reanalysis takes place phase-internally, whereas it does not in (30).

In (31), we see an example involving reanalysis from the first edge of VP to a VP-adjoined position, which is also fine:

- (31) a. De soldaat dacht aan het front aan zijn meisje  
 the soldier thought at the front at his girl  
 'The soldier thought of his girlfriend at the front'
- b. ... dat de soldaat aan het front aan zijn meisje dacht  
 that the soldier at the front at his girl thought  
 'that the soldier thought of his girlfriend at the front'

The same kind of reanalysis can take place with a clausal complement:

- (32) a. De gebedsgenezer bad om niet in slaap te vallen om een  
 the miracle healer prayed for not asleep to fall for a  
 wonder  
 miracle  
 ‘The miracle healer prayed for a miracle in order not to fall  
 asleep’
- b. ... dat de gebedsgenezer om niet in slaap te vallen om een  
 that the miracle healer to not asleep to fall for a  
 wonder bad  
 miracle prayed  
 ‘that the miracle healer prayed for a miracle in order not to fall  
 asleep’

This reanalysis is also performed without conscious processing difficulty.

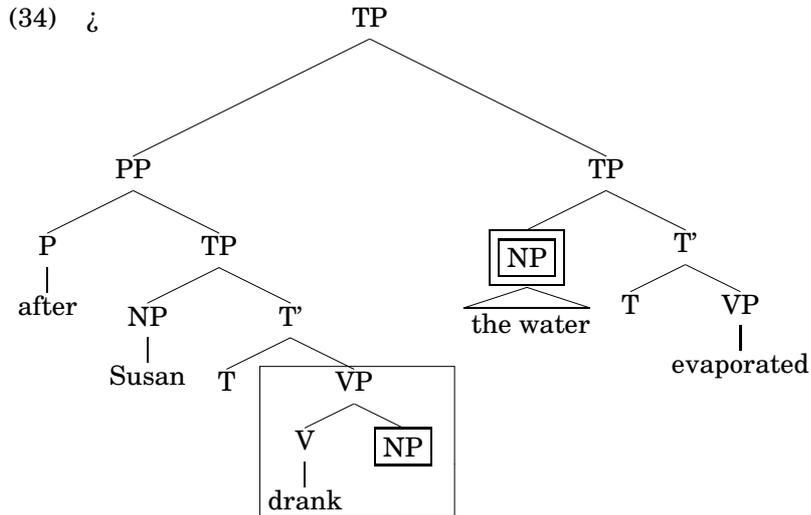
#### 5.4.2 Reanalysis from complement position

The intuition underlying the edge clause of the ROLLC is that a phase is inaccessible for operations relating to positions outside the phase, except for material in its edge. This predicts that reanalysis from a complement position to a position outside a phase is always impossible. Indeed, these are exactly the configurations that lead to the most severe garden path effects in English. In this subsection, I will review these cases.

The first case of reanalysis from inside a phase to a position outside that phase that we will explore is the most straightforward case of object-subject ambiguity in English: (34) from chapter 2, repeated here as (33):

- (33) ; After Susan drank the water evaporated

The structure is the following (relevant phase boxed):

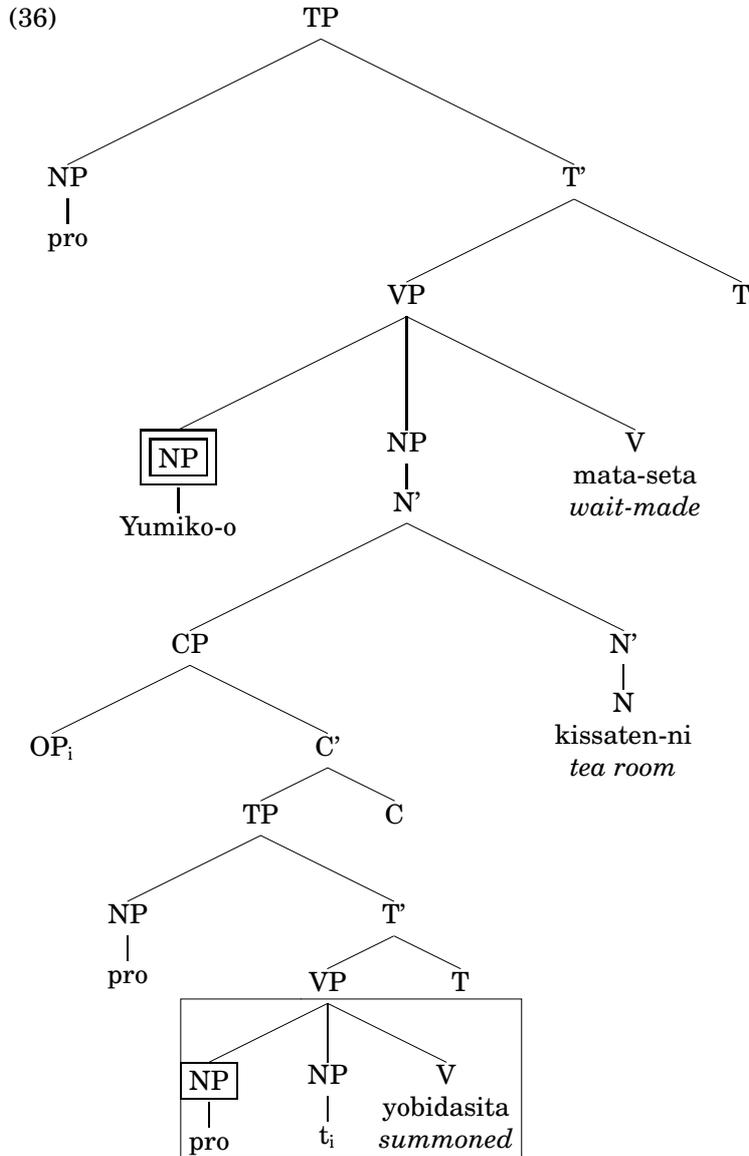


Clearly, the phase-clause of the ROLLC does not allow this instance of costly reanalysis, as the source position is not located in the first edge of a phase; it is in the complement position of *drank*.

Note how structurally similar this case seems to be to the Japanese example (53) we saw in the previous chapter, repeated here as (35):

- (35) <sub>OK</sub>  $\emptyset$  Yumiko-o yobidasita kissaten-ni nagai koto mata-seta  
 Yumiko-ACC summoned tea room-LOC long time wait-made  
 ' $\emptyset$  made Yumiko wait for a long time at the tea room to which he  
 summoned her'  
 (Mazuka and Itoh's (18b))

Its structure is given below, with a box indicating the phase from which reanalysis takes place:



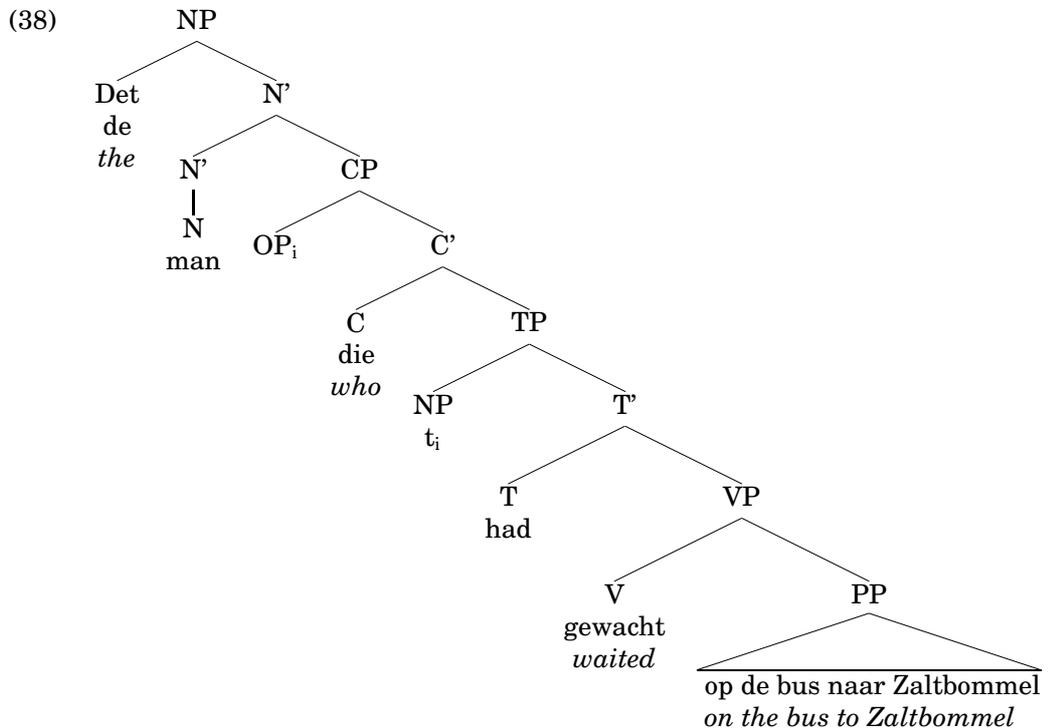
Both (36) and (34) involve reanalysis of a direct object from an embedded clause to a higher clause, forced by the main verb. In both cases, the original argument position (the direct object position of *drank* in (34), and the direct object position of *yobidasita* ‘summoned’ in (36)) is left unexpressed phonetically, even though the thematic role associated with the position is present semantically. In neither case does reanalysis obey the government clause of the OLLC. But whereas the reanalysis is allowed in Japanese, it

is not in English. Note that the reanalysis constraint formulated in (2c) allows for the reanalysis we see in the Japanese case, since the source position is located in the first edge, whereas in (35), the source position is in complement position.

