ABSTRACT

Title of dissertation: THE GRAMMAR AND PARSING OF

WH-DEPENDENCIES

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The aim of this thesis is to explain how grammar relates to real-time comprehension of \textit{wh}-dependencies. It proposes an explanatory model which makes minimal assumptions to derive the facts seen in both performance and comprehension. The assumptions are twofold. One is that grammatical constraints drive learning and parsing theory. The other is that incrementality and efficiency force left corner analysis. The proposed model can explain the following, heretofore unrelated, facts; (i) the time course of gap-creation for filler-gap dependencies suggests incremental gap-positing, (ii) structure-building is incremental in head-final structures, (iii) the insertion principle forced by the left corner constraint derives unforced reanalysis only for predicted
categories, (iv) the constraint on rapid gap interpretation is derived from restrictions on merger enforced by left corner constraint, (v) off-line / on-line contrasts of *wh*-scope interpretation are also explained by early prediction of question marker given *wh*-element, and (vi) Subjacency governs (*wh*-)scrambling, which is an overt movement operation.

The psycholinguistics experiments, which take advantage of the strict verb-final property of Japanese, provide evidence that the real-time formation of filler-gap dependencies is driven by the satisfaction of grammatical constraints, rather than simply by the need to create a gap. They also find a filler-gap relation prior to the linearly first verb, suggesting that structure-building operates incrementally even when critical lexical heads are delayed. The experimental findings imply that there is a case where reanalysis is allowed even though it is not forced. This unforced reanalysis contrasts with a view of reanalysis as a last resort operation.

A feature-based left-corner parsing model developed in this thesis can not only predict the time course of gap-creation in head-final structures and incremental structure-building, but also can distinguish between contrasting views of reanalysis. In addition, it accounts for why the gap is postulated in a grammatically legitimate position ‘as soon as possible’. Under the current system, furthermore, the same grammatical principles underlying the local relation of a *wh*-element and a *wh*-scope marker also predict both on-line and off-line *wh*-scope interpretations observed here. The model thus shows that the competence grammar operates dynamically as part of the parsing process.
THE GRAMMAR AND PARSING OF *WH*-DEPENDENCIES

by

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Professor Colin Phillips, Co-chair
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LIST OF ABBREVIATIONS

The following abbreviations are used in this thesis:

Acc  accusative
Aff  affirmative
C    complementizer
Cl   classifier
Comp complementizer
CP   complementizer phrase
Dat  dative
Decl declarative
DeclC declarative complementizer
Det  determiner
e    empty category
Gen  genitive
GP   garden path
Lit  literary translation
LF   logical form
N    noun
Neg  negation
Nom  nominative
NP   noun phrase
Nl   noun linkage
Op   operator
PF   phonetic form
P    pre/post-position
PP   pre/post-positional phrase
Q    question marker
θ    thematic role, thematic grid
t    trace
T    tense
Top  topic
TP   tense phrase
VP   verb phrase
WH   wh-phrase, wh-feature
*    unacceptable, ungrammatical
!    surprising
CHAPTER 1

INTRODUCTION

1.1 Overview

This thesis explores what drives formation of \textit{wh}-dependencies from both the side of performance and the side of competence systems. Taking advantage of the word order properties of Japanese \textit{wh}-interrogatives, I provide evidence supporting my hypotheses about the mechanisms that guide the real-time formation of \textit{wh}-dependencies and the grammatical principles that determine \textit{wh}-scope construal. The strict verb-final property of Japanese has the effect of ensuring that more deeply embedded verbs appear before the structurally highest verbs in a sentence. A scrambling operation may move a canonically in-situ \textit{wh}-element to the sentence-initial position with little effect on the \textit{wh}-scope interpretation. These properties allow testing of the claim that the real-time formation of filler-gap dependencies is driven by the satisfaction of syntactic and semantic constraints, rather than simply by the need to create a gap. These properties also provide structures in which we can find evidence for a filler-gap relation prior to the linearly first verb, suggesting that even when critical lexical heads are delayed, structure-building operates fully incrementally and follows grammatical principles accurately. The morphological
fact that a Japanese \textit{wh}-scope marker is a morpheme bound by a verb further implies the existence of locality effects on \textit{wh}-scope construal. On-line and off-line \textit{wh}-scope interpretations both share the same grammatical principles underlying the local relation of a \textit{wh}-element and a \textit{wh}-scope marker. Taken together, a set of examples from Japanese \textit{wh}-interrogatives provide us with a situation where performance-based parsing mechanisms can be replaced by mechanisms based in independently motivated grammatical principles. This thesis documents a mass of evidence supporting the claim that parsing is a local, incremental application of grammatical principles which are needed independently to account for language learning or language variation (Pritchett, 1988, 1991a, b, 1992; Gibson, 1991; Weinberg, 1993, 1999; Gorrell, 1995; Phillips, 1995, 1996, 2003a, b).

A parsing model plausible under the grammatical principle-based approach must be formulated explicitly in terms of grammatical principles operating on articulated grammatical structures. The real-time structure-building follows application of the principles under some particular theory of competence grammar. This study develops a parsing model which assumes grammatical principles and involves explicit left-corner parsing algorithm. It predicts time course of gap-creation and incrementality in head-final structures. In this sense, a grammar-parser relation is formed with the latter dependent upon the former. However, one property of real-time comprehension does not obviously follow any grammatical principle. That is, the gap in a filler-gap formation is posited ‘as soon as possible’. The current model explains why the gap has to be postulated in a grammatically legitimate position as soon as possible. It also accounts for why there are
contrasting cases regarding reanalysis even in the same language. Furthermore, contrasts of off-line and on-line interpretation of *wh*-scope can be explained by the parser’s early prediction of a question marker given a *wh*-phrase. This model, thus, shows that the competence grammar operates dynamically in the parsing process.

This study is organized as follows. Chapter 2 presents a series of experimental studies that show that Japanese speakers associate sentence-initial *wh*-phrases with the most deeply embedded clause of a multi-clause sentence. Because the first verb in a Japanese sentence appears in the most deeply embedded clause, the findings provide evidence that the processing of filler-gap dependencies is driven by the rapid incremental satisfaction of grammatical requirements on thematic interpretation and/or scope licensing (Pritchett, 1988, 1991a, 1992; Gibson, 1991, Weinberg, 1993, 1999; Gibson, Hickok, & Schütze, 1994). I contrast this with the approach that says the parser independently needs to create a gap as soon as possible (Frazier, 1987; Frazier & Flores D’Arcais, 1989; Frazier & Clifton, 1989; among others). Using three different measures of *wh*-dependency formation, three experiments show that a grammatical principle-based approach is correct in predicting that fronted *wh*-phrases should be preferentially associated with an embedded clause in Japanese. Experiment 1 shows that in sentences with sentence-initial *wh*-phrases, Japanese speakers expect to encounter a question-marker on the verb of the embedded clause. Experiment 2 demonstrates that a Japanese counterpart of the Filled Gap Effect (Stowe, 1986) occurs at a preverbal position in an embedded clause in sentences with fronted *wh*-phrases. Experiment 3 shows an
embedded clause preference for the positioning of question particles in an off-line sentence completion task involving scrambled wh-phrases.

The results also have implications for long-standing debates over the status of gaps in real-time sentence processing, and about how much structure is built in advance of the verb. In Chapter 3, I make arguments concerning both issues by presenting experimental evidence for accurate, incremental structure-building in Japanese, based on the on-line application of structural constraints on anaphoric interpretation of pronouns before verb information is available (Experiment 4). Together with the results from Experiment 2, these findings of pre-verbal effects of dependency formation show that filler-gap dependencies are created incrementally. In head-final languages like Japanese, just as in English, there is no need to assume that dependency formation is delayed until the clause-final verb is processed. This supports incremental, full-attachment models of the processing of head-final languages over ‘head-driven’ delay models that assume that structure-building is delayed until the verb is processed. The findings further suggest that the constraints that drive dependency formation are independent of the lexical properties of individual verbal heads. The findings can in turn be taken to support gap-based parsing models and to argue against direct association models which clearly entail a commitment to a mechanism based directly upon the direct dependencies between the wh-filler and a verb.

Chapter 4 starts with discussion of what the findings imply for theories of reanalysis in sentence processing. The present experimental results indicate that Japanese readers must carry on an unforced reanalysis of the gap site when they read multi-clausal
sentences in which a wh-phrase is in the sentence-initial position. This contrasts with a number of recent studies that have argued that reanalysis is a last resort operation. The apparent discrepancy is accounted for under the parsing model adopted, which I slightly revise from the original SPARSE (Schneider, 1999). The model has four properties: (i) structure-building is motivated by satisfying grammatical requirements (feature-checking of a licensing head), (ii) structure-building is fully incremental, (iii) the model can handle head-final structures, and (iv) the model can deal with (non-)canonical word order. Implementing this model, I demonstrate that it not only predicts the experimental results but also explains why an unforced reanalysis is permitted in the relevant wh-scrambling structures and reanalysis is avoided in other cases. In addition, this parsing model, without any specific steps being added to the algorithm, predicts that the gap is posited ‘as soon as possible’. In this regard, the current approach accounts for processing of filler-gap dependencies without stipulating that the filler-gap relation is achieved as soon as possible.

Chapter 5 considers some implications for the syntax of wh-dependencies. The experimentally-demonstrated embedded scope preference is sometimes incompatible with the off-line scope preference. Chapter 5 first presents an off-line questionnaire study (Experiment 5) that ensures that Japanese wh-scrambling constructions do not exhibit a scope-fixing effect, as opposed to Takahashi (1993)’s claim. There still exists a divergence in preferred scope interpretations between on-line and off-line reading. The discussion continues with syntactic analyses on long-distance wh-scrambling. I point out that a preference principle can capture both on-line and off-line preferences, and that the
difference of preferences between those readings stems from the timing of when the head of a scope marker is confirmed.

Chapter 6 turns from psycholinguistics discussion of *wh*-dependencies to a proper account of syntactic restriction on *wh*-scope interpretation in Japanese. It focuses on locality constraints as syntactic properties in the scope construal process in the *wh*-in-situ questions and their relations with scrambling operation. Sharing the spirit of Ochi (1999)’s work, I present supporting evidence that the locality effects seen in LF are not constrained by Subjacency conditions at all but only by minimality constraints (Rizzi, 1990; Chomsky, 1993). Once Subjacency effects observed in LF are reduced to the minimality conditions, it follows that Subjacency holds only on the S-Structure level. This conclusion leads us to re-examine the radical view of scrambling recently proposed by Bošković and Takahashi (1998). I point out that their hypothesis that scrambling is an LF lowering operation is not compatible with the current account of the Subjacency effects witnessed in Japanese scrambling constructions.

Chapter 7 recapitulates the main conclusions of this study.

1.2 Some Preliminary Descriptions of the Syntax of Japanese *Wh*-interrogatives

This section introduces some preliminary syntactic descriptions of Japanese *wh*-interrogatives, which will provide background in particular for key predictions, the experimental materials, and the essential discussion. I briefly describe four properties of
Japanese syntax: (i) head-final structure, (ii) canonical word order, (iii) wh-question formation, and (iv) scrambling and reconstruction.

Japanese is a strongly verb-final language, so that verbs follow all of their arguments, including clausal arguments. This contrasts with Germanic verb-final languages, where verbs may follow their nominal arguments, but typically precede clausal complements. As a result, in multi-clause sentences the verb of the embedded clause appears before the verb of the main clause (1).

(1) John-wa Mary-ga kodomo-ni sono hon-o ageta-to omotteiru.
   John-top Mary-nom child-dat that book-acc gave-Comp thinks
   ‘John thinks that Mary gave that book to the child.’