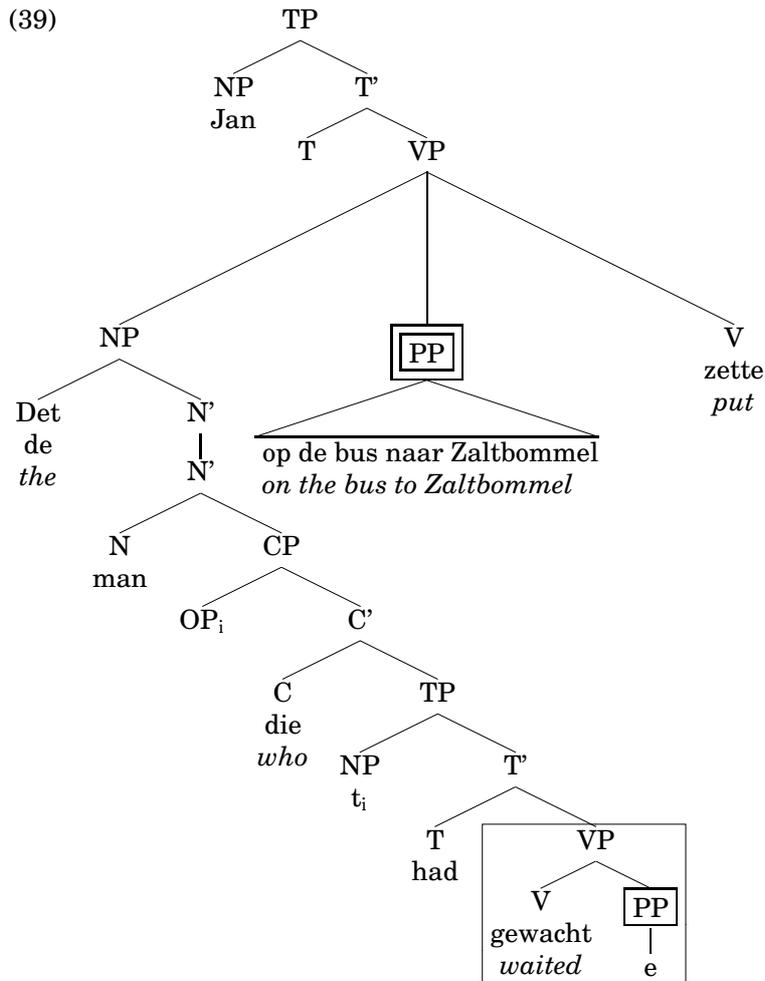
The example in (33) has no counterpart in Dutch, since in Dutch the direct object appears before the verb in the embedded clause. However, we can construct a counterpart involving a prepositional object, since prepositional objects *can* appear after the head noun of the relative clause, but to the right of the embedded verb. Consider the following example:

- (37) ¿Ik dacht dat Jan de man die had gewacht op de bus  
 I thought that Jan the man who had waited for/on the bus  
 naar Zaltbommel zette  
 to Zaltbommel put  
 'I thought that Jan put the man who had been waiting, on the bus  
 to Zaltbommel'

In the initial parse, the PP *op de bus naar Zaltbommel* is analyzed as an argument of *gewacht* 'waited'. The structure of the NP containing the relative clause looks like this:



When the verb *zette* ‘put’ is encountered, the PP has to be reanalyzed as an argument of *zette*:



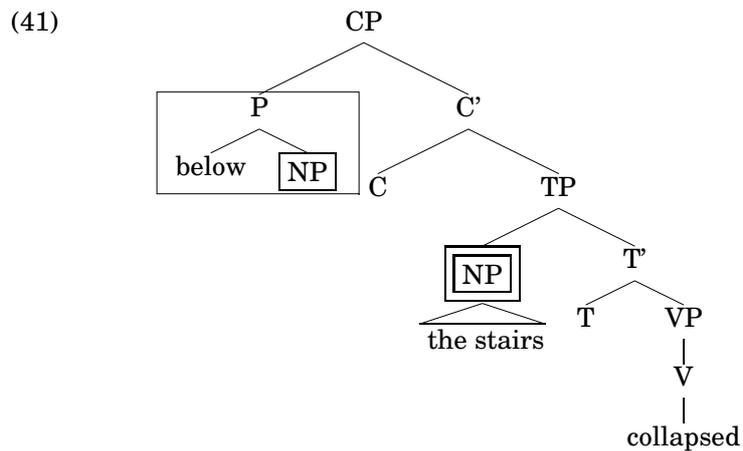
The reanalysis constraint (2c) correctly rules out this reanalysis, since the source position does not occur in the first edge of the VP. Again, we see that the structural position of the source is relevant to the availability of reanalysis.

Another case of reanalysis from a complement position inside a phase to a position outside the phase, is (9) from chapter 2, repeated here as (40):

(40) ¿ Below the stairs collapsed

In (40), *the stairs* is initially attached as an argument of *below*, and needs to be reanalyzed as an argument of *collapsed*. The reanalysis is depicted

below:



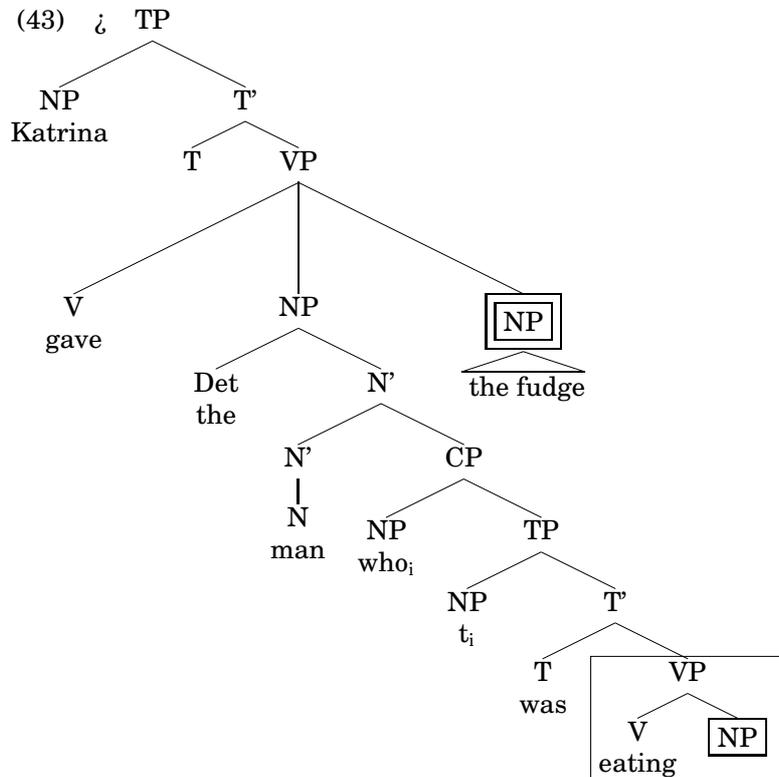
It is excluded by the OLLC: the source position does not appear in the first edge of the PP-phase<sup>4</sup>, nor does it govern or dominate the target position.

To complete our overview of cases of costly reanalysis from a complement position, recall the following case, which was discussed in chapter 2:

(42)  $\frac{1}{2}$  Katrina gave the man who was eating the fudge

If *the fudge* is initially analyzed as the complement of *eating*, a garden path effect arises. Subsequent reanalysis would result in (43):

<sup>4</sup>However, it does appear *inside* the first edge of the CP-phase; apparently, reanalysis is restricted to *members* (i.e. the highest maximal projection) of the first edge; the parser cannot look *inside* the constituent in the first edge.



The reanalysis in (43) is not allowed by (2c), since the source position is not located in the edge of the phase.

## 5.5 Towards a more elegant formulation of the ROLLC

In the system developed here, there are three possible configurations in which the Human Sentence Processor can automatically perform reanalysis: it can build material on top of a constituent (the dominance clause of the ROLLC), it can shuffle VP-internal arguments around (the government clause), and it can reanalyze material from the edge of a phase to a position outside the phase (the edge-clause).

While the ROLLC as stated works empirically, as we saw in this chapter and the previous one, the way it is formulated is not particularly elegant: the government and the dominance clause are of a ‘different kind’ than the edge-clause.

Ideally, it should be possible to state the ROLLC as follows:

(44) **Twice Revised On-Line Locality Constraint (TROLLC):**

The Human Sentence Processor cannot access material inside a phase once it is closed, unless the material is located in the first edge of that phase

The patterning of the data under this constraint would be essentially the same as under the ROLLC.

Reanalysis from complement position would be excluded because the VP is a closed phase, and the parser can't access material inside a closed phase, unless it's in the edge. As we saw, reanalysis from a complement position results in the most severe garden path effects:

- (45) ¿ Below the stairs collapsed
- (46) ¿ After Susan drank the water evaporated
- (47) ¿ Without her contributions failed to come in

The cases that are ruled in by the dominance clause, would in principle follow because material is added to a phase (which shows that it is not yet closed); the same would go for the cases that are ruled in by the government clause; these cases involve shuffling material around inside a phase, namely a VP 'under construction'.

Recall that there are cases that also involve shuffling material around inside a VP which do evoke a garden path effect:

- (48) ¿ I put the candy in the jar into my mouth

These cases should be excluded because the reanalysis involves adjunction that adds material to a phase that has already been closed (*the candy* in (48)).

Of course, the part of (44) that remains to be defined is the 'once it is closed' part; we have to find a way to define when exactly a phase is closed. Finding the right definition is not trivial.

On the up side, it seems that the ROLLC, also in the way it is stated now, opens a possibility to account for the difference in the severity of garden path effects in Japanese versus English. In the previous chapter, in footnote 1, I referred to Mazuka and Itoh's observations that there is a difference in judgments between English garden path sentences and Japanese garden paths. According to Mazuka and Itoh, the Japanese garden paths are less difficult:

By using the tentative attachment strategy, we can also reflect the Japanese speaker's intuitive judgment that none of the reanalyses we considered here cause a garden-path effect as clearly and robustly as some of English garden-path sentences. At the same time, it is not the case that the garden-path effect is missing in Japanese. Rather, the difficulties caused by various

types of reanalysis seems to be of various degrees. If we attempt to ascribe the garden-path phenomena to the fact that certain reanalyses violate some processing principle (e.g. a relicensing constraint, as in Pritchett, 1991, or as a parsing breakdown, as in Marcus, 1980), then the effect should be all or none, and it would be difficult to account for the "somewhat difficult" sentences we have discussed here.

(Mazuka and Itoh (1995), p.325)

Recall (21) in chapter 4, repeated here as (49):

- (49) ¿Yoko-ga kodomo-o koosaten-de mikaketa takusii-ni  
 Yoko-NOM child-ACC intersection-LOC saw taxi  
 noseta  
 put-on  
 'Yoko put the child on the taxi she saw at the intersection.'  
 (Mazuka and Itoh's (14a))

In (49), two arguments have to be reanalyzed, both from an edge position. Mazuka and Itoh do label sentences like (49) a garden path, because there is a conscious processing effort associated with them; but they report that the psychological effect is not the same as in English. I'm assuming that they have in mind English garden paths like the following:

- (50) ¿ Without her contributions failed to come in.

This type of garden path is not found in Japanese, because this type of complement-subject ambiguity cannot be constructed in Japanese. Garden paths like these can also not be found in Dutch, for the same reason (except for cases like (37) in this chapter, which indeed really is very difficult, in the same way that (50) is). We do, however, find intuitions of reanalysis *complexity* in Dutch, just as in Japanese; recall the discussion of (85b) in the previous chapter.

The environments in which we find these intuitions of 'processing complexity' rather than a more or less persistent impression of ungrammaticality (as in reanalysis from complement position), is understandable if we look at the data from the perspective of the ROLLC. Reanalysis from edge positions in principle lies within the capabilities of the Human Sentence Processor, albeit only one edge at a time. It is not surprising that having two or more of these operations to be performed simultaneously, causes a conscious impression of 'complexity of reanalysis', even though they are permitted in principle.

This seems to me to be a convincing argument in favor of the approach in terms of phases that has been defended in this dissertation.

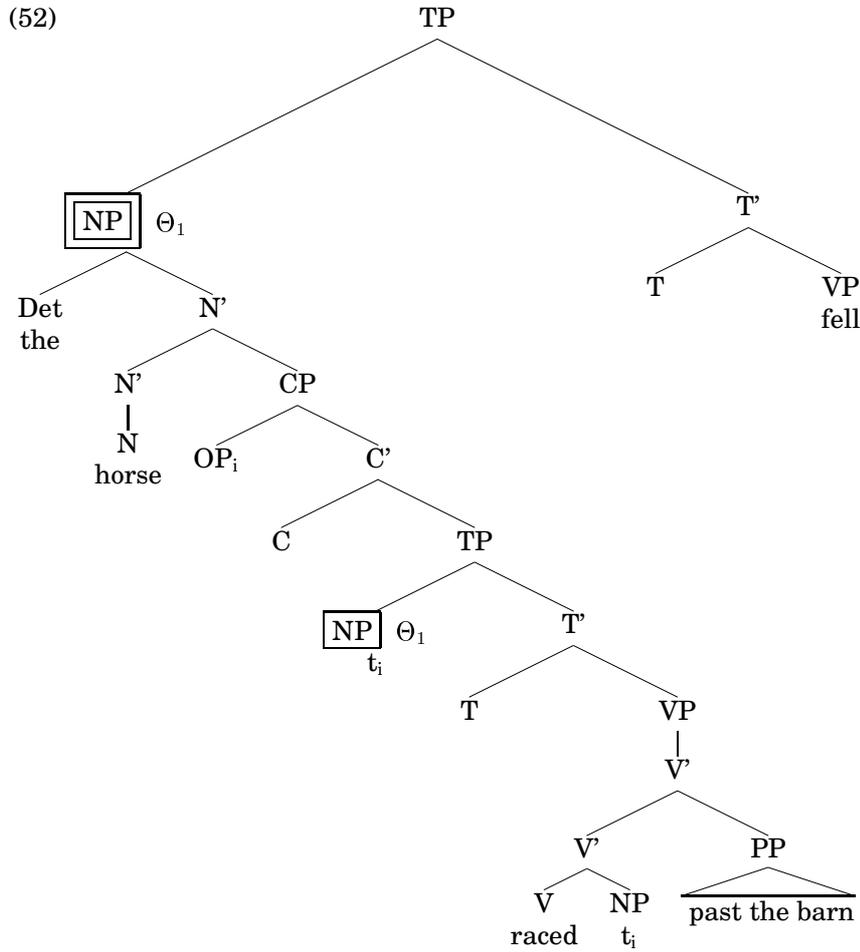
## 5.6 Reduced relatives

### 5.6.1 Reanalysis and the ROLLC

We have seen that so far, the ROLLC is rather successful in distinguishing costly from uncostly reanalysis. However, there is one structure where the edge-clause fails (quite spectacularly): it allows for reanalysis from the subject position of an initially parsed main clause to the subject position of the actual main clause. This is the type of reanalysis we find in reduced relative-main clause ambiguities, and as is well known, this can *not* take place cost-free:

(51) ¿ The horse raced past the barn fell.

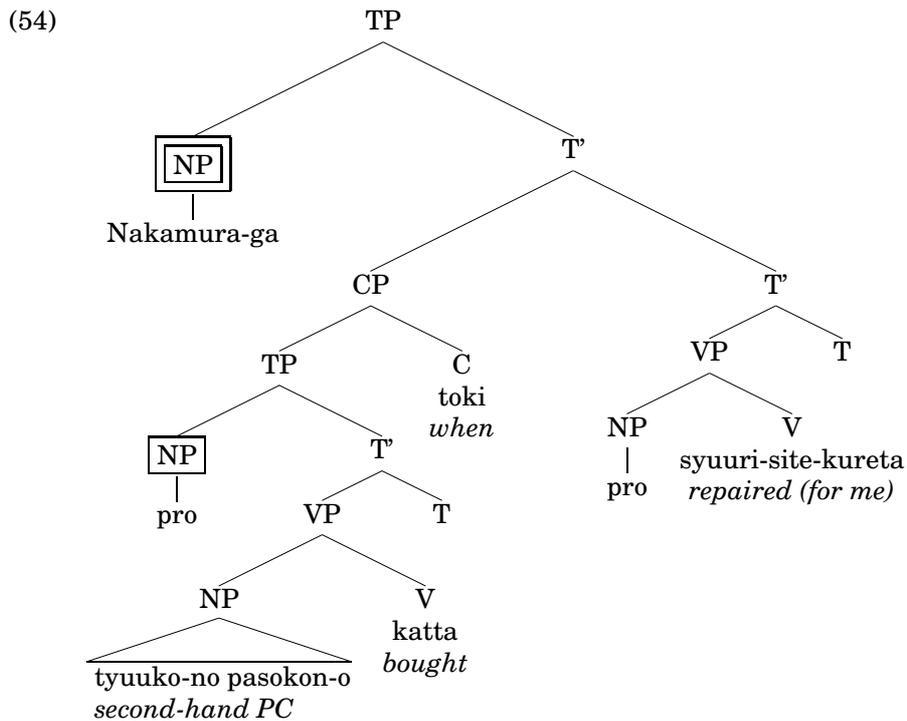
In chapter 2, we saw that Pritchett's OLLC can account for the difficulty of reanalysis in (51), since the source position (the subject position of *raced*) neither governs nor dominates the target position (the subject position of *fell*).



The ROLLC does allow for reanalysis of *the horse*: the reanalyzed element originates in the first edge of the embedded CP-phase, and the target position is outside the phase. This clearly is a problem for the ROLLC: these types of structures are generally very difficult to process:

- (53) a.  $\zeta$  The students advanced to the next grade had to study very hard  
 b.  $\zeta$  The clipper sailed to Portugal carried a crew of eight  
 c.  $\zeta$  The troops marched across the fields all day resented the general  
 d.  $\zeta$  The model planet rotated on the metal axis fell off the stand  
 e.  $\zeta$  The dog walked in the park was having a good time  
 f.  $\zeta$  The ship glided past the harbor guards was laden with treasure  
 (Stevenson and Merlo's (1997) (3))

On the other hand, we know that there are cases in Japanese which are very similar structurally to (51), and which do not lead to a garden path effect, such as (51) from chapter 4, repeated here as (54):



In both (51) and (54), reanalysis involves the subject of a clause (an initial main clause in (51), and an unattached adverbial clause in (54)). In both cases, the target position is the subject position of the matrix verb which triggers the reanalysis. In both cases, the reanalysis is allowed by the edge clause of the ROLLC. But (51) is a garden path, and (54) is not.

There is one interesting structural difference between the two cases; this difference lies in the attachment site of the phase from which the sub-

ject is reanalyzed. In (51), the attachment of the initial main clause structure, is in a position adjoined to *horse*. In (54), the adjunction site of the adverbial clause is a projection of the verb which triggers the reanalysis.

Under the TROLLC, this latter adjunction should be allowed, since the VP headed by *katta* 'bought' in (54) is not yet closed: after all, its head *katta* has just been encountered. However, it would be entirely reasonable to suspect that *the horse* in (51) is closed at the point when the reduced relative should be attached to it. This would mean that adjunction to *horse* is not possible under the TROLLC (compare (48)), and this could explain why (51) is a garden path, whereas (54) is not.

If this explanation is on the right track, we have also found an empirical way to distinguish the ROLLC from the TROLLC.

However, I am hesitant to take a final position here, because it is not clear to me whether it is not actually desirable to allow for reanalysis from an initial main clause to a reduced relative clause, as is predicted to be fine by the ROLLC. To see this, let us take a look at some of the data.

In chapter 4, I already discussed Pritchett's observation that reduced relative clauses do not lead to a garden path effect if the verb in the relative clause is obligatorily transitive. Recall the contrast between (55) and (56):

- (55) a. ζ The horse raced past the barn fell  
 b. ζ (Rex knows) the boy hurried out the door slipped
- (56) a. The spaceship destroyed in the battle disintegrated  
 b. The bird bought in the store flew away  
 c. The children found in the woods were frozen

Pritchett resorted to a system of rebuffering: he proposed that the reason why the examples in (56) are processed without effort is that the structure is broken up when the PP is encountered, because the PP shows that the main clause analysis is not the right one.

Now, it has been observed in the literature that reduced relatives are not only processed effortlessly when the verb is obligatorily transitive, but also when the verb is the transitive alternate of an unaccusative rather than an unergative verb. Consider the examples in (57) and (58):

- (57) <sup>OK</sup>The butter melted in the microwave was lumpy  
 (Stevenson and Merlo's (2))
- (58) a. The witch melted in the Wizard of Oz was played by a famous actress  
 b. The genes mutated in the experiment were used in a vaccine  
 c. The oil poured across the road made driving treacherous  
 d. The picture rotated 90 degrees was easy to print  
 (Stevenson and Merlo's (10))

Note that Pritchett's rebuffering system predicts no rebuffering here (for instance, *The butter melted in the microwave* is a perfectly acceptable main clause), but the sentences in (57) and (58) are still easy to process, even though they violate the OLLC.

Stevenson and Merlo (1997) argue that the reason why (51) is bad is not that the reanalysis that has to be performed there cannot be performed, but that there is some syntactic problem with building a reduced relative clause with the transitive alternate of an unergative verb. To support this claim, they tested (in a questionnaire) sentences with morphologically unambiguous participle forms of verbs of this type, in contexts which were either neutral or biased towards the reduced relative reading. The result they got was that people had great difficulty even with these morphologically unambiguous participle forms:

- (59) a. ??The greyhound run around the track all day was tired  
 b. ??The children withdrawn from the religion class could study music instead  
 c. ??The albatross flown to Australia was very tired  
 (Stevenson and Merlo's (4))
- (60) ??The bell rung only at Easter rusted from disuse  
 (Stevenson and Merlo's (5))

So it does indeed seem as though the problem with (51) could be due to a more general problem, and is not a problem with the required reanalysis per se.