Another important property of Japanese clause structure involves the canonical word order of clauses with multiple arguments. There is broad agreement that the canonical order of arguments is nominative-dative-accusative-verb, as in the embedded clause in (1) (Hoji, 1985; Kitagawa, 1994; Takano, 1998; Yatsushiro, 1999; among others). This assumption is confirmed by the results of corpus studies on Japanese (Miyamoto & Takahashi, 2002a). When a verb takes a clausal complement and a dative argument (e.g. tutaeru, ‘tell’), the canonical position of the dative argument is before the clausal complement (Tsujimura, 1996), as shown in (2).

‘John told the teacher that Mary lost that book.’

Two properties of Japanese wh-question formation are important for the studies that follow. First, whereas English uses the position of a wh-phrase to indicate the scope of a question as either a direct question (main clause scope, 3a) or an indirect question (embedded clause scope, 3b), in Japanese wh-scope needs to be indicated by a scope marker such as the question particles -ka (embedded or main clauses) and -no (main clauses only). These particles appear as verbal suffixes, and they are considered to be complementizers, contrasting with the standard declarative clause complementizer -to. Direct questions have a question particle on the main verb (4a), and indirect questions have a question particle on an embedded verb (4b). In contrast to English, the position of the wh-phrase has no impact on the scope interpretation of the question.

(3) a. Whom did John say that Mary saw?
   b. John said who Mary saw.
   
(4) a. John-wa [Mary-ga dare-ni sono hon-o ageta-to] itta-no?
   John-top Mary-nom whom-dat that book-acc gave-Comp said-Q
   ‘Who did John say Mary gave that book to?’
   John-top Mary-nom whom-dat that book-acc gave-Q said
   ‘John said who Mary gave that book to.’
Second, Japanese allows *wh*-phrases to either appear in their canonical, thematic position (*‘wh*-in-situ’, 5a), or displaced to a position earlier in the sentence, including the front of the main clause (*‘wh*-fronting’ or *‘wh*-scrambling’, 5b). Both sentences in (5) are interpreted as indirect questions, due to the presence of a question particle on the embedded clause verb.


   *John-top Mary-nom whom-dat that book-acc gave-Q said*

   ‘John said to whom Mary gave that book.’


   *whom-dat John-top Mary-nom that book-acc gave-Q said*

   ‘John said to whom Mary gave that book.’

Scrambling as in (5b) has an important property called ‘radical reconstruction’. Scope-taking occurring inside the embedded clause as in (5b) motivates radical reconstruction. Saito (1989) originally argued that Japanese *wh*-scrambling has little effect on the scope of the *wh*-phrase, unlike English *wh*-movement, which establishes an operator-variable relation. As pointed out first in Harada (1972), a *wh*-phrase can only take scope at a clause that contains it. In (6), *dare-ni* ‘who-dat’ must take scope in the embedded clause, which is the only question in the sentence. However, the overt *wh*-phrase is not contained within this clause.

John-nom who-dat Mary-nom that book-acc bought-Q asked

Lit. ‘John asked whom Mary bought that book.’

By contrast, reconsider (5b). Since the wh-phrase out of the embedded clause is outside the clause where it takes scope, this sentence is expected to be as unacceptable as (6). However, it is grammatical. Saito (1989) explains this contrast by assuming that a scrambled phrase can be freely ‘moved back’ to the position within the c-command domain of the scope marker at LF. He calls this phenomena ‘radical reconstruction’.¹

I briefly described four syntactic properties of Japanese wh-interrogatives, crucial for the present study. First, Japanese verbs follow multiple arguments. Secondly, a sequence of nominative-dative-accusative/clausal complement-verb is a canonical word order in Japanese. Third, Japanese wh-scope needs to be indicated by a scope marker such as a question particle. Fourth, a Japanese wh-phrase can be either in-situ or scrambled. The word order permutation does not induce semantic effects.

¹ Reconstruction phenomena observed in scrambling constructions have been intensively discussed in literature. It is also seen in other types of scope interpretation and binding interpretation. Relevant discussion is found in Tada (1990, 1993), Saito (1992, 2003), Kitahara (2000, 2001), and references cited therein.
CHAPTER 2

WHERE TO POSIT GAPS

2.1 Introduction

In this chapter, I use cross-linguistic evidence to investigate the mechanisms that underlie the formation of long-distance dependencies in sentence comprehension, with a focus on the Japanese counterparts of ‘filler-gap’ dependencies in *wh*-questions. After first reviewing evidence that English speakers consistently interpret *wh*-fillers in the highest position in the sentence that is grammatically or lexically appropriate, I then proceed to show that Japanese speakers present a profile that appears at first to be the exact opposite of this. However, I show that the English and Japanese patterns both follow from the same underlying parsing mechanism, and that the Japanese results help to decide among competing accounts of what drives the processing of long-distance dependencies.

Section 2.2 discusses how the processing of filler-gap dependencies is captured by two approaches in the literature: a strategy-based approach and a grammatical- principle-based approach. These approaches may capture the generalization about active positing of gap sites derived from studies based on English-type languages.
with equal success. In contrast, due to its word-order properties, a head final language like Japanese provides a useful testing ground in which the two accounts make divergent predictions. I discuss how the predictions of the two approaches differ with respect to processing Japanese long-distance *wh*-scrambling sentences.

Sections 2.3, 2.4 and 2.5 present two types of self-paced reading experiments on Japanese long-distance *wh*-scrambling sentences. Results from the experiments show that Japanese readers preferentially associate a fronted *wh*-phrase with the most deeply embedded clause of a multi-clause sentence, before they encounter the first verb.

Section 2.6 also presents an off-line experiment, and confirms that the fronted *wh*-phrase used in the previous experiments is overwhelmingly preferred to be an embedded argument in a multi-clause structure, not an argument in a simple clause.

Section 2.7 discusses the implications of the results from all the experiments. The findings provide evidence that the processing of filler-gap dependencies in either a head-initial or head-final language is driven by the need to satisfy the grammatical requirements of a *wh*-phrase, rather than by the need to create a gap as soon as possible. Furthermore, I point out that the results of Experiment 2 favor an incremental model of long-distance dependencies, over models that assume that dependencies cannot be created until the verb position due to head-driven structure-building (Pritchett, 1988, 1991b, 1992; Mulders, 2002). In Chapter 3, this conclusion will be reinforced with results from another self-paced reading experiment.

2.2 Filler-gap Dependencies
2.2.1 Two Approaches to Filler-gap Dependencies

Most languages contain a number of constructions in which an argument of a verb is displaced from its canonical position to a position in the sentence at some distance from the verb, most commonly to the left of the verb. For example, in addition to the English declarative sentence in (1a) in which the NP cereal appears in canonical direct object position following the verb eat, there is also the wh-question in (1b) in which the corresponding NP which cereal appears in sentence-initial position, and no NP appears in the canonical post-verbal object position of eat.

(1)  
   a. Kim knows that Sam likes to eat cereal for breakfast.  
   b. Which cereal does Kim know that Sam likes to eat ___ for breakfast?

Displacements of this kind are found in questions, relative clauses, topicalization and focus constructions, among others. In the language processing literature it has become common to refer to the displaced NP as a filler, and to refer to its canonical position as a gap (marked by underlining in (1b)). Accordingly, the relation between the displaced phrase and its canonical, thematic position has become known as a filler-gap dependency, and a focus of research on such dependencies has been on how speakers link fillers to their corresponding gaps during real-time processing.
An important early set of studies demonstrated that the parser actively predicts potential gap sites as a sentence unfolds (‘filler-driven’ parsing: Fodor, 1978; Crain & Fodor, 1985; Stowe, 1986; Frazier, 1987; Frazier & Flores D’Arcais, 1989), rather than waiting to identify an empty argument position before positing a gap (‘gap-driven’ parsing: Jackendoff & Culicover, 1971; Wanner & Maratsos, 1978). For instance, Stowe (1986) observed a *Filled Gap Effect* at the direct object position of the embedded verb in (2b), reflected in slower reading times for the pronoun *us* in the *wh*-fronting condition (2b), relative to a control condition that did not involve *wh*-fronting (2a). This slowdown is expected if the parser actively posits a direct object gap position in (2b) as soon as it encounters the transitive verb *bring*, and hence encounters difficulty when it finds an overt pronoun in the direct object position. The slowdown is unexpected if the parser waits to identify an empty argument position before positing a gap. Experiment 2 below applies a similar technique in Japanese.

(2)  

a. My brother wanted to know if Ruth will bring us home to Mom Christmas.  

b. My brother wanted to know who Ruth will bring us home to __ at Christmas.  

Additional studies showed that the active positing of gap sites is constrained by the lexical argument structure requirements of the verb (Clifton, Frazier, & Connine, 1984; Tanenhaus, Boland, Garnsey, & Carlson, 1989; Stowe, Tanenhaus, & Carlson,
1991; Boland, Tanenhaus, Garnsey, & Carlson, 1995). For example, Boland et al. (1995) found that the Filled Gap Effect disappeared when the filler was an implausible direct object of an object control verb that allowed an additional gap site inside its complement, as in (3a), as opposed to (3b), in which the Filled Gap Effect emerges since the filler was a possible direct object of the verb, *remind*.

\[ (3) \]
\[
a. \text{Which movie did Mark remind them to watch ___?} \\
b. \text{Which child did Mark remind them to watch ___?} \\
\]

Further evidence for construction of filler-gap dependencies as soon as an appropriate verb is identified has been found using techniques such as implausibility detection (Garnsey, Tanenhaus, & Chapman, 1989; Traxler & Pickering, 1996), head-mounted eye-tracking (Sussman & Sedivy, *in press*), cross-modal priming (Nicol & Swinney, 1989; Nicol, 1993), and event-related potentials (Garnsey et al., 1989; Kaan, Harris, Gibson, & Holcomb, 2000). Related evidence has also been found in many languages, including Dutch (Frazier, 1987; Frazier & Flores D’Arcais, 1989; Kaan, 1997), Russian (Sekerina, *in press*), Hungarian (Radó, 1999), Italian (de Vincenzi, 1991), and German (Schlesewsky, Fanselow, Kliegl, & Krems, 2000).

The observed active positing of gap sites may be explained by at least two different approaches, which account equally well for the results listed above. One approach attributes active gap creation to an independent subroutine of the parser that initiates a search for a gap as soon as a filler has been identified. Frazier and Clifton
(1989) provide a well-known formulation of this principle as the Active Filler Strategy (henceforth, AFS) in (4). Importantly, the AFS focuses on the need to create a gap position as soon as possible. It does not assume to posit later gaps after first creation of a gap.

(4) Active Filler Strategy (Frazier & Clifton, 1989: 95)
When a filler has been identified, rank the option of assigning it to a gap above all other options.

A second approach focuses instead on the grammatical and semantic consequences of identifying a gap position, in particular the availability of thematic role assignment. I call this approach the grammatical principle-based approach. Under such approaches, active gap creation is the result of parsing mechanisms that seek to maximize the satisfaction of lexical and grammatical constraints. Therefore, it is possible that the parser keeps positing a gap until it is interpreted; gap creation is not an end in itself. This approach is well-represented in both the principle-based parsing tradition (Pritchett, 1988, 1991a, 1992; Gibson, 1991; Weinberg, 1993, 1999; Gibson, Hickok, & Schütze, 1994) and the constraint-based lexicalist tradition (Boland et al., 1995; Altmann, 1999). For example, Pritchett’s Theta Attachment constraint states that “The Theta Criterion attempts to apply at every point during processing…” (1988, p. 542).

The distinction between these two accounts of active gap creation has received limited attention, since they have very similar consequences in English-type languages.
Nevertheless, the distinction is important, since it implies rather different underlying parsing mechanisms. The AFS attributes active gap creation to an independent strategy of the parser that initiates a search for a gap as soon as a filler has been identified, whereas the grammatical principle-based approach dispenses with this heuristic in favor of the direct instantiation of a grammatical principle for parser control.