It is not easy to take a position here, since the literature on the processing of reduced relative abounds with conflicting judgments and considerations of (discourse and other) factors that supposedly facilitate or complicate reanalysis<sup>5</sup>. For instance, Stevenson and Merlo's analysis is challenged by Filip (1998), who claims that the problem with (51) lies in the trigger for reanalysis (the main verb). She claims that

the fewer agentive properties and the more patient-like properties the main verb assigns to its subject, the easier the whole sentence with a reduced relative clause is judged  
 (Filip's (1998), p.5)

To substantiate this claim, Filip gives the following examples with transitive alternates of unaccusative verbs that are actually easy to process:

- (61) a. The victims rushed to the emergency room died upon arrival  
 b. The prisoners paraded past the mob was [sic, IM] later executed

---

<sup>5</sup>Or selection of the main clause or reduced relative analysis, for the adherents of parallel processing models.

- c. The cat rolled down the ramp overturned when it hit a bump
- d. The dog walked in the park was wearing a choke collar
- e. The debutante waltzed across the floor wore a beautiful dress
- f. The diplomats jetted to Iraq were unable to diffuse the crisis
- g. The convict moved into an isolation cell became depressed
- h. The contraband floated down the river was discovered by the border patrol
- i. the soldiers marched across the fields were ambushed by the enemy  
(Filip's (5))

And she also gives a set of examples with transitive alternatives of unaccusative verbs which are difficult to process:

- (62) a. ζ The theatre darkened for the movie frightened some preschoolers
- b. ζ The Klingon disintegrated during the battle had launched a rocket
- c. ζ The solution crystallized in the oven burned a hole into the petri dish
- d. ζ The plaster hardened in the oven cracked with loud popping sounds
- e. ζ The bubble burst in the made the principle jump [sic, IM]
- f. ζ The paper yellowed in the sun was wrinkled  
(Filip's (6))

She also gives the following contrasts:

- (63) a. ζ The patients rushed to the emergency room complained to the nurse
- b. The patients rushed to the emergency room died  
(Filip's (7))
- (64) a. ζ The Great Dane walked in the park tugged on the leash
- b. The Great Dane walked in the park wore a choke collar  
(Filip's (8))
- (65) a. ζ The theatre darkened for the movie frightened some preschoolers
- b. The theatre darkened for the movie smelled like popcorn  
(Filip's (9))
- (66) a. ζ The genes mutated in the experiment attacked their host
- b. The genes mutated in the experiment were used in a new vaccine  
(Filip's (10))

My main point here is not to develop a comprehensive analysis of the data above, but to show that there seems to be significant confusion about the data. The reduced relative-main clause ambiguity is one of the most widely researched ambiguities in the field, and probably for good reasons: the reduced relative clause construction is rather frequent in English, so it would be odd if it were as extremely difficult to process as many processing theories predict.

In the remainder of this section, I will focus on the predictions of the model that has been developed here; whether these predictions are right is a topic for future research.

### 5.6.2 Theta Attachment and reduced relative clauses

In this section, we will see that Theta Attachment entails many interesting predictions about the initial analysis of reduced relatives. In the introduction to Pritchett's model in chapter 2, I pretended that Theta Attachment always forces reduced relatives to be analyzed as main clauses initially, but as we will see in some detail in this section, Theta Attachment actually predicts optionality between the main clause analysis and the reduced relative clause analysis. This is interesting because, as we have seen above, there is a lot of confusion about the data, and the optionality predicted under Theta Attachment may actually give us a handle to better understand this confusion.

To see how Theta Attachment predicts optionality in reduced relative clauses, reconsider for instance the all-too-familiar (67):

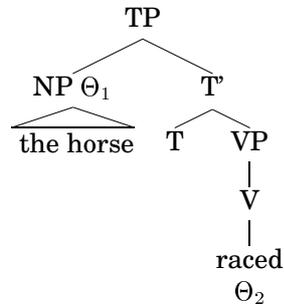
(67)  $\zeta$  The horse raced past the barn fell.

Let us go over this example step by step. At *the horse*, nothing happens; there is no theta assigner available. When *raced* is encountered, its maximal theta grid is retrieved; *race* can assign two theta roles:

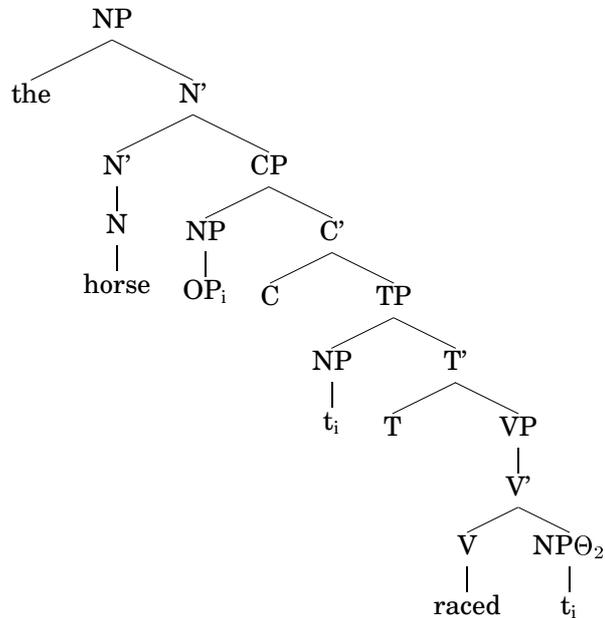
(68) race  
 $\Theta_1 \Theta_2$

There are in principle two options for structure building: a main clause can be constructed, with *the horse* as subject, or a reduced relative clause modifying *the horse*. The two alternatives are given below:

(69) a.



b.

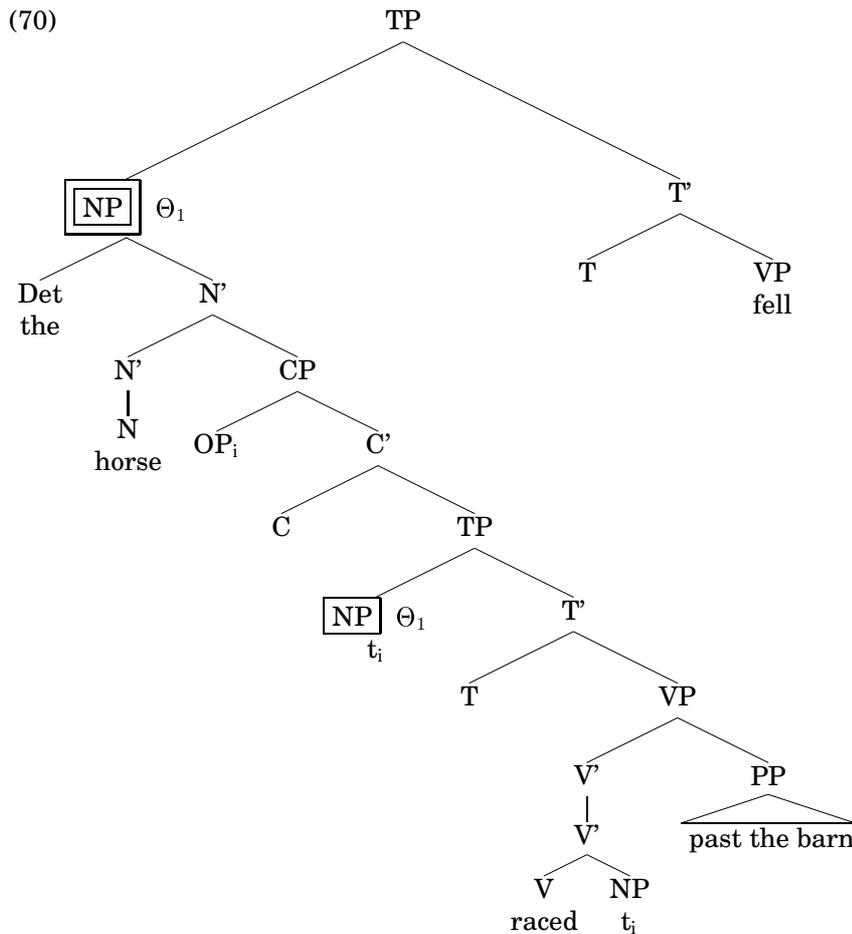


Both analyses satisfy Theta Attachment equally well. In (69a), one theta role from the maximal theta grid of *raced* is left unassigned, namely the internal theta role. In the analysis in (69b), both theta roles of *raced* are assigned: since the verb is passivized, the external theta role of *raced* is absorbed, while the internal theta role is assigned to the relative operator. The constructed NP headed by *horse* does need a theta role itself, though. So, the structure in (69b) consists of an NP without a theta role, while the structure in (69a) contains an unassigned theta role. They therefore satisfy Theta Attachment (as formulated in (1)) equally well.

This is a problematic situation, since the prediction now is that the sentence in (67) leads to a garden path only half the times it is parsed. To see this, let us consider what happens exactly under each alternative.

First, let us consider what happens if the parser chooses to start with

the structure in (69a). The parse continues with the input of *past the barn*, which is attached as an adjunct<sup>6</sup>. When *fell* is encountered, the initial main clause analysis must be revised; *horse* must be reanalyzed as the subject of *fell*.



As noted in the previous section, this reanalysis violates the OLLC (and the TROLLC). The source position (the subject position of *raced*) does not dominate or govern the target position (the subject position of *fell*). The parse that starts with the structure in (69a) therefore correctly predicts a garden path effect here.

The situation is quite different, however, if the Human Sentence Processor starts with the reduced relative clause analysis in (69b). Under that scenario, no reanalysis is needed since the reduced relative analysis

<sup>6</sup>Note that Theta Attachment does not give any directive for the processing of adjuncts.

is pursued from the beginning, and we predict no garden path effect.

So the problem is that Theta Attachment actually predicts only 50% garden path here, while (67) is always a garden path. One can think of a number of solutions for this problem.

One solution is to say that the Human Sentence Processor favors theta role reception over theta role assignment, i.e. it is more important for NPs to receive a theta role, than it is for theta assigners to assign their theta roles. Let us formulate this guideline for the parser as follows:

- (71) When faced with a choice between two analyses for a particular string, one of which leaves a theta role undischarged, and one of which leaves an NP without a theta role, the parser chooses the first analysis.