I point out that Japanese is a language in which the two accounts of active gap creation make divergent predictions, due to the word order properties of Japanese. Recall that Chapter 1 overviews the properties of Japanese question formation. Two properties of Japanese wh-question formation are important in this discussion. Let us briefly review them. First, Japanese wh-scope needs to be indicated by a scope marker such as –ka, contrasting with the declarative clause complementizer –to. Direct questions have a question particle on the main verb (5a), and indirect questions have a question particle on an embedded verb (5b).

    
    John-top Mary-nom whom-dat that book-acc gave-Comp said-Q

    ‘Who did John say Mary gave that book to?’


    John-top Mary-nom whom-dat that book-acc gave-Q said

    ‘John said to whom Mary gave that book to.’
Second, Japanese also allows \textit{wh}-phrases to appear in the argument position (6a), or displaced to a sentence-initial position (6b). Note that in contrast to English, the position of the \textit{wh}-phrase in (6) has no impact on the scope interpretation of the question. (6a) and (6b) are both indirect questions.

\begin{equation}
(6) \quad \begin{array}{l}
\text{a. } \text{John-wa [Mary-ga dare-ni sono hon-o ageta-ka] sitteiru.} \\
\quad \text{John-top Mary-nom whom-dat that book-acc gave-Q knows} \\
\quad \text{‘John knows to whom Mary gave that book.’} \\
\text{b. } \text{Dare-ni John-wa [Mary-ga sono hon-o ageta-ka] sitteiru.} \\
\quad \text{whom-dat John-top Mary-nom that book-acc gave-Q knows} \\
\quad \text{‘John knows to whom Mary gave that book.’}
\end{array}
\end{equation}

These properties of Japanese make it possible to distinguish the predictions of the AFS and the grammatical principle-based accounts of processing filler-gap dependencies. In a two-clause question in Japanese, a dative-marked \textit{wh}-filler may appear in sentence-initial position. If the parser’s objective is to assign the filler to a gap position as soon as possible, as predicted by the AFS, the filler should be associated with a gap position in the main clause, preceding the embedded clause, since this is the first canonical argument position for dative arguments. On the other hand, if the parser’s goal is to ensure that the filler receives a thematic interpretation as soon as possible, it should explore all possible positions of interpretation. The parser posits a gap in the embedded clause, where the first verb will be encountered. Hence, an additional opportunity for
thematic interpretation will arise. In other words, the gap is predicted until it can be interpreted. These two alternatives are illustrated in (7). The reading-time studies reported below focus on testing the prediction of the grammatical principle-based approach that Japanese speakers will preferentially associate a sentence-initial filler with an embedded clause, rather than with the main clause.²

\[(7) \quad \begin{align*}
\text{a.} & \quad \text{b.}
\end{align*}\]

It is important to clarify the relationship between my primary focus in this chapter, namely the mechanisms that drive the formation of filler-gap dependencies, and some other related issues in the processing of head-final languages and long-distance dependencies, which I will extensively discuss in Chapter 3 and 4.

² Since the parser cannot know that it is dealing with a multi-clause sentence until it encounters embedded clause material, a gap site may initially be posited in the main clause, just as in (7a). Chapter 3 will also present experimental evidence for positing a local gap in a simple clause. However, the results of Experiments 1 and 2 will also show that the parser’s analysis involves an embedded clause gap, as in (7b). This means that the first gap in (7a) must be canceled, once the embedded clause subject is parsed, placing the gap inside the embedded clause instead. This scenario has implications for theories of reanalysis. I take up this issue in Chapter 4.
First, an important issue in the processing of head-final languages involves the question of whether structure is built in a fully incremental way. (Frazier, 1987; Inoue & Fodor, 1995; Mazuka & Itoh, 1995; Schneider 1999), or whether structure-building is delayed until key lexical heads, such as verbs, are encountered (‘head-driven’ parsing: Pritchett, 1991b, 1992; Mulders, 2002). Although this issue is logically independent from the main concern here, and incremental structure-building models are clearly compatible with either a main clause or an embedded clause gap site preference, it is possible that a head-driven model would independently predict a preference for an embedded clause gap site. This is because a model that delays structure-building until verbs are processed would have its first opportunity to build structure at the position of the embedded verb. Thus, this could be both the first opportunity to create a gap position and the first opportunity to give a thematic interpretation to a \textit{wh}-filler.

Second, the main question about the mechanism driving the formation of filler-gap dependencies is of course related to questions about whether such dependencies genuinely involve the construction of gap sites in canonical argument positions (‘gap-based’ accounts: Stowe, 1986; Frazier & Clifton, 1989; Nicol & Swinney, 1989; de Vincenzi, 1991; Nicol, 1993; Gibson & Hickok, 1993; Nakano, Felser, & Clahsen, 2002), or whether they involve direct dependencies between the \textit{wh}-filler and a verb (‘direct association’ accounts, Pickering & Barry, 1991; Pickering, 1993, 1994; Sag & Fodor, 1994; Steedman, 2000). Gap-based accounts are consistent with either of the mechanisms outlined above, and the literature contains gap-based accounts that favor either of the two approaches. On the other hand, direct dependency accounts clearly entail a commitment
to a mechanism based directly upon the formation of relationships between displaced NPs and verbs, and therefore the first opportunity in Japanese to form a direct dependency between a fronted phrase and a verb is at the first (i.e. most deeply embedded) verb.

In sum, fully-incremental models and gap-based models entail no commitment to whether dependency formation is driven by the need to create a gap or by the need to assign a thematic interpretation to the filler. Meanwhile, head-driven (delay) models and direct association models are committed to the assumption that dependency formation is driven by interpretive requirements of the predicate. These models thus entail an additional commitment, involving the time-course of dependency formation. These models predict that dependency formation should occur at a verb position, and not earlier, whereas incremental and gap-based models allow for the possibility of dependency formation in advance of the verb. For this reason, it is interesting not only to investigate where Japanese speakers preferentially interpret fronted \(wh\)-phrases, but also to investigate the time course of this process. The two experiments reported below address both where and when \(wh\)-dependencies are formed during the time course of processing.

### 2.2.2 Previous Studies on Japanese Filler-gap Dependencies

Although there have been, to my knowledge, no previous studies of the processing of ambiguous multi-clause \(wh\)-fronting in Japanese, previous literature on the processing of both scrambling constructions and questions in Japanese provides relevant background information. A number of studies have investigated whether scrambled word
orders in Japanese induce increased processing load. Despite initial uncertainty on this issue (Nakayama, 1995; Yamashita, 1997), there is now a consensus that scrambling does increase processing load, and a number of studies have begun to examine the time-course of this processing load, using both behavioral methods (Mazuka, Itoh, & Kondo, 2002; Miyamoto, 2002; Miyamoto & Takahashi, 2002a, b; Nakano et al., 2002) and event-related potential techniques (Ueno & Kluender, 2003).

A study by Nakano et al. (2002) investigates the processing of phrases that have undergone long-distance (i.e., multi-clause) scrambling. Using a cross-modal priming technique, Nakano et al. argue that a sentence-initial accusative-marked NP is ‘reactivated’ shortly before the embedded verb, at least in those participants that receive high scores on a reading-span test of memory (Daneman & Carpenter 1980). Although participants in that study clearly interpreted fronted NPs in an embedded clause, this finding equally supports the position-based AFS approach and the grammatical principle-based approach. This is because the scrambled NP in that study became unambiguous as soon as the embedded clause was processed. The scrambled NP was marked with accusative case, and no verb in Japanese selects both a clausal complement and an accusative argument. Therefore, as soon as readers encountered an embedded clause, they could be fairly confident that the scrambled accusative NP was not an argument of the main clause verb.3 By contrast, the materials used in the studies presented in this chapter

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3 It would be possible, in principle, for speakers to maintain a main clause analysis of the accusative NP, if the embedded clause were analyzed as a non-complement clause, i.e. a relative clause or an adjunct clause. However, results from Experiment 3 (a sentence fragment completion study) suggest that speakers are unlikely to do this. Participants provided multi-clause completions to sentence fragments beginning with dative-topic-nominative sequences in 99% of trials, but 96.4% of these multi-clause completions involved
are globally ambiguous because dative-marked *wh*-phrases are used, keeping open the possibility of either main clause or embedded clause interpretation. Therefore, I can trace the source of the embedded interpretation of the displaced constituent more precisely to interpretive constraints using the data shown in Experiment 1 and 2.

Of particular relevance to Experiment 1 is a recent series of experiments by Miyamoto and Takahashi (Miyamoto & Takahashi, 2000, 2001, 2002c) that have investigated the processing of in-situ *wh*-phrases in Japanese. As seen above, the surface position of a *wh*-phrase in Japanese does not determine the scope of a question; this property is instead indicated by a question particle affix that appears on either the main clause verb (direct question) or an embedded clause verb (indirect question). Miyamoto and Takahashi reasoned that whereas in English the processing of a fronted *wh*-phrase in a scope position initiates a search for a thematic position, in Japanese the processing of an in-situ *wh*-phrase should initiate a search for a question particle. Using materials like the examples in (8), they show that in sentences that contain an in-situ *wh*-phrase, Japanese speakers expect to encounter a question particle on the verb in the same clause. This is shown by slower reading times for verbs marked with the declarative complementizer –*to* than for verbs marked with the question marker –*ka*. Miyamoto and Takahashi refer to this slowdown upon encountering an unexpected verbal affix as the *Typing Mismatch Effect*.

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complement clauses; only 3.6% of completions involved relative clause completions, and there were no adjunct clause completions at all.
Importantly for the purposes here, a *wh*-question in Japanese must be associated with a question particle that is *at least as high* in the sentence as the thematic position of the *wh*-phrase. This fact is confirmed both by off-line acceptability judgment (Harada, 1972; Nishigauchi, 1986; see also Chapter 5) and by reading-time studies (Miyamoto & Takahashi, 2002c). For example, the sentence in (9a) is ungrammatical because the *wh*-phrase in main clause subject position receives its thematic interpretation in a higher clause than the question particle that appears on the embedded clause verb. The *wh*-phrase cannot be interpreted in the embedded clause, because a *wh*-phrase can only take scope at a clause that contains it (Harada, 1972; Nishigauchi, 1986, 1990; Saito, 1989). This means that readers should first expect a question particle to appear on the
verb in the same clause as the thematic position of the wh-phrase. Miyamoto and Takahashi’s studies confirm this generalization for in-situ wh-phrases.


\[John-top who-dat Mary-nom come-Q told\]
Lit. ‘*John said to whom whether Mary is coming.’


\[John-top Mary-dat who-nom come-Q told\]
‘John told Mary who is coming.’

Experiment 1 below builds upon this generalization to provide a diagnostic of where a fronted wh-phrase receives its thematic interpretation, using dative wh-phrases that can be associated with either the main clause or an embedded clause. If long-distance dependency formation is driven by the need to create a gap as soon as possible, as predicted by the AFS, then readers should interpret the wh-phrase in the main clause, and no Typing Mismatch Effect should be observed at the embedded clause verb. If, on the other hand, dependency formation is driven by requirements for thematic interpretation and scope marking, the wh-phrase should be interpreted in the embedded clause, and a Typing Mismatch Effect should be observed at the embedded clause verb.

2.3 Experiment 1A
This experiment was designed as an initial test of how *wh*-expressions are interpreted in Japanese *wh*-fronting structures, using Miyamoto and Takahashi’s Typing Mismatch Effect as a diagnostic of where a *wh*-expression is interpreted. The aim was to determine whether a fronted *wh*-expression in Japanese is preferentially interpreted in the main clause or in a more deeply embedded clause. Consider the following structures, repeated from (7).

(10)  

a.  
b.