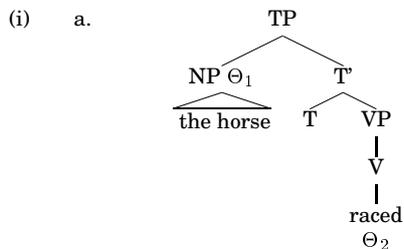
This guideline is not made explicit in Pritchett's work, but it seems to be present implicitly in his discussion on pp.88-89. A strategy like this seems reasonable, considering that theta roles may be optionally assigned, while NPs can never occur without a theta role. The guideline in (71) provides an account for why the analysis in (69a) is chosen over the analysis in (69b) in the following way. In (69a) one theta role has been assigned and every NP has a theta role; this is better than the situation in (69b) because there one theta role has been assigned and one absorbed, while the resulting NP still needs a theta role. In other words, the local theta criterion violation in (69b) involves an NP without a theta role, while the local theta criterion violation in (69a) involves an undischarged theta role. Therefore, the main clause analysis must be pursued first under guideline (71).<sup>7</sup>

Note that the approach taken in (71) predicts that the situation changes when the ambiguous region appears embedded under a higher verb:

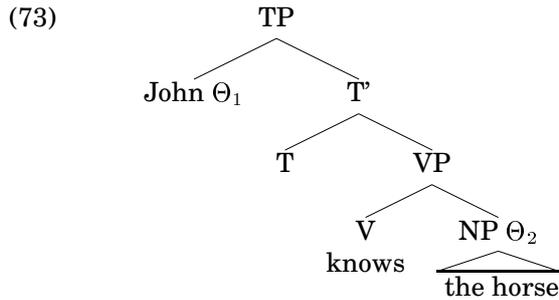
- (72) ¿ John knows the horse raced past the barn fell

To see the difference, let us look carefully at what happens during the parsing of this sentence. *John* and *knows* can be integrated in the familiar

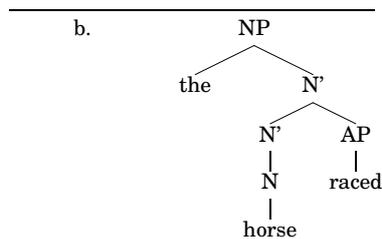
<sup>7</sup>A related "solution", suggested by Pritchett on p.90, is that the syntactic analysis of reduced relative clauses should in fact be different from the traditional analysis involving a relative clause. Following Abney (1987) and McCawley (1988), he suggests that reduced relatives might in fact be better analyzed as APs. The alternatives between which the parser has to choose then, are (69), repeated here as (ia), and something like (ib):



way, *John* being attached as the subject of *knows*. When *the horse* is encountered, it has to be attached as the direct object of *knows* in accordance with Theta Attachment:

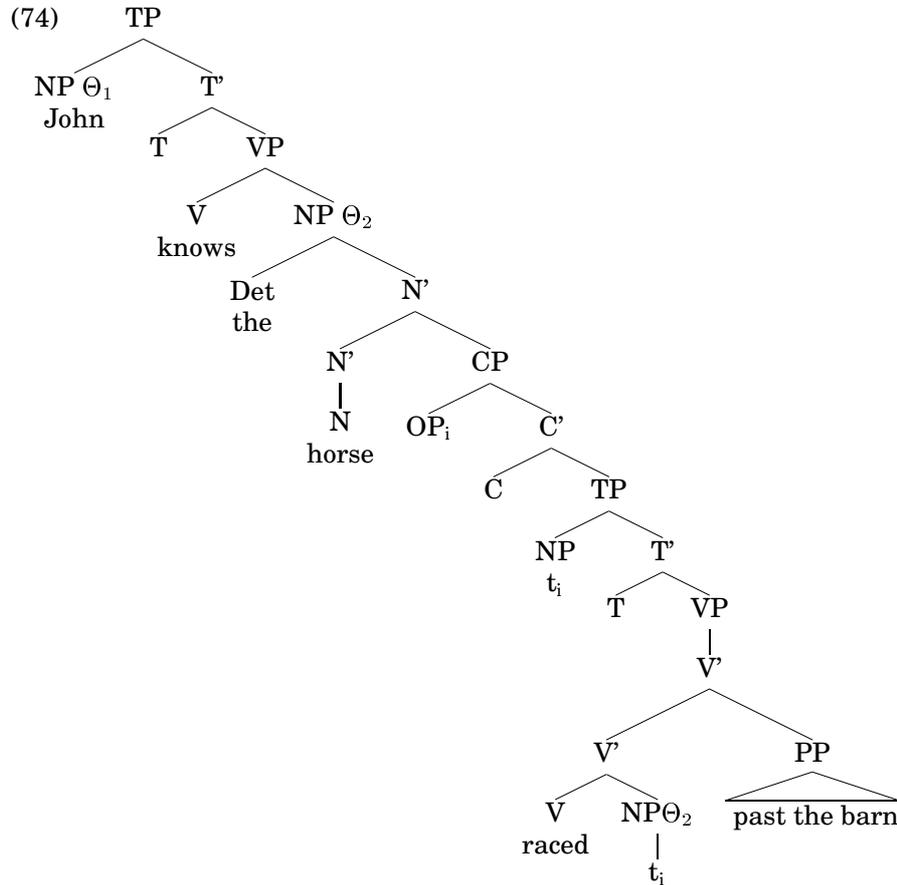


The next input consists of *raced*. There are two ways to fit in *raced* into the existing structure. One is to simply build a reduced relative clause and adjoin it to the N' projection of *horse*. The resulting structure is the following:



Under the assumption that APs don't assign theta roles, we see that we still need guideline (71) to explain why the Human Sentence Processor initially chooses analysis (ia). In the structure in (ia), there is one theta role left unassigned, while the structure in (ib) consists of an NP without a theta role. This means that, again, the number of local violations of the Theta Criterion is the same for both structures (namely one); and we need an additional mechanism, like (71), to force initial analysis as (ia) rather than (ib).

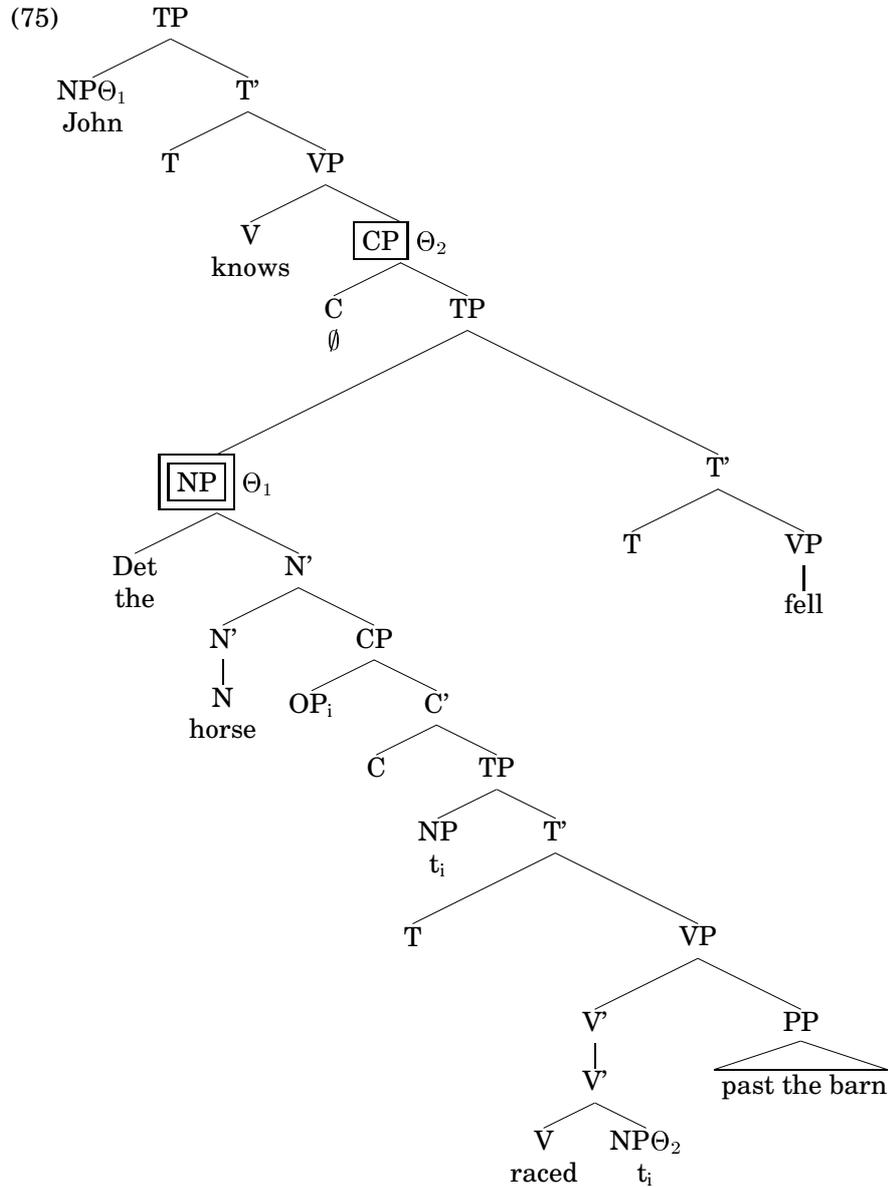
Since the AP-analysis of sentences like (67) seems to make the same predictions as the reduced relative clause analysis, I will ignore it here and continue to use the reduced relative clause analysis.



'John knows the horse (which) raced past the barn'

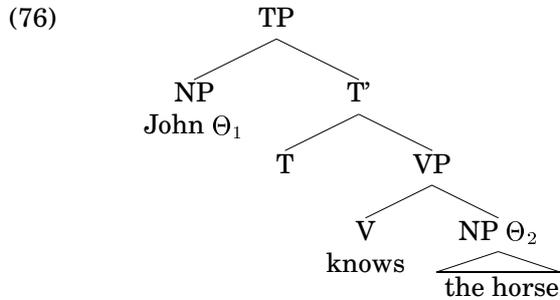
In this structure, no theta roles are left unassigned, and no NPs are left without a theta role; specifically, *the horse* continues to receive its theta role from *knows*. Apparently, assuming that theta role absorption counts as an optional satisfaction of the maximal theta-grid, we expect the reduced relative analysis to be considered first, rather than second, in an embedding context, so that no garden path effect should occur.

When *fell* is encountered, the structure has to be reanalyzed; the NP *the horse raced past the barn* has to be reanalyzed as the subject of *fell*, and the embedded sentence *the horse raced past the barn fell* receives the internal theta role of *knows*.