If the parsing of *wh*-expressions is driven by a strategy for gap creation, then a main clause analysis is predicted, (10a). If, on the other hand, the parsing of *wh*-expressions is driven by grammatical requirements such as thematic interpretation, an embedded clause analysis is predicted, (10b). Building upon Miyamoto and Takahashi’s findings about the parsing of in-situ *wh*-expressions in Japanese, it is expected that in the clause in which the *wh*-expression is interpreted, readers will anticipate a question particle, and hence read a declarative complementizer more slowly than a question particle, i.e. a Typing
Mismatch Effect. Under the claim of the grammatical principle-based theory that creation of gap positions is driven by grammatical constraints, it is predicted that gap creation should persist until the filler is actually interpreted. Thus, a gap should be posited in the embedded clause (as well, perhaps, as in the main clause). Therefore, this experiment included conditions in which the \textit{wh}-phrase was in-situ in an embedded clause, in order to allow direct comparison of fronted and in-situ \textit{wh}-expressions. If the fronted \textit{wh}-phrase is interpreted in an embedded clause, a parallelism of Typing Mismatch Effects in \textit{wh}-fronting and \textit{wh}-in-situ conditions should also be observed.

2.3.1 Methods

2.3.1.1 Participants

Seventy-four native speakers of Japanese participated in the experiment. All of them were students either at the University of Maryland, USA, or at Shizuoka University or Shizuoka Sangyo University, Japan. They were paid $5.00 or its yen equivalent for their participation in the experiment, which lasted about 30 minutes.

2.3.1.2 Materials and Design

Twenty-four sets of four conditions each were used in the experiment, in a 2 x 2 factorial design, which manipulated the position of the \textit{wh}-phrase (in-situ vs. scrambled)
and the distribution of verbal affixes (question particle vs. declarative complementizer on
the embedded verb). The twenty-four sets of items were distributed among four lists in a
Latin Square design. Each participant saw exactly one of the lists intermixed with forty-
eight unrelated items in a random order.

In all four conditions a main clause subject NP marked with the topic-marker –wa
was immediately followed by an embedded clause. A nominative-marked NP following
the topic provided a strong cue for the onset of an embedded clause. The position of the
embedded clause immediately after the main clause subject is fully natural in Japanese.
Since Japanese is a verb-final language, the main clause verb appeared at the end of the
sentence, following the embedded clause. In order to ensure that any reading time effects
associated with the embedded verb would not be confounded with effects at the main
verb, an adverbial phrase and a dative-marked NP separated the embedded verb from the
main clause verb.

The only differences among conditions involved the position of the dative
wh-phrase and the distribution of verbal affixes. In the in-situ conditions the wh-phrase
immediately followed the subject of the embedded clause, and it appeared in
sentence-initial position in the scrambled conditions. Note that scrambling of the
wh-phrase has little effect on the interpretation of the sentences: the scope of the question
is determined by the position of the question particle. In two conditions the embedded
verb was marked with the question particle -ka and the main clause verb had declarative
force (‘question particle conditions’), and in the remaining two conditions the distribution

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4 This is also verified in Experiment 3. See Section 2.6.
was reversed: the embedded clause was marked with the declarative complementizer –to and the main clause verb was marked with the question particle, -ka.

A number of further details of the materials are relevant. First, the wh-phrase was marked with dative case in order to ensure that it could receive a grammatical interpretation in either the main clause or the embedded clause. Second, in order to ensure that any evidence for wh-phrase interpretation in the embedded clause could not be attributed to satisfaction of lexical requirements of the embedded verb, all embedded verbs were chosen such that they did not strictly subcategorize for a dative NP. All of the embedded verbs were simple mono-transitive verbs that do not require a dative-marked argument, but freely allow a dative-marked NP to be interpreted as the beneficiary of the action described. Third, a second dative-marked NP that appeared in pre-final position in all conditions was included to allow testing of a prediction of the gap-creation theory. Note that this second dative-marked NP is interpreted only as an argument of the matrix verb, due to scrambling of the entire embedded clause within the VP structure, preceding the fronting of the dative wh-phrase out of the embedded clause. If the fronted dative wh-phrase is preferentially interpreted in the main clause, then readers should be surprised to encounter a second dative-marked NP in the same clause, relative to in-situ conditions, in which the dative wh-phrase is unambiguously interpreted in the embedded clause.

One full set of experimental conditions is shown in (11). A full set of materials for this experiment can be found in Appendix A.
(11) a. *Scrambled, Declarative Complementizer*

Dono-seito-ni tannin-wa kootyoo-ga hon-o
\[ \text{which student-dat class teacher-top principal-nom book-acc} \]
yonda-to tosyositu-de sisyo-ni iimasita-ka?
\[ \text{read-DeclC library-at librarian-dat told-Q} \]

'Which student did the class teacher tell the librarian at the library that the principal read a book for?'

b. *In-situ, Declarative Complementizer*

Tannin-wa kootyoo-ga dono-seito-ni hon-o
\[ \text{class teacher-top principal-nom which student-dat book-acc} \]
yonda-to tosyositu-de sisyo-ni iimasita-ka?
\[ \text{read-DeclC library-at librarian-dat told-Q} \]

'Which student did the class teacher tell the librarian at the library that the principal read a book for?'

c. *Scrambled, Question Particle*

Dono-seito-ni tannin-wa kootyoo-ga hon-o
\[ \text{which student-dat class teacher-top principal-nom book-acc} \]
yonda-ka tosyositu-de sisyo-ni iimasita.
\[ \text{read-Q library-at librarian-dat told} \]

'The class teacher told the librarian at the library which student the principal read a book for.'

d. *In-situ, Question Particle*
"The class teacher told the librarian at the library which student the principal read a book for."

2.3.1.3 Procedure

The experiment was conducted on Macintosh G3 computers running the \texttt{mw-run} software developed at MIT. Participants were timed in a phrase-by-phrase self-paced non-cumulative moving-window reading task (Just, Carpenter, & Woolley, 1982). All sentences, including the filler items, were presented on a single line. The segmentation indicated with spaces in (11) was the actual segmentation used in the presentation. The embedded complementizer or question particle was presented together with the embedded verb, since both the complementizer and the question particle are bound morphemes in Japanese. Sentences were presented using Japanese characters with the font Osaka 14. Stimulus segments initially appeared as a row of dashes, and participants pressed the space bar of the keyboard to reveal each subsequent region of the sentences.\footnote{Note also that although Japanese text is often displayed in vertical columns, horizontal presentation is also common, and is the most familiar mode of presentation when Japanese text is presented on a computer screen.}
In order to ensure that participants attended to the stimuli, a subject-verb matching task was presented after each trial. A verb was displayed on the computer screen followed by two Agent NPs (one topic-marked NP and one nominative-marked NP) and participants had to decide which of the NPs was the subject of the verb in the sentence just read by pressing one of two keys of the keyboard. This task was adopted from Nagata (1993), and was the same task used in the studies by Miyamoto and Takahashi (2000, 2001, 2002c). This task was chosen due to the fact that half of the target sentences and a quarter of the fillers were themselves direct questions, thereby precluding the use of a standard yes/no comprehension question task. Note also that (correct) response in this comprehension task is independent of the parsing of the wh-phrase. Visual feedback indicated whether the answer given was incorrect. All trials on which the comprehension question was answered incorrectly were excluded from further analysis. The experimental trials were preceded by two screens of instructions and five practice trials.

2.3.1.4 Data Analysis

Analyses were conducted on comprehension task response accuracy and reading times, by subjects and by items. All data from participants whose comprehension task accuracy was below 70% for target sentences and below 75% in total were discarded. This affected a large number of participants in this study (n = 26, 35%). I address the reasons for this high attrition rate in the discussion section and in Experiment 1B. Items
whose accuracy among the remaining subjects fell below 60% were also excluded (n = 5). Reading times longer than 2500ms were discarded. This procedure affected 4.3% of trials. The means and analyses presented below are based on the remaining trials.

2.3.2 Results

Comprehension accuracy and reading times at each region were entered into a repeated-measures ANOVA, with word order (scrambled, in-situ) and embedded complementizer type (declarative, question particle) as within-subjects factors.

2.3.2.1 Comprehension Task Accuracy

Among the forty-eight participants included in the analysis, average comprehension accuracy was 79.9%. The average correct response percentage did not differ significantly across the four conditions (all $F$s < 1). In addition, there was no significant difference in the comprehension task accuracy between the subjects who live in Shizuoka, Japan (80%) and those who live in Maryland, USA (79%). A higher percentage of participants tested in Japan (37.5%) were excluded than participants tested in the United States (24%).

2.3.2.2 Self-Paced Reading
The reading time analysis yielded the following results. Reading times for in-situ conditions are shown in Figure 1, and those for scrambled conditions are shown in Figure 2.

At all regions preceding the embedded verb (region 5), there were no significant differences between reading times in the declarative complementizer and question particle conditions within each level of the word order factor (all $F$s < 1). This is expected, since the conditions are identical up to region 4. Comparisons between the in-situ and scrambled conditions are inappropriate for these regions, since the lexical material differed across conditions.

At the embedded verb (Region 5), which included the critical declarative or interrogative affixes, there was a significant main effect of complementizer type, such that reading times were 106 msec slower for declarative complementizers than for question particles ($F_{1}(1,47) = 10.53, MSE = 155791, p < .005; F_{2}(1,18) = 8.74, MSE = 221710, p < .01$). In the analysis of word order type, there was a tendency for slower reading times in the in-situ conditions than in the scrambled conditions, but this tendency did not reach significance ($F_{1}(1,47) = 0.78, MSE = 195248, p = .38; F_{2}(1,18) = 2.37, MSE = 251406, p = .14$). There was no interaction of complementizer type and word order ($Fs < 1$). Pairwise comparisons within each level of the word order manipulation at this region yielded the following results. In the in-situ conditions, the declarative condition was read significantly more slowly than the question particle condition, although the effect was only marginally significant in the items analysis ($F_{1}(1,47) = 4.74, MSE = 161175, p < .05; F_{2}(1,18) = 2.87, MSE = 305890, p = .11$). In the scrambled
conditions, the declarative complementizer condition was also read significantly more slowly than the question particle condition ($F_1(1,47) = 4.64, \text{MSE} = 188878, p < .05; F_2(1,18) = 8.0, \text{MSE} = 133387, p < .05$). This parallel pattern of results across in-situ and scrambled conditions indicates a Typing Mismatch Effect at the verb in the embedded clause, independent of the surface position of the $wh$-phrase.

The following regions all showed reading time patterns similar to region 5. At the main clause adverb (Region 6), there was a main effect of complementizer type, which was marginally significant both in the subject analysis and the item analysis ($F_1(1,47) = 3.83, \text{MSE} = 132974, p = .05; F_2(1,18) = 3.14, \text{MSE} = 176221, p = .09$). There was no significant main effect of word order or interaction (all $F$s < 1). Pairwise comparisons within each level of the word order manipulation yielded the following results. In the in-situ conditions the declarative condition was read more slowly than the question particle condition; this effect was significant in the subject analysis ($F_1(1,47) = 4.13, \text{MSE} = 101809, p < .05$), but showed only a non-significant tendency in the same direction in the item analysis ($F_2(1,18) = 2.45, \text{MSE} = 107438, p = .13$). In the scrambled conditions, on the other hand, there was no significant difference between the declarative condition and the question particle condition ($F_1 < 1; F_2(1,18) = 1.36, \text{MSE} = 213457, p = .26$), although there was again a tendency for slower reading times in the declarative condition.

At the main clause dative-marked NP (Region 7) there was a main effect of complementizer type, which was significant in the subject analysis and marginally significant in the item analysis ($F_1(1,47) = 6.01, \text{MSE} = 105418, p < .05; F_2(1,18) = 4.1,$
The main effect of word order was marginally significant in the subject analysis ($F_1(1,47) = 3.79, MSE = 97656.6, p = .06$), due to longer reading times for the scrambled condition, and showed a non-significant tendency in the same direction in the item analysis ($F_2(1,18) = 2.64, MSE = 98312.5, p = .12$). There was no interaction ($F_s<1$). Pairwise comparisons within each level of the word order manipulation yielded the following results. In the in-situ conditions, the declarative condition was read marginally more slowly than the question particle condition ($F_1(1,47) = 3.11, MSE = 68272.7, p = .08; F_2(1,18) = 1.31, MSE = 180872, p = .27$). In the scrambled conditions, the declarative condition was again read more slowly than the question particle condition; this effect was only marginally significant ($F_1(1,47) = 3.5, MSE = 125882, p = .07; F_2(1,18) = 4.19, MSE = 185088, p = .06$).

At the sentence-final main verb (Region 8) there was a main effect of complementizer type ($F_1(1,47) = 8.82, MSE = 136494, p < .01; F_2(1,18) = 6.1, MSE = 193193, p < .05$), again due to slower reading times for declarative conditions. The main effect of word order was marginally significant in the subject analysis, and did not reach significance in the item analysis ($F_1(1,47) = 3.04, MSE = 136491, p = .08; F_2 < 1$). There was no significant interaction of complementizer type and word order ($F_1(1,47) = 2.21, MSE = 136494, p = .14; F_2(1,18) = 2.0, MSE = 193193, p = .16$). However, pairwise comparisons within each level of the word order manipulation revealed a clear contrast. The in-situ conditions showed no effect of complementizer type ($F_1(1,47) = 1.38, MSE = 120997, p = .24; F_2 < 1$), but the scrambled conditions showed a clear effect of
complementizer type, due to longer reading times for the declarative condition ($F_1(1, 47) = 8.61, MSE = 148223, p < .005; F_2(1, 18) = 7.46, MSE = 212212, p < .01)$.

Figure 1: Experiment 1A, Reading times per region for the wh-in-situ conditions. (NP-top1, NP-nom2 Wh-dat3 NP-acc4 V-DeclC/Q5 Adverb6 NP-dat7 V-Q.8)

Figure 2: Experiment 1A, Reading times per region for the wh-scrambled conditions. (Wh-dat1 NP-top2 NP-nom3 NP-acc4 V-DeclC/Q5 Adverb6 NP-dat7 V-Q.8)
2.3.3 Discussion

The main finding of this experiment was that Japanese speakers demonstrated a Typing Mismatch Effect at embedded verbs, such that reading times were longer when there was a declarative complementizer on the embedded verb than a question particle, both when the *wh*-phrase was in-situ in the embedded clause and when it was scrambled to sentence-initial position. The Typing Mismatch Effect in the in-situ conditions replicated Miyamoto and Takahashi’s results for the processing of *wh*-phrases, and extended their finding to the processing of non-subcategorized *wh*-phrases. The Typing Mismatch Effect presumably occurs because readers expect to encounter a question particle as soon as possible after the thematic position of a *wh*-phrase. The parallel observation of a Typing Mismatch Effect at the embedded verb region in the scrambled conditions suggests that readers expected to encounter a question particle in the embedded clause. This expectation could only arise if readers interpret the fronted *wh*-phrase such that it has a thematic position inside the embedded clause. This reasoning follows from the grammatical requirement that *wh*-scope positions c-command thematic positions in Japanese. Thus, these results indicate that readers associate a fronted *wh*-phrase with the first verb that they encounter, rather than with the structurally highest verb. This also suggests that readers ultimately interpret fronted *wh*-phrases as indirect questions. The finding that fronted *wh*-phrases are preferentially interpreted in the
embedded clause clearly supports the prediction of the grammatical principle-based theory of parsing *wh*-expressions.

Figure 3 illustrates the parallelism in patterns of reading time slowdown at the embedded verb. As predicted, a significant parallelism is observed between the *wh*-in-situ and the *wh*-scrambled structures in terms of the difference in reading time patterns at the embedded verb. In both structures, readers take a longer time to read the embedded verbs affixed by a declarative complementizer than to read those affixed by a question particle.

![Figure 3: Experiment 1A, Reading times at the embedded verb (Region 5)](image)

Slower reading times were also observed in the declarative complementizer conditions at regions 6-8. It is likely that this reflects the continued cost of the disruption caused at the embedded verb in region 5.

Recall that the dative-marked NP in region 7 was included as an additional test of whether readers interpret the fronted dative *wh*-phrase in the main clause or the embedded clause. If readers preferentially interpret the fronted *wh*-phrase in the main
clause, then they should be surprised to encounter a second dative-marked NP in region 7 in the declarative-scrambled condition, but in no other conditions. There should be no slowdown in the in-situ conditions, since the thematic position of the wh-phrase is unambiguously inside the embedded clause. Also, there should be no slowdown in the question particle/scrambled condition, since the question particle in Region 5 in this condition provides a strong cue that the thematic position of the wh-phrase is inside the embedded clause. However, since the results show a slowdown in both declarative complementizer conditions, relative to their corresponding question particle conditions, I consider it more likely that the slowdown at Region 7 reflects a spillover from Region 5, rather than an effect of interpreting the fronted wh-phrase in the matrix clause. Note that in the region following the second dative-marked NP (Region 8) pairwise comparisons revealed that the main effect of complementizer type was primarily due to a slowdown in the declarative-scrambled condition. I cannot at this point exclude the possibility that this slowdown reflected a delayed surprise effect due to the second dative-marked NP, rather than the continued effect of the disruption in Region 5, although the results of Experiment 1B favor the second of these interpretations.

Although the results of this experiment support the predictions of the grammatical principle-based theory, there are also some concerns with the results. First, there were many participants who showed low accuracy on the comprehension task, and there were also a number of items that yielded low comprehension accuracy. The low comprehension accuracy may have been due to the fact that participants found the subject-verb matching task with the filler items too easy, leading them to be
over-confident in target trials (overall accuracy: Target 73.6% vs. Filler 90.7%, n = 72). Additionally, it is possible that some participants had difficulty understanding the concept of ‘subject’, which was necessary in order to perform the task. Second, a substantial proportion of the Japanese speakers included in the study (18/48) was resident in the United States and were highly proficient users of English. It might be objected that the results could have been affected by these speakers’ familiarity with *wh*-fronting constructions in English. Experiment 1B is a replication study that was run specifically to address these concerns, and to verify the robustness of the results observed in Experiment 1A.

2.4 Experiment 1B

This experiment was designed to confirm the results of Experiment 1A, while also addressing concerns about comprehension accuracy and participant backgrounds from the first experiment. The materials, design, and procedure in Experiment 1B were identical in format to those used in Experiment 1A, except in the following respects. First, items that yielded very low comprehension accuracy in Experiment 1A were replaced (n = 6). Second, the length and difficulty of the forty-eight filler items was modified, so as to more closely match the complexity of the experimental items. Third, in order to address the possibility that some participants had difficulty understanding the subject-verb matching comprehension task, prior to the self-paced reading task, an off-line practice session was added for answering comprehension questions of the type used in the on-line
experiment. Since the aim of the practice session was simply to ensure that participants were familiar with the concept of ‘subject’, only two instances of $wh$-scrambling were included among the twenty practice sentences.

2.4.1 Methods

2.4.1.1 Participants

Fifty-seven native speakers of Japanese participated in the experiment. All of them were students either at Shizuoka University or at Shizuoka Sangyo University, Japan. They were paid 500 yen for their participation in the experiment, which lasted about 30 minutes.

2.4.1.2 Data Analysis

Analyses were conducted on comprehension task response accuracy and reading times, by subjects and by items. All data from participants whose comprehension task accuracy was below 70% for target sentences and below 80% in total were discarded. Seven participants failed to meet this criterion (12%). Items for which accuracy among the remaining subjects was below 65% were also excluded ($n = 3$). Reading times longer than 3000ms were discarded. This procedure affected 2.85% of trials. The means and analyses presented below are based on the remaining trials.
2.4.2 Results

Comprehension accuracy and reading times at each region were entered into a repeated-measures ANOVA, with word order (scrambled, in-situ) and embedded complementizer type (declarative, question particle) as within-subjects factors.

2.4.2.1 Comprehension Accuracy

Among the fifty participants included in the analysis, average comprehension accuracy was 88.4%. In this study many fewer participants needed to be rejected, and overall error rates were cut almost in half, relative to Experiment 1A; therefore, it is clear that the low accuracy scores in the previous study reflected design artifacts rather than problems with the experimental items themselves. Mean accuracy scores did not differ significantly across the four conditions (all $F$s < 1).

2.4.2.2 Self-Paced Reading

The reading time analysis yielded the following results. Reading times for in-situ conditions are shown in Figure 4, and those for scrambled conditions are shown in Figure 5.
At all regions prior to the fifth region, there were no significant differences between reading times in the declarative complementizer and question particle conditions (all $F$s $< 1$). Comparisons between the in-situ and scrambled conditions are inappropriate for these regions, since the lexical material differed across conditions.

At the following regions a Typing Mismatch Effect was again observed, reflected in longer reading times for declarative complementizers than question particles, in both in-situ and scrambled word orders. In this respect, the results closely parallel Experiment 1A. However, due to the fact that the reading-time slowdowns were more short-lived than in Experiment 1A, and appeared earlier in one word order than the other, the pattern of statistical results appears different from Experiment 1A.

At the embedded verb (Region 5), there was no significant main effect of either complementizer type ($F_1 < 1; F_2(1,20) = 2.5, MSE = 148942, p = .13$) or word order type ($F_1(1,49) = 1.1, MSE = 224462, p = .32; F_2(1,20) = 2.52, MSE = 168329, p = .13$). Although the main effect of complementizer type was not significant, the trend observed was that embedded verbs with declarative complementizers were read more slowly (+31 milliseconds) than embedded verbs with question particles. However, there was a significant interaction of the two main effects in the subject analysis ($F_1(1,49) = 5.38, MSE = 118612, p < .05$), although not in the item analysis ($F_2 < 1$). Pairwise comparisons revealed that within the scrambled conditions, declarative conditions were read more slowly than question particle conditions; this effect was significant in the subject analysis and marginally significant in the item analysis ($F_1(1,49) = 5.42, MSE = 124402, p < .05$;
$F_2(1,20) = 3.11, \text{MSE} = 190840, p = .09$). On the other hand, the same comparison for the in-situ conditions showed no corresponding slowdown (all $F$s < 1).

At the main clause adverb (Region 6) there was no main effect of either complementizer type or word order type (all $F$s < 1). There was a marginally significant interaction ($F_1(1,49) = 3.47, \text{MSE} = 115769, p = .06; F_2(1,20) = 3.46, \text{MSE} = 167599, p = .07$). However, pairwise comparisons within each level of the word order factor revealed the mirror image of the results at Region 5. There was a significant slowdown in reading times for declaratives in the in-situ conditions ($F_1(1,49) = 4.08, \text{MSE} = 162058, p < .05; F_2(1,20) = 3.89, \text{MSE} = 200673, p = .06$), but no corresponding slowdown in the scrambled conditions (all $F$s < 1). Therefore, a Typing Mismatch Effect appears in both in-situ and scrambled conditions, but it appears one word later in the in-situ conditions.

At the main clause dative NP (Region 7) there was no main effect of complementizer type or word order (all $F$s < 1). The interaction was marginally significant in the subject analysis ($F_1(1,49) = 2.87, \text{MSE} = 68395.1, p = .09; F_2 < 1$). At the sentence-final main verb (Region 8) there was a marginal main effect of complementizer type ($F_1(1,49) = 4.0, \text{MSE} = 120355, p = .05; F_2(1,20) = 2.63, \text{MSE} = 129773, p = .12$). There was no main effect of word order ($F_1(1,49) = 1.37, \text{MSE} = 99312.3, p = .25; F_2 < 1$), and no interaction of complementizer and word order type (all $F$s < 1).
Figure 4: Experiment 1B, Reading times per region for the in-situ conditions (NP-top1, NP-nom2, Wh-dat3, NP-acc4, V-DeclC/Q5, Adverb6, NP-dat7, V-Q/.8).