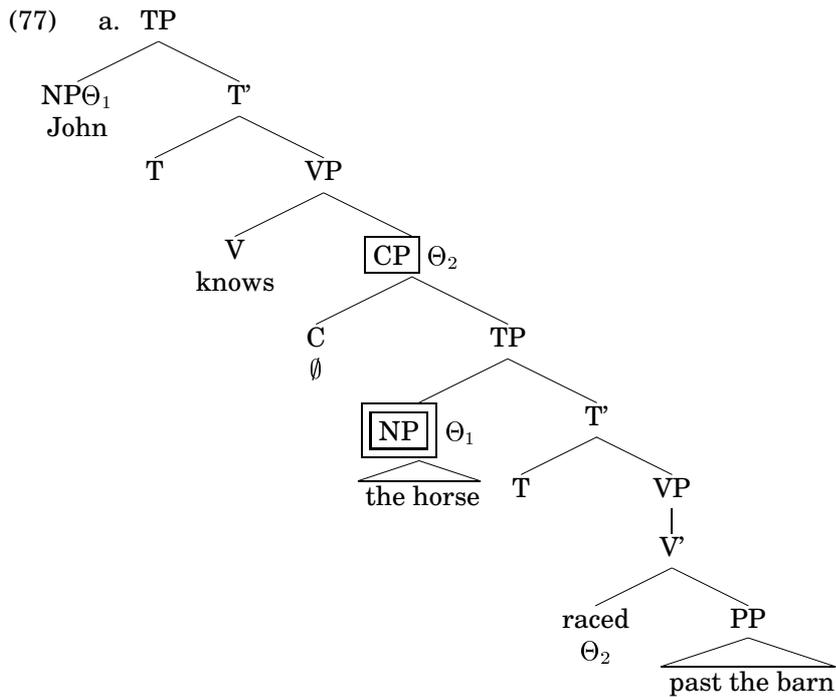


As can be seen in the structure above, the source position of *the horse raced past the barn* dominates its target position; therefore, this reanalysis is permitted by the OLLC, the ROLLC, and the TROLLC.

Let us now go one step back, to the point where *raced* was encountered. At this point, the structure looked like (73), repeated here as (76):



In principle, the parser can also choose to reanalyze the structure to one containing an embedded clause when it encounters *raced*; it can construct *the horse raced past the barn* as an embedded sentence, assigning it the internal theta role of *knows*:



‘John knows (that) the horse raced past the barn’

However, this analysis leaves open one theta role: the second theta role of the maximal theta grid of *raced*. Compare this situation to the structure in (74). There, no theta role is left unassigned. This means that for Theta Attachment, with or without guideline (71), the analysis in (74) is the only option. We have already seen that that analysis only leads to an unclosely

reanalysis when *fell* is encountered. Hence, Theta Attachment predicts no garden path effect in (72). Guideline (71), which gave us the right result for the choice between the main clause analysis (as given in (69a)) and the reduced relative analysis (given in (69b)) in non-embedded contexts, does not have an effect in embedded contexts.

Note that the same predictions are also made for reduced relatives with an obligatorily transitive verb. This means that Theta Attachment predicts no garden path effect in (78a); it also means that in (78b), reanalysis is predicted under Theta Attachment.

- (78) a. I saw the gangster just murdered lay in the street.  
 b. I saw the gangster just murdered a kid.

To sum up: we saw that Theta Attachment has some difficulties in accounting for the garden path effect in main clause-reduced relative clause ambiguities. We discussed one possibility for an additional guideline that forces the main clause analysis in the simple cases, which seems to be implicit in Pritchett's work. This guideline has no effect in embedded contexts.

As we have seen, the model makes many interesting predictions that should be looked into. Given that a crucial aspect of the model is that in case of optionality one analysis is chosen, reading time studies do not seem to be a suitable method to test the predictions of the current model, as we would expect some readers to choose one option, and another group of readers to choose the other option. It is not clear to me how this could be tested in a reading time study. A better method would be to use questionnaires, and ask readers for introspective judgments.

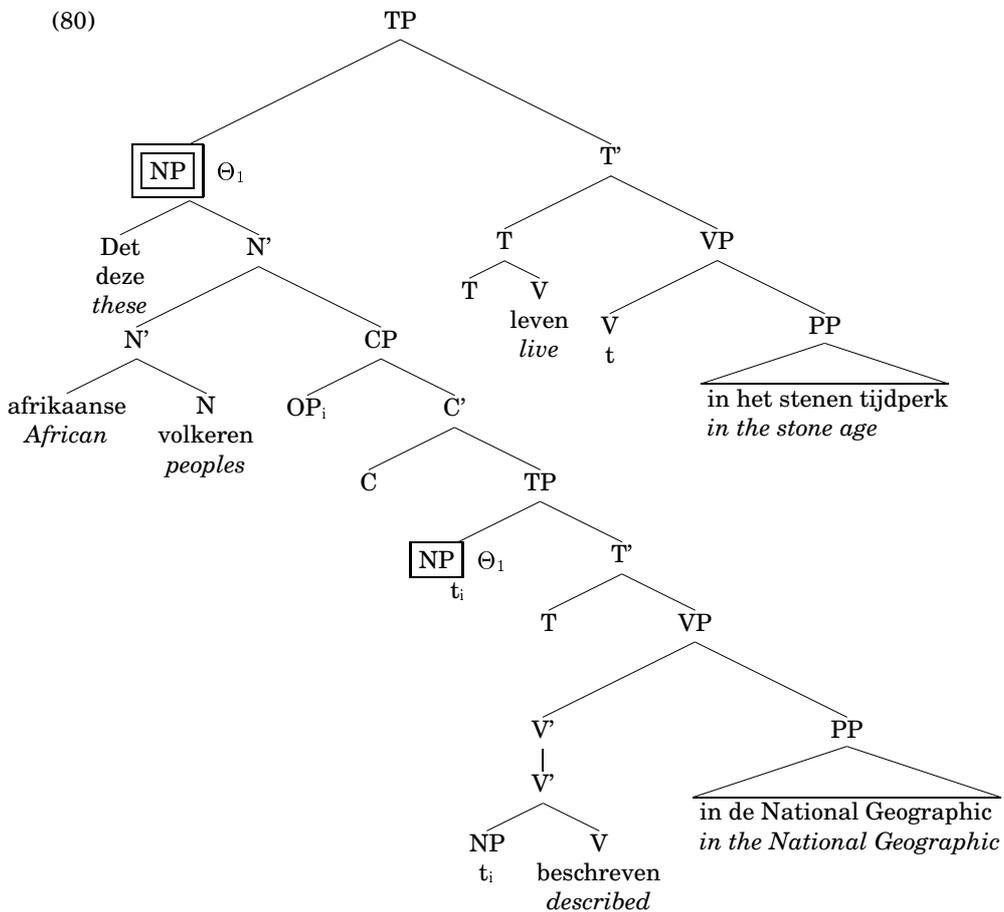
### 5.6.3 Reduced relatives in Dutch

To complete the discussion of the predictions made by the current model for reduced relative clauses, I would like to point out some predictions for the parsing of reduced relatives in Dutch. Under the ROLLC, we expect that reanalysis of two arguments from an initial main clause analysis, will be much more difficult than reanalysis of one argument. This cannot be tested in English main clause-reduced relative clause ambiguities, but it can be tested in Dutch because Dutch is verb-final. It must be noted, however, that reduced relatives are much less common in Dutch than they are in English (they are somewhat archaic). Nevertheless, I tested the following cases of reanalysis of one argument:

- (79) a. Deze afrikaanse volkeren beschreven in de National  
 these african peoples described in the National  
 Geographic hun hopeloze situatie  
 Geographic their hopeless situation  
 'These African peoples described their hopeless situation in the

- National Geographic’  
 b. OR Deze afrikaanse volkeren beschreven in de National  
 these african peoples described in the National  
 Geographic leven nog in het stenen tijdperk  
 Geographic live still in the stone age  
 ‘These African peoples described in the National Geographic  
 are still living in the stone age’

(79b) is a reduced relative clause. If the initial analysis is a main clause, the necessary reanalysis involves the subject of this initial analysis. This is allowed by the edge clause of the ROLLC because it involves only one argument, but not by the TROLLC, nor by the OLLC.



My subjects generally seemed to have no garden path effect in (79b). One speaker actually reported a garden path effect on the simple main clause in (79a).

For completeness, I also include the other cases I tested below.

- (81) a. De bergbeklimmers beschreven in de National Geographic  
 the mountainiers described in the National Geographic  
 een moeilijke tocht vol hindernissen.  
 a difficult journey full obstacles  
 ‘The mountainiers described a difficult journey full of obstacles  
 in the National Geographic’
- b. (¿)De bergbeklimmers beschreven in de National Geographic  
 the mountainiers described in the National Geographic  
 voltooiden een moeilijke tocht vol hindernissen  
 completed a difficult journey full obstacles  
 ‘The mountainiers described in the National Geographic com-  
 pleted a difficult journey full of obstacles’
- (82) (¿)De ontdekkers van dit merkwaardige verschijnsel beschreven  
 the discoverers of this strange phenomenon described  
 in een invloedrijk artikel hebben de nobelprijs gewonnen.  
 in an influential article have the Nobel prize won  
 ‘The discoverers of this strange phenomenon described in an in-  
 fluential article won the Nobel prize’ (example from Oele Koorn-  
 winder)
- (83) (¿)Een slikker is een drugskoerier die bolletjes drugs verpakt  
 a swallower is a drugs trafficker who balls drugs wrapped  
 in stevig plastic vervoert in de maag.  
 in strong plastic carries in the stomach  
 ‘A ‘swallower’ is a trafficker who carries balls of drugs wrapped in  
 strong plastic in the stomach’  
 (example heard in the tv-show ‘Opsporing Verzocht’)

The verbs here are all obligatorily transitive, and the judgments for the reduced relatives vary from ‘perfectly fine’ to ‘complex but not unprocess-able’.

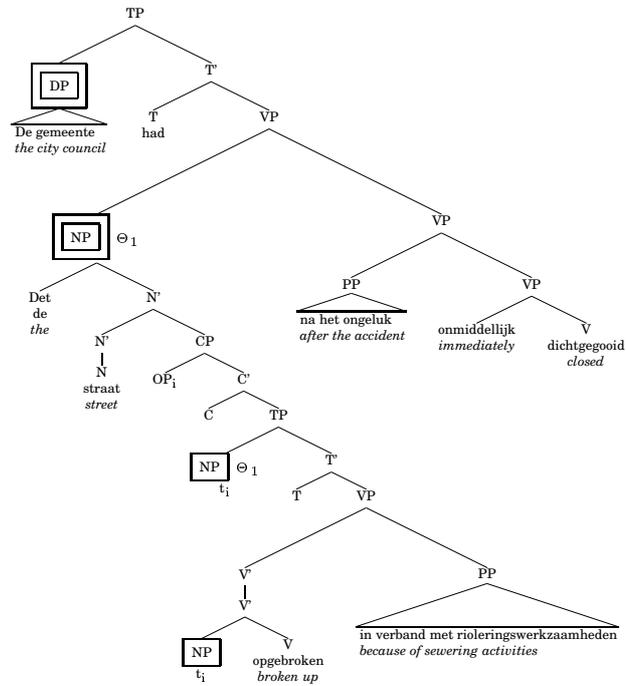
As for cases where two overt arguments must be reanalyzed, I tested the following examples:

- (84) ¿De agent heeft bolletjes drugs verpakt in stevig plastic  
 the police officer has balls drugs wrapped in firm plastic  
 gevonden.  
 found  
 ‘The police officer found balls of drugs wrapped in firm plastic’

- (85) a. ?Uiteindelijk heeft een buurtbewoner het mes verpakt in een  
eventually has a neighbor the knife wrapped in a  
plastic tas gevonden  
plastic bag found  
'Eventually, a neighbor found the knife, wrapped in a plastic  
bag'
- b. (¿)Een buurtbewoner heeft het mes verpakt in een plastic tas  
a neighbor has the knife wrapped in a plastic bag  
gevonden  
found  
'A neighbor found the knife, wrapped in a plastic bag'
- c. Een buurtbewoner heeft het mes verpakt in een plastic tas  
a neighbor has the knife wrapped in a plastic bag  
'A neighbor wrapped the knife in a plastic bag'
- (86) ¿De gemeente had de straat opgebroken in verband met  
The city council had the street broken up in connection with  
rioleringswerkzaamheden afgezet.  
sewering activities closed off  
Intended meaning: The city council closed off the street, broken up  
because of sewerage activities.  
(example from Oele Koornwinder)

To see that these cases involve reanalysis of two arguments, consider for instance the structure of (86), which is given in (87):

(87)



The judgments here vary from 'rather complex' to 'garden path'.