Figure 5: Experiment 1B, Reading times per region for the scrambled conditions. (Wh-dat1, NP-top2, NP-nom3, NP-acc4, V-DeclC/Q5, Adverb6, NP-dat7, V-Q/.8)
2.4.3 Discussion

Experiment 1B was successful both in obtaining consistently high comprehension accuracy and in replicating the finding of a Typing Mismatch Effect in both in-situ and scrambled conditions. As in Experiment 1A I assume that the embedded verb triggers slower reading times in the declarative conditions because readers expect to encounter a question particle as soon as possible after the thematic position of a wh-phrase. In the scrambled conditions, this expectation could only arise in the embedded clause if readers create a gap-site in the embedded clause, given the requirement that wh-scope positions c-command thematic positions. The higher accuracy scores in this experiment indicate that the low accuracy observed in Experiment 1A was due to extraneous factors. Also, since all of the participants in Experiment 1B were resident in Japan, I can also exclude the possibility that the results of Experiment 1A might somehow be due to the high English proficiency of many of the participants.

The main contrast between the results of Experiment 1A and Experiment 1B is that the Typing Mismatch Effect was shorter-lived, appearing at one region only, and was slightly delayed in the in-situ conditions, appearing at the adverb immediately following the embedded verb. Although it is unclear why the Typing Mismatch Effect appeared at the embedded verb in the scrambled conditions and immediately after the embedded verb in the in-situ conditions, I see no reason not to assume that in both cases this effect was caused by the complementizer type on the embedded verb. It is common in studies using the self-paced reading paradigm to observe effects that are delayed by one or more
regions, and I am aware of no reason why the adverb itself should elicit slower reading
times in the declarative condition. The fact that the slowdowns in reading times were
shorter-lived in this study may be a corollary of the improved comprehension accuracy.
By reading targets and fillers more cautiously, participants may have been able to correct
errors more immediately.

Taken together, the results of Experiments 1A and 1B confirm the prediction of
the grammatical principle-based theory of the processing of long-distance dependencies,
and indicate that Japanese speakers preferentially interpret a fronted wh-phrase inside the
most deeply embedded clause. This finding argues against incremental models that
assume that gap-creation is an end in itself, as predicted by the AFS. Due to the use of
dative-marked wh-phrases and mono-transitive verbs, it is likely that this effect is due not
to the lexical argument structure requirements of the embedded verb, but rather reflects
the requirement of the wh-phrase to receive a thematic interpretation. However, as
discussed in Section 2.2, the preference to interpret the fronted wh-phrase in the
embedded clause might also be explained by a head-driven (delay) model or by a direct
association model, because in both cases the first verb provides the first opportunity in
the sentence to construct a wh-dependency.\(^6\) In light of these alternative explanations of

\(^6\) I thank Yuki Kamide and Edson Miyamoto for bringing this question to my attention. Note also that
because the declarative complementizer or question particle is part of the verb and follows the verb stem,
the Typing Mismatch Effect on the complementizer or particle unavoidably follows processing of the
embedded verb.
the results, Experiment 2 sets out to examine the time-course of \(wh\)-dependency formation in more detail.\(^7\)

2.5 Experiment 2

Building upon the finding in Experiment 1 that fronted \(wh\)-phrases in Japanese are preferentially associated with the most deeply embedded clause, Experiment 2 was designed with the goal of investigating the time-course of this association process. This time-course information is important, in order to distinguish among different possible accounts of what drives this process. The finding that declarative complementizers were read more slowly than question particles indicates that the association with the embedded clause occurs no later than the embedded verb. In fact, a direct association account of \(wh\)-dependency formation would predict that association with the embedded clause could only take place at the verb, since under this approach the fronted \(wh\)-phrase forms a dependency directly with the verb. Alternatively, the fronted \(wh\)-phrase may be associated with the embedded clause before the embedded verb is processed. Such a scenario would be possible under a theory in which the fronted \(wh\)-phrase is associated with a gap in a pre-verbal argument position in the embedded clause, rather than directly associated with the verb. Note, however, that the ‘indirect association’ approach does not automatically entail that filler-gap dependencies are computed in advance of the verb in a

\(^7\) The results of Experiments 1A and 1B also have implications for theories of reanalysis on gap creation; I will address this issue in Chapter 4.
head-final language such as Japanese. For example, the ‘head-driven’ approach to parsing Japanese (Pritchett, 1991b, 1992; Mulders, 2002) assumes the existence of pre-verbal gaps, but also assumes that structure-building is delayed until the verb is processed.

This experiment adapted the ‘filled gap’ paradigm (Crain & Fodor, 1985; Stowe 1986; Clifton & Frazier, 1989) for Japanese, in order to test whether filler-gap dependencies are created in advance of the verb in Japanese embedded clauses. In studies on English, the Filled Gap Effect is a surprise effect that is elicited when readers encounter an overt NP in a post-verbal position where a gap was anticipated. The Japanese equivalent should also involve an overt NP in a position where a gap was anticipated, but this position should appear prior to the verb.

2.5.1 Methods

2.5.1.1 Participants

Forty-one native speakers of Japanese participated in the experiment. All of them were students either at the University of Maryland, USA (n = 23), or at Shizuoka University or Shizuoka Sangyo University, Japan. They were paid $5.00 or its yen equivalent for their participation in the experiment, which lasted about 30 minutes.
Experimental materials consisted of twenty sets of sentences with two conditions each, which I refer to as the scrambled condition and the control condition, respectively. (12) shows one set of conditions used in the experiment. A full set of materials for this experiment can be found in Appendix B.

(12) a. *Scrambled condition*

Dono-syain-ni senmu-wa syatyoo-ga

*Which employee-dat managing director-top president-nom*

kaigi-de katyoo-ni syookyuu-o yakusokusita-to

*meeting-at assistant manager-dat raise-acc promised-DeclC*

iimasita-ka?

told-Q

‘To which employee did the managing director tell that the president promised a raise to the assistant manager at the meeting?’

b. *Control condition*

Dono-syain-ga senmu-ni syatyoo-ga

*Which employee-nom managing director-dat president-nom*

kaigi-de katyoo-ni syookyuu-o yakusokusita-to

*meeting-at assistant manager-dat raise-acc promised-DeclC*

iimasita-ka?

told-Q

‘Which employee told the managing director that the president
promised a raise to the assistant manager at the meeting?’

In both conditions, the two main clause NPs at the start of the sentence were followed by an embedded clause that contained an overt dative-marked NP. The verb of the embedded clause was marked with a declarative complementizer, and the verb of the main clause with a question particle, indicating that the sentence had the force of a direct question. In both conditions, the dative NP in the embedded clause was the second dative NP in the sentence. However, in the scrambled condition (12a), in which a nominative-marked NP is preferred to be interpreted as an embedded subject (see Experiment 3, Section 2.6), the dative wh-phrase in sentence-initial position should also be associated with the embedded clause, based upon the results of Experiment 1. If the fronted wh-phrase in the scrambled condition is associated with the embedded clause before the second dative NP is encountered, readers should be surprised to encounter the second dative NP, due to the fact that it is highly marked in Japanese to have two arguments marked with the same case in a single clause. This surprise effect would be the Japanese equivalent of the Filled Gap Effect (Stowe 1986).

In the control condition (12b) the two sentence-initial NPs are matched to the scrambled condition in the respect that there is one wh-phrase and one dative NP. However, in this condition there is no expectation that either of these NPs should be associated with the embedded clause. First, the sentence-initial nominative wh-phrase cannot be associated with the embedded clause, since nominative NPs in Japanese cannot be scrambled (Miyara 1982; Saito 1985; Takezawa 1987; Nemoto 1999). Second, the
The dative NP in second position should be interpreted in-situ, and should not be interpreted as if it were scrambled from the embedded clause, according to the results of Kamide and Mitchell (1999), who investigated the processing of dative-marked NPs in Japanese in very similar positions. Therefore, the second dative NP in (12b) should be understood as the only dative NP in the embedded clause, and should be read more quickly than the corresponding NP in the scrambled condition, despite the fact that readers have already encountered both a wh-element and a dative NP, just as they do in the scrambled condition.

The twenty sets of items were distributed in a Latin Square design, creating two lists. Each participant saw one of the lists intermixed with sixty unrelated filler items in a random order.

2.5.1.3 Procedure

The self-paced reading procedure and the comprehension task were identical in format to that used in Experiment 1.

2.5.1.4 Data Analysis

Analyses were conducted on comprehension task response accuracy and reading times, by subjects and by items. All data of subjects whose comprehension task accuracy was less than 70% in the target sentences and 75% in total were discarded (n = 7, 17%).
Reading times longer than 2500ms were discarded. This procedure affected 2.8% of trials. The means and analyses presented below are based on the remaining trials.

2.5.2 Results

Comprehension accuracy and reading times at each region were entered into a repeated-measures ANOVA, with word order (scrambled, control) as the within-subjects factors.

2.5.2.1 Comprehension Task Accuracy

Among the subjects who were included in the analysis, average comprehension accuracy was 86.3%. The average correct response percentage did not differ significantly across the four conditions ($F < 1$). In addition, there was no significant difference in the comprehension task accuracy between the subjects who live in Shizuoka, Japan (87.3%) and those who live in Maryland, USA (85.2%) ($F < 1$).

2.5.2.2 Self-Paced Reading

Reading times for all regions are shown in Figure 6. At all regions except the third and fifth regions there were no significant differences between reading times in the scrambled and control conditions (all $F$s $< 1$).
At the embedded nominative subject NP in Region 3 the control condition was read more slowly than the scrambled condition; this effect was significant in the participant analysis but not significant in the items analysis ($F_1(1,33) = 5.93, \text{MSE} = 290485, p < .05; F_2(1,19) = 1.23, \text{MSE} = 373698, p = .28$).

At the dative NP in region 5 there was a significant difference between the two conditions ($F_1(1,33) = 11.37, \text{MSE} = 102598, p < .005; F_2(1,19) = 6.4, \text{MSE} = 128504, p < .05$), such that reading times were 83 milliseconds slower in the scrambled condition than in the control condition. There were no other observed significant differences.

![Figure 6: Experiment 2, Reading times per region](image)

Figure 6: Experiment 2, Reading times per region
(Scrambled: Wh-dat$_1$ NP-top$_2$ NP-nom$_3$ Adv$_4$ NP-dat$_5$ NP-acc$_6$ V-DeclC$_7$ V-Q$_8$)
(Control: Wh-nom$_1$ NP-dat$_2$ NP-nom$_3$ Adv$_4$ NP-dat$_5$ NP-acc$_6$ V-DeclC$_7$ V-Q$_8$)

### 2.5.3 Discussion
The main result of this experiment is an observed slowdown in reading time in the scrambled condition at the embedded dative NP (Region 5), relative to the reading time for the same region in the control condition. I interpret this slowdown as the Japanese counterpart to the Filled Gap Effect (Stowe 1986). The slowdown arises because readers do not expect to encounter a second dative NP in the embedded clause after they interpret the wh-phrase in the embedded clause. This effect could only arise if readers create a gap-site in the embedded clause before they reach the embedded verb, which does not appear until Region 7. The embedded dative NP is read more quickly in the control condition, because the other dative NP in that sentence is, by assumption (cf. Kamide & Mitchell 1999) interpreted in the main clause. These results are in turn consistent with the results of Experiment 1: readers ultimately associate a fronted wh-phrase with the first verb that they encounter, rather than with the structurally highest verb or the first possible gap position.

One might argue that the slowdown at Region 5 in the target condition reflects the discovery of multi-clausal structure, not a Filled Gap effect. In scrambled conditions, the second dative-marked NP would be the first clear indication of clause boundary, whereas in the control condition there is a strong cue for making a clause boundary earlier on at the second nominative-marked NP (Miyamoto, 2002; Uehara, 2003). The underlying assumption for this argument is that the mono-clausal parse would be the preferred analysis of a sequence of the first three NPs in the scrambled conditions. However, the next experiment (Experiment 3) shows that the preference turns out to be opposite. The

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8 I thank Tom Wasow for pointing out this possible interpretation.
bi-clausal analysis to the sentence-initial NPs is strongly preferred. Therefore, this alternative interpretation does not capture the slowdown at Region 5.

I assume that the slower reading time in the control condition at Region 3 reflects the cost of the multiple nominative-marked subject NPs, as opposed to the scrambled condition, where the two subject NPs were marked with a topic marker and a nominative marker, respectively. 18% of trials recorded in this region were slower than the 2500ms cut-off, and hence had to be discarded (compared to a 2.8% rejection rate overall). This implies that readers read the second nominative subject NP particularly slowly. Note that this difficulty did not extend beyond Region 3, and reading times for the two conditions were closely matched by Region 4.

One remaining concern with the results involves the assumption that participants clearly recognized that the target items in Experiments 1 and 2 required an embedded clause analysis as soon as the embedded clause subject was read. In both experiments the critical items began with a sequence of three animate NPs as in (13a). Although it is quite natural to analyze the nominative-marked NP as the subject of an embedded clause (13b), this is not the only possible continuation of the sentence, since the topic-marked NP in second position could potentially be a direct object NP (13c), or the nominative-marked NP could be the object of the special class of Japanese verbs that allows nominative objects (13d).

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9 Thanks go to Satoru Muraoka, who first pointed out that a mono-clausal analysis of three animate NP (13a) might confound the results.
Experiments 1 and 2 were predicated upon the assumption that the bi-clausal parse would be the preferred analysis, and that this preference should be enhanced by the use of animate NPs for both the topic-marked and the nominative-marked NP. However, it is important to validate this assumption.

2.6 Experiment 3

An off-line sentence completion test was conducted in order to examine the assumption that Japanese readers prefer to give a bi-clausal analysis to sequences of NPs
appearing in the order dative-topic-nominative, as in the critical items in Experiments 1 and 2. If speakers provide bi-clausal completions to sentence fragments consisting of dative-topic-nominative sequences, then it is reasonable to also assume that the participants in Experiments 1 and 2 also gave bi-clausal analyses to the sentence-initial NPs in the on-line studies.

2.6.1 Methods

2.6.1.1 Participants

Sixty-eight native speakers of Japanese participated in the experiment. All of them were students at Meiji Gakuin University, at the University of Tokyo, or at Kanda University of International Studies, Japan. The experiment lasted about 20 minutes.

2.6.1.2 Materials and Design

Experimental materials consisted of twelve sets of four conditions each, in a 2 x 2 factorial design, which manipulated the distribution of case morphemes (topic-nominative vs. nominative-nominative) and the position of the dative *wh*-phrase (scrambled vs. in-situ). (14) shows one set of conditions used in the experiment. A full set of materials for this experiment can be found in Appendix C.

(14) a. Dono sinnyuusei-ni tannin-wa sisyo-ga tosyositu-de ...
The fragments in all conditions consisted of a dative-marked *wh*-phrase, two referential NPs, and an adverbial phrase. All of the fragments except an adverbial phrase consisted of only animate NPs. The case morpheme of the first referential NP (topic marker –*wa* vs. nominative marker –*ga*) was manipulated, because both forms were used in the previous on-line experiments (Experiment 1 and 2), and in order to allow comparison with the on-line results of (Miyamoto, 2002; Uehara, 2003), which shows that nominative-nominative sequences are preferentially analyzed as bi-clausal structures. The position of the *wh*-phrase was manipulated in order to examine whether the position of the *wh*-phrase affects the frequency of completions in which speakers place a question particle in the embedded clause.

The phrases used in the fragments were taken from the target items used in Experiment 2. The twelve sets of items were distributed among four lists in a Latin Square design. Each participant saw exactly one of the lists intermixed with twenty-four unrelated items in a random order. The filler items were designed in such a way that
speakers would be likely to give similar numbers of mono-clausal and bi-clausal completions, in order to offset the danger of a structural priming effect that might lead participants to use the same structure in all completions.

2.6.2 Results and Discussion

The completions were classified according to the number of clauses used to complete the sentence fragment, and according to the position of question markers that indicate the scope of the wh-phrase. Completions were classified as multi-clause responses if more than one verb was provided. Responses were classified as embedded (i.e. indirect) questions if exactly one question marker was provided, affixed to an embedded verb. Other possible responses placed the question marker on the main verb (direct question), or placed a question marker on main and embedded verbs (‘both’). Results are shown in Table 1.

10 A question marker can grammatically appear on both the embedded and main verb in a sentence. In this case, one of the question markers is interpreted as a question complementizer. For instance,

(i) Tannin-wa sisyo-ga tosyositu-de dono sinnyuusei-ni sono hon-o
Class teacher-top librarian-nom library-at which new student-dat that book-acc
miseta-ka oboeteiru-no?
showed-Q remember-Q
‘Does the class teacher remember which new student the librarian showed that book to?’
Table 1: Experiment 3, Classification of sentence completions according to clause-number and question-type.

<table>
<thead>
<tr>
<th>Conditions</th>
<th>Multi</th>
<th></th>
<th>Mono</th>
<th></th>
<th>Embedded</th>
<th></th>
<th>Main</th>
<th></th>
<th>Both</th>
<th></th>
</tr>
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<tbody>
<tr>
<td></td>
<td>n</td>
<td>%</td>
<td></td>
<td>n</td>
<td>%</td>
<td>n</td>
<td>%</td>
<td>n</td>
<td>%</td>
<td>n</td>
</tr>
<tr>
<td>Scrambled, Top-Nom</td>
<td>193</td>
<td>39.0</td>
<td>2</td>
<td>1.0</td>
<td>106</td>
<td>54.4</td>
<td>66</td>
<td>33.8</td>
<td>23</td>
<td>11.8</td>
</tr>
<tr>
<td>Scrambled, Nom-Nom</td>
<td>172</td>
<td>84.5</td>
<td>10</td>
<td>5.5</td>
<td>75</td>
<td>41.2</td>
<td>78</td>
<td>42.9</td>
<td>29</td>
<td>15.9</td>
</tr>
<tr>
<td>In-situ, Top-Nom</td>
<td>193</td>
<td>100.0</td>
<td>0</td>
<td>0.0</td>
<td>190</td>
<td>98.4</td>
<td>3</td>
<td>1.6</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>In-situ, Nom-Nom</td>
<td>184</td>
<td>97.9</td>
<td>4</td>
<td>2.1</td>
<td>183</td>
<td>97.3</td>
<td>5</td>
<td>2.7</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

Participants provided completions for the sentence fragments on 92.9% of the trials (758 trials). Of these, 97.9% were multi-clausal (742 trials). The proportion of multi-clause completions was above 94% in all conditions. In the critical condition containing a scrambled wh-phrase followed by a topic and a nominative NP, 99.0% of responses were multi-clause completions. Fisher Exact tests were used, in order to determine whether any of the small differences among conditions were reliable. Although mono-clausal completions were rare for all conditions, they were more common in scrambled than in in-situ conditions ($p < .05$, 2-tailed). Pairwise comparisons showed that among the scrambled conditions mono-clausal completions were less common for topic-nominative fragments than for nominative-nominative fragments ($p < .05$, 2-tailed), and that there was a marginally significant tendency in the same direction among the in-situ conditions ($p < .06$, 2-tailed).

In the analysis of question-type, overall 72.8% of sentence fragments (554 trials) were completed as indirect questions, with a question marker on an embedded verb only. Once trials are added in which participants provided a question marker in both clauses, the number of embedded clause responses rises to 81.7%. Fisher Exact tests were used, in
order to determine whether the differences among conditions were reliable. Since the primary interest was in the question of whether a question particle was produced on an embedded verb, the ‘embedded clause only’ and ‘both clauses’ categories were combined for purposes of this analysis. Results showed a highly reliable effect of word order ($p < .0001$, 2-tailed), due to many fewer main clause question particles in the in-situ conditions. Pairwise comparisons within each level of the word-order factor showed no significant effect of case marker, although among the scrambled conditions there was a marginally significant tendency for more embedded question particles in the topic-nominative condition ($p < .09$, 2-tailed).

Although more embedded question responses were provided in the in-situ conditions, it is important to note that in the critical conditions with fronted $wh$-phrases that began with a dative-topic-nominative sequence, 66.4% of sentence completions contained a question marker in an embedded clause.

The main finding of this experiment is that Japanese readers have a strong preference to analyze the nominative-marked NP as the subject of an embedded clause in a dative-topic-nominative sequence. Therefore, it is safe to assume that participants in Experiments 1 and 2 also recognized that the target items required an embedded clause analysis as soon as the embedded clause subject was read.

This study also shows that in sentences that began with a fronted $wh$-phrase, participants mostly provided completions with a question marker attached to the embedded verb (i.e. indirect questions). This finding corroborates the reading-time results
presented in Experiments 1 and 2, and shows further evidence that Japanese speakers have a strong propensity to interpret fronted *wh*-phrases inside an embedded clause.

### 2.7 General Discussion

The strict verb-final property of Japanese has the effect that more deeply embedded verbs appear before the structurally highest verbs in a sentence. This property allows me to test a prediction of theories that claim that the formation of long-distance dependencies is driven by the satisfaction of syntactic and semantic constraints, rather than simply by the need to create a gap. Such theories predict that a fronted phrase will be preferentially interpreted with a more deeply embedded verb in configurations where the more deeply embedded verb appears earlier in the sentence. This prediction amounts descriptively to the opposite of a robust generalization about the processing of verb-medial languages like English. In English it is consistently found that fronted *wh*-phrases are preferentially interpreted with the verb in the clause that contains the *wh*-phrase.

Experiments 1A and 1B both showed that Japanese readers demonstrate a clear parallelism between the processing of *wh*-questions in which the *wh*-phrase is scrambled to the front of the main clause and *wh*-questions in which the *wh*-phrase is in-situ in an embedded clause. In both configurations, participants read embedded verbs more quickly if they were marked with question particles than if they were marked with a standard declarative complementizer. The results for in-situ *wh*-phrases replicate and extend the
finding of Miyamoto and Takahashi (2000, 2001, 2002c) that Japanese readers expect to encounter a question particle on the verb of a clause that contains an in-situ *wh*-phrase. The parallel results for fronted *wh*-phrases indicate that readers treat the fronted *wh*-phrase as if it has been scrambled from the embedded clause, and therefore anticipate a question particle on the embedded clause verb.

Experiment 2 also showed that Japanese readers preferentially interpret a fronted *wh*-phrase in an embedded clause, based on a Japanese version of the Filled Gap Effect. The design of the experiment made it possible to show that participants formed *wh*-dependencies with the embedded clause before they encountered the embedded clause verb.

Experiment 3 used an off-line sentence completion task to verify that Japanese speakers show an overwhelming bias to interpret the sequences of NPs that appeared at the start of the key items as part of a multi-clausal structure. This lends support to the assumption that when readers form a *wh*-dependency after the embedded clause subject, they are doing so in the context of a structure that is already bi-clausal.

Taken together, therefore, the results indicate that readers create a gap in the embedded clause before they encounter the embedded verb, and hence prefer to associate a fronted *wh*-phrase with an embedded clause. This means that the *wh*-phrase is related not to the structurally highest verb with which the first possible gap position would be associated (i.e. the main clause verb), but instead to the first verb that readers encounter (i.e. the embedded verb). Crucially, the parser seems to build enough structure in the embedded clause to allow immediate interpretation of the displaced constituent (cf.
Chapter 4). The embedded clause preference could not be due to the argument structure of the embedded verb, since Experiment 1 only used embedded verbs that do not require a dative-marked complement, and since Experiment 2 showed that the wh-dependencies are formed in advance of the embedded verb, and Experiment 3 left the choice of verb to the participants. Furthermore, it is unlikely that the embedded clause preference reflects a grammar-blind mechanism that associates a wh-phrase with the closest verb, regardless of whether this is grammatically possible: recall that Miyamoto and Takahashi (2002c) showed that nominative-marked wh-phrases in Japanese, which are known to resist scrambling, do not give rise to a Typing Mismatch Effect on the immediately following verb, if that verb is in a more deeply embedded clause.