It seems like the judgments go in the direction that is predicted by the ROLLC: the reduced relatives which involve reanalysis of two arguments seem to be more difficult to process than the ones which involve only one argument. However, much more research is clearly called for.

## Chapter 6

# Conclusions

The goal of this dissertation has been to construct a parser that 1. is formulated in linguistically relevant terms, and 2. can uniformly account for processing difficulties in various languages. As a starting point, I took the model developed in Pritchett (1992), which was designed to meet both of these criteria, and tested it for head-final structures in Japanese and Dutch. In chapter 3, I showed that the objections that have been raised in the literature against head-driven processing on the basis of evidence from head-final languages are not convincing. In chapter 4, I added a condition to Pritchett's reanalysis constraint, which allows us to account for permitted cases of reanalysis in Dutch and Japanese that were excluded under Pritchett's original formulation.

The system developed in this way gives us an interesting new perspective on what seems to be widely perceived as a mystery in the processing of Japanese as compared to English. In the words of Mazuka and Itoh (1995), the problem is this:

Most models of sentence processing developed for English predict that almost all sentences in a language such as Japanese should induce a garden path. But the majority of Japanese sentences predicted to induce a garden-path effect by these models do not produce difficulties in processing (e.g. Mazuka and Lust, 1988, 1989; Mazuka et al., 1989).  
(Mazuka and Itoh (1995), p.296)

Pritchett's system, which is head-driven and therefore does not build structure before the verb, does not predict nearly as many garden paths for Japanese as models do that employ Immediate Attachment. Therefore, head-driven processing is a much better bet for a universal parser than Immediate Attachment.

However, as Mazuka and Itoh point out, Pritchett's OLLC is still too restrictive. The step that Mazuka and Itoh take basically is to say that

processing Japanese is done in an entirely different way than processing English. Consider again their Tentative Attachment Strategy:

(1) *The Tentative Attachment Strategy:*

In Japanese, a parsing decision is tentative until the sentence is finished. By tentative, we mean that reanalysis of each decision will have a psychologically measurable cost (i.e., it is not cost-free), but any single reanalysis will not be costly enough to cause conscious processing difficulty. When reanalysis is combined with other complexities (e.g., lexical ambiguities, multiple reanalyses, pragmatic naturalness, etc.), it becomes increasingly costly and may become conscious.

(Mazuka and Itoh's (45))

This approach entails a departure from a universal parser: attachment is tentative in Japanese, but not in English. To see this, consider the English garden path in (2):

(2) ¿ Without her contributions failed to come in

In order to solve the garden path here, all the parser has to do is to take out *contributions*, and attach it in the subject position of *failed*. In chapter 4, we have seen various instances of uncostly reanalysis in Japanese which also involve reanalysis of one element. Recall for instance (16), repeated here as (3):

- (3) OK Yoko-ga kodomo-o koosaten-de mikaketa onnanoko-ni  
 Yoko-NOM child-ACC intersection-LOC saw girl-DAT  
 koe-o kaketa  
 called  
 'Yoko called the girl who saw the child at the intersection'  
 (Mazuka and Itoh's (8b))

In (3), *Yoko* has to be reanalyzed from its initial main clause subject position. This is also one operation; so if the attachment and reanalysis strategies employed by the Japanese parser would be the same as those employed by the English parser, we would not expect the huge contrast in processing difficulty between (2) and (3).

Evidently, the concept of having different parsers for head-final and head-initial languages, raises the question of how these language-specific parsers would be acquired. Mazuka (1998) argues that there is no problem in departing from the ideal of a universal parser for all languages; she argues that children at a very early age can decide on the basis of prosodic properties of the language they are learning whether their language is head-final or not; and that they can choose a parser according to that property.

While this approach may be feasible when applied to the Japanese-English contrast, it raises significant questions for Dutch. Japanese is head-final throughout its grammar, and English is head-initial. But Dutch has a mixed system: it is head-initial in all projections except the verbal projections. What would this mean for the Dutch child trying to decide which parser to use? Would it use a different parser for different projections in the same sentence?

The reanalysis constraint developed in this dissertation tackles the problem of English versus Japanese from a different angle. It says that reanalysis from a specifier is possible for the Human Sentence Processor. This type of reanalysis will occur quite frequently in Japanese, and it will only rarely occur in English, due to the different syntactic properties of these languages. Dutch, with its mixed system, provides an excellent opportunity to test whether the predictions of the constraint are correct, and as we have seen in chapter 4 and 5, this appears to be the case.

Thus the puzzle of the virtual absence of garden path effects in Japanese compared to the robustness of garden path effects in certain contexts in English can be solved with a universal parser which is formulated in terms that can directly be linked to competence theory.



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# Samenvatting

Dit proefschrift gaat over de manier waarop mensen hun grammaticale kennis van hun moedertaal gebruiken terwijl ze luisteren en lezen.

Het onderzoek concentreert zich op een bepaald type zinnen dat moeilijk te lezen is, de zogenaamde *garden paths* oftewel *intuinzinnen*:

- (1) a. ¿After Susan drank the water evaporated  
nadat Susan dronk het water verdampte  
'Nadat Susan gedronken had, verdampte het water'
- b. ¿Without her contributions failed to come in  
zonder haar bijdragen verzuimden te komen binnen  
'Zonder haar kwamen er geen bijdragen binnen'
- c. ¿Below the stairs collapsed  
onder de trap instortte  
'Beneden stortte de trap in'

De Engelse zinnen hierboven zijn grammaticaal wel correct, maar ze zijn moeilijk om te lezen. Laten we bekijken wat er gebeurt als een lezer (1a) leest. De lezer begint van links naar rechts te lezen; op het moment dat hij *the water* tegenkomt, denkt hij dat *the water* het lijdend voorwerp is van *drank*. Dat zou op het moment dat *the water* gelezen wordt, heel goed kunnen; *the water* is immers ook het lijdend voorwerp van *drank* in een zin zoals (2), en tot en met *the water* is er geen verschil tussen (1a) en (2):

- (2) After Susan drank the water, she left  
nadat Susan dronk het water zij wegging  
'Nadat Susan het water had opgedronken, ging ze weg'

In (1a) is *the water* evenwel niet het lijdend voorwerp van *drank*, maar het onderwerp van *evaporated*. Dat blijkt op het moment dat de lezer *evaporated* leest, maar dan is het blijkbaar al te laat: *the water* is tegen die tijd al geïnterpreteerd als het lijdend voorwerp van *drank*, en de parser heeft geen element in de zin tot z'n beschikking dat als onderwerp van *evaporated* zou kunnen dienen. Daar raakt de lezer van in de war. Dit in de war zijn geven we aan met het symbool ¿.

Elementen zoals *the water* in (1a) noemen we *lokaal ambigu*: ze kunnen op de positie waarin ze in de zin voorkomen in principe zowel bij het element ervoor, als bij het element erna horen. De zinnen in (1) bevatten alledrie zo'n element: in (1b) is dat *contributions*, in (1c) is het *the stairs*.

Leesfouten zoals die in (1) zijn interessant, omdat ze ons aanwijzingen verschaffen over hoe de parser werkt. In dit proefschrift bouw ik voort op een specifiek parsermodel, dat van Pritchett (1992). In hoofdstuk 2 leg ik uit hoe dat model in elkaar zit. Het komt er ruwweg op neer dat in Pritchett's model het werkwoord een centrale rol speelt bij het interpreteren van zinnen. De parser probeert om zo snel mogelijk de argumenten bij elk werkwoord te vinden.

Voor de zin in (2a) wordt dus voorspeld dat *the water* geanalyseerd wordt als het lijdend voorwerp van *drank*, omdat *drank* op zoek is naar een lijdend voorwerp. We hebben al gezien dat dat klopt, en dat die vergissing van de parser verklaart waarom we in de war raken als we (2a) lezen.

Zo simpel is het echter niet helemaal: er zijn ook configuraties waarin de parser in eerste instantie dezelfde vergissing maakt als in (1a), maar die desalniettemin geen leesproblemen opleveren:

- (3) John knows Mary left  
 John weet Mary wegging  
 'John weet dat Mary wegging'

In (3) wordt *Mary* in eerste instantie ook opgevat door de parser als het lijdend voorwerp van *knows*. Dat blijkt fout te zijn als *left* verschijnt: *Mary* moet eigenlijk geanalyseerd worden als het onderwerp van *left*.

Aangezien (3) geen leesprobleem oplevert, is de parser blijkbaar in staat om de oorspronkelijke aanhechting van *Mary* als lijdend voorwerp van *knows*, te *heranalyseren* tot een aanhechting als onderwerp van *left*. Pritchett stelt voor om deze heranalyse op te vatten als een 'verplaatsing' van *Mary* van de oorspronkelijke positie naar de uiteindelijke positie. Hij beweert dat de menselijke parser beschikking heeft over een heranalysemechanisme dat in staat is om de heranalyse in (3) uit te voeren omdat de oorspronkelijke positie van *Mary* en de uiteindelijke positie in een bepaalde structurele verhouding tot elkaar staan (de oorspronkelijke positie *domineert* namelijk de uiteindelijke positie).

Pritchett's heranalysemechanisme staat ook nog heranalyse toe in een andere configuratie:

- (4) I gave her books to Ron  
 ik gaf haar boeken aan Ron

In (4) analyseert de parser *her* in eerste instantie als meewerkend voorwerp bij *gave*, en *books* als lijdend voorwerp. Als *to Ron* gelezen wordt, wordt

evenwel duidelijk dat *her books* in z'n geheel als lijdend voorwerp fungeert, en dat het eigenlijke meewerkend voorwerp niet *her* is, maar *to Ron*. De heranalyse die nodig is om deze structuur te bouwen, wordt toegestaan in Pritchetts model, omdat de oorspronkelijke positie (van *books*) de uiteindelijke positie weer in een bepaalde structurele relatie tot elkaar staan (de oorspronkelijke positie *regeert* de uiteindelijke positie in dit geval).

Pritchetts heranalysemechanisme is evenwel niet in staat om de relatie te leggen tussen de oorspronkelijke en de uiteindelijke positie van *the water* in (1a); vandaar dat (1a) wel tot leesproblemen leidt.

Pritchetts model bestaat dus uit twee ingrediënten: een aanhechtingsmechanisme en een heranalysemechanisme dat heranalyse kan uitvoeren in twee mogelijke configuraties.

Een kenmerk van Pritchetts aanhechtingsmechanisme is, zoals gezegd, dat het werkwoord een centrale rol speelt bij het verbinden van woorden tot zinnen: de parser wacht dus op het werkwoord voordat hij begint met relaties tussen zinsdelen vast te stellen. De meeste parsingtheorieën nu, gaan ervan uit dat het bouwen van zinsstructuur anders verloopt; namelijk dat ieder woord onmiddellijk in een structuur wordt aangehecht. Het is moeilijk om dit soort modellen op basis van het Engels empirisch te onderscheiden van Pritchetts model, omdat het werkwoord in het Engels altijd direct na het onderwerp staat; het is dus al vrij vroeg in de zin beschikbaar.

Er zijn evenwel talen, zoals het Japans, waarin het werkwoord altijd op het einde van de zin staat. Ook in Nederlandse bijzinnen is dit het geval. Dit soort zinnen kunnen dus gebruikt worden om te kijken welk model beter is: Pritchetts model voorspelt minder leesfouten in zinnen met het werkwoord op zinseinde, en de meeste andere modellen voorspellen juist meer leesfouten.

In de literatuur op dit gebied (bijvoorbeeld Frazier (1987), Frazier (1989), Schneider (1999)) is wel beweerd dat zinnen waarin het werkwoord op het einde staat, kunnen dienen als bewijsmateriaal voor onmiddellijke aanhechting van zinsdelen, nog voordat het werkwoord beschikbaar is. In hoofdstuk 3 laat ik zien dat dit bewijsmateriaal ook anders geïnterpreteerd kan worden, en dus geen aanleiding geeft om Pritchetts aanhechtingsmechanisme te verwerpen.

Het blijkt zelfs zo te zijn dat in werkwoordsfinale talen zoals het Japans, minder intuïnzinnen gevonden worden dan in talen zoals het Engels. Dit is een sterk argument voor Pritchetts model.

Dat wil niet zeggen dat Pritchetts model vlekkeloos werkt voor het Japans. Er blijken namelijk configuraties te zijn in het Japans die géén intuïneffect vertonen, terwijl Pritchetts model voorspelt dat ze dat wel doen (zie Mazuka en Itoh (1995)). Een voorbeeld van zo'n zin die zonder problemen gelezen wordt door Japanse moedertaalsprekers, is de volgende:

- (5) Yoko-ga [[kodom-o koosaten-de mikaketa] onnanoko-ni]  
 Yoko-NOM child-ACC intersection-LOC saw girl-DAT  
 koe-o kaketa  
 called  
 'Yoko riep het meisje dat het kind op de kruising zag'  
 (Mazuka en Itoh's voorbeeld (8b))

In (5) bouwt de parser in eerste instantie een hoofdzin: de elementen *Yoko-ga*, *kodom-o* 'kind' *koosaten-de* 'kruising' en *mikaketa* 'zag' kunnen geïntegreerd worden tot een hoofdzin 'Yoko zag het kind op de kruising'. Deze analyse blijkt fout te zijn als *onnanoko-ni* 'meisje' gelezen wordt. In het Japans gaan betrekkelijke bijzinnen vooraf aan het zelfstandig naamwoord waarop ze betrekking hebben, en *onnanoko-ni* 'meisje' blijkt zo'n zelfstandig naamwoord te zijn dat gemodificeerd wordt door een betrekkelijke bijzin. De parser moet heranalyseren, en het resultaat van die heranalyse is een zelfstandig naamwoord met een betrekkelijke bijzin: 'het meisje dat het kind op de kruising zag'. Om deze betrekkelijke bijzin te kunnen bouwen, moet *Yoko* uit de oorspronkelijk gebouwde hoofdzin verwijderd worden. Als het werkwoord in de eigenlijke hoofdzin, *koe-o kaketa* 'riep' beschikbaar komt, kan dan de zin 'Yoko riep het meisje dat het kind op de kruising zag' gebouwd worden.

Pritchetts heranalysemechanisme is in principe wel in staat om *Yoko* uit de oorspronkelijk gebouwde hoofdzin te verwijderen, maar Mazuka en Itoh laten zien dat er ingewikkeldere gevallen in het Japans te vinden zijn die wél makkelijk te lezen zijn door Japanners, maar waarin een heranalyse plaats moet vinden die níet toegestaan wordt door Pritchetts heranalysemechanisme.

Aan de andere kant is het ook weer niet zo dat in het Japans alles maar kan; ook de Japanse parser blijkt in sommige gevallen vast te kunnen lopen. In hoofdstuk 4 bespreek ik deze gevallen, en stel ik voor om Pritchetts heranalysemechanisme uit te breiden met een clause die heranalyse toestaat in gevallen waarin de oorspronkelijke positie van een element dat geheranalyseerd moet worden, in de *first edge* van een *phase* zit.

In hoofdstuk 5 laat ik zien dat deze toevoeging aan Pritchetts heranalysemechanisme geen ongewenste nieuwe voorspellingen doet voor het Engels, en dat hij ook kan verklaren dat bepaalde zinnen in het Nederlands makkelijk te lezen zijn hoewel Pritchetts model anders voorspelt. Daarnaast stip ik aantal kleine technische problemen met Pritchetts formulering aan, en geef ik aan hoe mijn herziening zou kunnen dienen als basis voor een elegantere formulering van het heranalysemechanisme.

Mijn oplossing voor de problemen die Mazuka en Itoh aandragen voor Pritchetts model, is dus om Pritchetts models enigszins aan te passen, zodanig dat er één universele parser is die zowel het Engels als het Japans kan verwerken. Mazuka en Itoh slaan een andere weg in: zij beweren dat de Japanse parser volgens andere principes werkt dan de Engelse parser.

Dat is een drastische stap; immers, kinderen moeten de beschikking hebben over een parser om hun moedertaal überhaupt te kunnen leren. Stel nu dat de parser verschilt per taal; dan moeten kinderen dus eerst hun taal leren om vast te stellen hoe hun parser eruit ziet. Maar ze kunnen hun taal niet leren als ze geen parser hebben, dus dat wordt problematisch.

Volgens Mazuka (1998) is de oplossing voor dit probleem de volgende. Het aangeboren taalvermogen geeft kinderen de beschikking over twee parsers: een parser die zinnen met het werkwoord op het einde analyseert (de 'Japanse' parser) en een parser die zinnen met het werkwoord in tweede positie kan analyseren (de 'Engelse' parser). Kinderen kunnen volgens Mazuka op basis van intonatie-eigenschappen van hun taal vaststellen of ze de 'Japanse' of de 'Engelse' parser moeten gebruiken.

Deze oplossing is denkbaar voor het contrast tussen het Engels en het Japans, maar het is niet duidelijk hoe Nederlandse kinderen onder deze theorie hun parser moeten kiezen, omdat het Nederlands een gemengd systeem heeft wat betreft de positie van het werkwoord: het werkwoord komt in het Nederlands in hoofdzinnen op de tweede positie, en in bijzinnen op de laatste positie. Een universele parser voor alle typen talen is te prefereren, omdat duidelijk is hoe zo'n parser talen met een gemengd systeem structureert: als het werkwoord in het begin staat worden zijn argumenten snel aangehecht, en als het werkwoord achteraan de zin staat worden de argumenten opgeslagen totdat het werkwoord beschikbaar komt.

Er is nog een andere reden om de weg die in dit proefschrift genomen wordt, te prefereren. Die reden heeft te maken met de vraag hoe mensen de kennis van hun moedertaal gebruiken tijdens luisteren en lezen.

De kennis die een mens heeft van de structuur van zijn taal noemen we *grammatica* of *competence*. In het Minimalistisch Programma (Chomsky, (1995), (1998), (1999)) gaat men ervan uit dat de structuur van een taal een afgeleide is van de woorden van de taal; alle talen gebruiken dezelfde principes om structuur te bouwen met die woorden, en de structurele verschillen tussen talen zijn terug te voeren op verschillende eigenschappen van de woorden en zogeheten *functionele* elementen (denk aan naamval, tijdsmarkering op het werkwoord, voegwoorden, voorzetsels, etcetera). In deze opvatting is het leren van een moedertaal een kwestie van het leren van de eigenschappen van de woorden; de principes die woorden samensmeden tot zinnen, zijn universeel en aangeboren.

In dit proefschrift beargumenteer ik dat het structureringsmechanisme dat de menselijke parser gebruikt, hetzelfde mechanisme is als we in de grammatica-theorie gebruiken. Met andere woorden: de parser is *transparent* met betrekking tot de competence-theorie. Ik wijk hiermee af van meer gangbare theorieën over de parser, die ervan uitgaan dat de parser structuurtoekennende heuristieken gebruikt die specifiek zijn voor de parser, en die in de competence-theorie geen rol spelen.

Gegeven de eigenschappen van het structuurbouwende mechanisme in

de competence-theorie van het Minimalistisch Programma, is zo'n transparante parser noodzakelijk een parser waarvoor het werkwoord een centrale rol speelt. In die zin betekent het onderzoek waarover hier gerapporteerd wordt, een stap in de richting van de formulering van een transparante parser.

# Curriculum vitae

Iris Mulders was born in Vierpolders on June 24 1972. She attended the Christelijk Gymnasium in Utrecht, and graduated in 1990.

In 1990, she began her studies at Utrecht University. In 1991, she obtained her 'propedeuse' in Dutch Language and Literature, and in 1996 she received her Master's degree in General Linguistics, cum laude. That same year, she joined the Utrecht Institute of Linguistics OTS as a PhD-student. There she carried out the research that resulted in this dissertation. She also functioned as a representative for the PhD-students in the Faculty of Arts and in UiL OTS.

She is currently employed by the UiL OTS to conduct and support eye-tracking research.