The preference to associate fronted wh-phrases with an embedded clause is unexpected if the formation of wh-dependencies is driven simply by the requirement to create a gap position as soon as possible, as predicted by the Active Filler Strategy and related approaches (Frazier & Clifton, 1989; de Vincenzi, 1991). As explained in Section 2.2, the AFS predicts that Japanese readers should be able to posit a gap for a fronted wh-phrase in the first possible position, following the main clause subject. A gap in this position would satisfy the AFS. This would leave no reason to revise this analysis once the embedded clause is encountered, since an embedded clause gap site would be more distant from the surface position of the wh-phrase, under any measure of linear or hierarchical distance.

On the other hand, the finding of an embedded clause preference for fronted wh-phrases confirms a prediction of approaches that claim that the creation of
long-distance dependencies is motivated by the need to satisfy syntactic and semantic requirements of the fronted phrase. This view can be found in both gap-based and direct association models of long-distance dependencies. However, based on the evidence from Experiment 2 that Japanese speakers form \textit{wh}-dependencies in the embedded clause before they reach the embedded verb, I concluded that the results favor an incremental model of long-distance filler-gap dependencies, over models that assume that dependencies cannot be created until the verb position due to direct association or to head-driven structure-building. In Chapter 3, I will present results of another self-paced reading experiment which also shows that filler-gap dependencies are formed in advance of the verb. After presenting the experimental results, I will compare incremental parsing models and head-driven delay parsing models, and also indirect-association models and direct association models. The results of the experiment, along with the results of Experiment 2, strongly favor incremental models and indirect association models.

It is important to note that in the interrogative structures tested in the present experiments, two independent grammatical requirements can be satisfied at the position of the embedded verb. First, the thematic interpretation of the \textit{wh}-phrase can be fixed by the verb. Second, the scope interpretation of the \textit{wh}-question can be fixed by the presence of a question-marker affixed to the verb. Therefore, the results provided here do not allow us to conclude that formation of \textit{wh}-dependencies is driven specifically by the need to satisfy thematic requirements. The present results could be due to thematic requirements, scope-fixing requirements, or both. In order to determine whether thematic requirements
are sufficient to give rise to an embedded clause interpretation preference, it would be necessary to conduct additional studies involving scrambled non-interrogative phrases.\textsuperscript{11}

It is also important to clarify the relationship between the findings presented here and theories that argue that the processing of filler-gap dependencies is driven by the need to minimize the consumption of resources in working memory or in a specialized resource pool for sentence processing (Just \& Carpenter, 1992; Gibson, 1998; Caplan \& Waters, 1999). First, it should be noted that such models do not replace grammatical requirements with working memory metrics – rather, they use grammatical requirements such as thematic and scope relations as the currency of memory cost calculations. Second, it is possible to implement a version of either the position-based AFS approach or the grammatical principle-based approach in memory-based models, depending on the specific representational assumptions adopted. For example, if cost were calculated in terms of whether a displaced constituent is held in working memory or structurally linked to a gap position, then this theory would make the same predictions as the AFS, and would make incorrect predictions for Japanese. Alternatively, if cost were calculated in terms of whether a displaced constituent has been entered into the compositional interpretation of the sentence, then it could be argued that memory cost is lower when the gap is created in the embedded clause, because the embedded verb provides the first opportunity in the linear order of the sentence to fix the scope and thematic status of the

\textsuperscript{11} In Chapter 4, I implement the parsing model with \textit{wh}-fronting sentences which the current experiments used. Based on the algorithm of the parsing model, it is predicted that formation of \textit{wh}-dependencies is driven by the need to satisfy all the grammatical requirements the filler requires. In this regard, it is predicted that there is no relevant difference between scrambled \textit{wh}-phrases and scrambled non-\textit{wh}-phrases. See Chapter 4 Section 4 for details.
wh-phrase. Such an approach could account for the present findings in Japanese. It should be clear, however, that such an approach is a specific implementation of the view that long-distance dependency formation is driven by syntactic and semantic constraints, rather than an alternative to this view.

Finally, the present results bear on the eliminative program that has informed much recent work in constraint-based processing. This work has shown that much of the psycholinguistic data previously attributed to general grammatical constraints such as the Theta Criterion, or other interpretive principles, was in fact more correctly attributable to stochastically conditioned constraints stored with specific lexical items. Taken to its logical conclusion, this approach suggests elimination of these general constraints in favor of conditions that track the frequency with which a lexical item appears in one construction or in one form over another. The Japanese case is interesting in this regard. Experiment 2 in particular, suggests that a wh-element is interpreted as the indirect object of a clause without reference to how frequently any particular item appears as the indirect object of any particular verb, since the Filled Gap Effect occurs before readers encounter the embedded verb. This favors an approach that incorporates the drive for early interpretation as a direct constraint, independent of the statistical or selectional properties of individual verbs, and so can apply even before the verb that checks the interpretive features is accessed. A similar argument is presented by Drury, Resnik, Weinberg, Gennari, and Aoshima (2002), based on evidence from reciprocal verbs in English. Furthermore, a construction-based stochastic constraint in the sense of Jurafsky (1996) is also unlikely to capture the current findings about Japanese. One might argue that
scrambled dative NPs are frequently indirect objects, allowing them to be placed inside a VP before the head verb is encountered. However, this would predict a gap site in the highest clause, as this is the first opportunity to satisfy this purely syntactic fact about this construction. In order to account for the creation of a gap inside the embedded clause, I must appeal to the additional interpretive benefits that result from positing an embedded clause gap.

2.8 Summary

Accounts of the processing of long-distance dependencies fall into two general classes. Some accounts assume that long-distance dependency formation is driven by the need to associate a filler with a gap position as soon as possible after encountering the filler. Other accounts assume that dependency formation is driven by the need to satisfy syntactic and semantic principles or constraints as soon as possible. Both families of approaches make rather similar predictions for verb-medial languages such as English. However, the predictions of the two approaches diverge in head-final languages such as Japanese. In this chapter, I tested a prediction of the grammatical principle-based approach, that fronted *wh*-phrases should be preferentially associated with an embedded clause in Japanese, because this allows earlier satisfaction of constraints on thematic interpretation and scope licensing. This prediction was confirmed in three studies, using three different measures of *wh*-dependency formation. Experiment 1 showed that in sentences with sentence-initial *wh*-phrases Japanese speakers expect to encounter a
question-marker particle on the verb of the embedded clause. Experiment 2 demonstrated that a Japanese counterpart of the Filled Gap Effect occurs at a preverbal position in an embedded clause in sentences with fronted *wh*-phrases. The finding of a pre-verbal effect of dependency formation in Experiment 2 shows that filler-gap dependencies are created incrementally in Japanese, just as in English, and that there is no need to assume that dependency formation is delayed until the clause-final verb is processed. It further suggests that the constraints that drive dependency formation are independent of the lexical properties of individual verbal heads. Experiment 3 showed an embedded clause preference for the positioning of question particles in an off-line sentence completion task involving scrambled *wh*-phrases.

Theories of parsing that are variously known as ‘principle-based’, ‘constraint-based’, 'lexicalized', or ‘head-driven’ have been associated with two closely related but logically independent claims. The first claim is that real-time dependency formation is driven by the need to satisfy the syntactic and semantic requirements of lexical heads (e.g. Ford, Bresnan, & Kaplan, 1982; Pritchett, 1988; MacDonald, Pearlmutter, & Seidenberg, 1994). The second claim is that when critical lexical heads are delayed, as in a head-final language such as Japanese, dependency formation should be correspondingly delayed (e.g. Pritchett, 1991b, 1992; Mulders, 2002). The findings on Japanese filler-gap dependencies provide support for the first of these claims, but also show that this is compatible with incremental parsing, assuming a slightly more expansive notion of constraint (one not necessarily tied to a lexical head), contrary to the
second claim. Chapter 3 reinforces this conclusion by presenting the results from another self-paced reading experiment.
CHAPTER 3

WHEN STRUCTURES ARE BUILT

3.1 Introduction

In this chapter, I present experimental evidence for accurate, incremental structure-building in Japanese, based on the on-line application of structural constraints on anaphoric interpretation of pronouns before verb information is available. In doing so, I will strengthen the claim, already presented by the results of Experiment 2 (Chapter 2, Section 2.5), that the experimental findings support incremental, full-attachment models of the processing of head-final languages over head-driven delay models that assume that structure-building is delayed until the verb is processed (Pritchett 1991b, 1992; Mulders, 2002). The findings also support gap-based parsing models (Stowe, 1986; Frazier & Cliffton, 1989; Nicol & Swinney, 1989; de Vincenzi, 1991; Nicol, 1993; Gibson & Hickok, 1993; Nakano et al., 2002; Miyamoto & Takahashi 2002a, b, c, d) over direct association models which entail a commitment to a mechanism based directly upon the direct dependencies between the wh-filler and a verb (Pickering & Barry, 1991; Pickering,
Making use of various types of head-final structures, particularly in Japanese and German, a number of studies have tested head-driven delay models. Most studies argue for incremental parsing models, and against the head-driven delay models (e.g. Bader & Lasser, 1994; Fodor & Inoue, 1995; Inoue & Fodor, 1995; Mazuka & Itoh, 1995; Kamede & Mitchell, 1999; Kamide, Altmann, & Haywood, 2000; Miyamoto & Takahashi, 2002a; Mazuka, Itoh, & Kondo, 2002; Fodor & Hirose, 2003; Nakatani & Gibson, 2003). In, showing the motivation for my own study in Section 3.2, I will distinguish it from previous studies. The following section, Section 3.3 introduces Experiment 4.

Based on the results from Experiment 2 and 4, Section 3.4 will revisit the discussion of the two pairs of competing theories: between incremental full-attachment models and head-driven delay models, and between gap-based parsing models and direct association models. I will conclude that structure-building is fully incremental and that the parser posits gaps when it builds sentence structures.

3.2 On-line Computation of Structural Relations

3.2.1 Full Attachment Models and Head Driven Delay Models

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12 More precisely, the present results argue against a strong version of direct dependency accounts (Pickering & Barry, 1993; Pickering, 1993; Steedman, 2000), while they are not straightforwardly inconsistent with Sag and Fodor (1994)’s account. I will return to this point when I discuss the direct association models in Section 3.4.2. See also Aoshima, Phillips, and Weinberg (2003e).
This section illustrates the differences in how the parser builds structure under the incremental attachment models and under the head-driven delay models. To begin, let us sketch a simple ditransitive sentence in (1).

(1) John-ga Mary-ni bara-o ageta.

*John-nom Mary-dat rose-acc gave*

‘John gave Mary roses.’

The incremental attachment models (Inoue & Fodor, 1995; Mazuka & Itoh, 1995) assume that the model is incremental in that there is no delay in parsing, and phrases are associated to each other immediately when local information is available. In other words, the parser builds appropriate structure every time it encounters a new phrase. Crucially, parsing decisions are made even when the relevant head (in this case, the verbal head) is not accessible. The tree diagrams from (2a) to (2d) illustrate this.\(^\text{13}\)

\(^{13}\) Of course, the trees as in (2) and (3) are too simple to explain syntactic and semantic relations among the phrases in a structure. Chapter 4 will present more explicit illustrations by implementing the parsing model developed therein.
On the other hand, head-driven delay models (Pritchett 1991b, 1992; Mulders, 2002) assume that constituents remain unattached until a licensing head is available, as illustrated in (3a). Given the assumption that a licensing head is a necessary and sufficient condition for attachment, attachment must occur as soon as a relevant head is available. In addition, Pritchett (1992) and Mulders (2002) assume that all grammatically permissible constituents are attached to the current head being processed. Given this, when the parser encounters a verbal head as in (3b), the parser is responsible for assigning θ-grids on the verb to an appropriate argument to satisfy the grammatical requirements, as in (3c). At this point, the previously unattached phrases should be integrated in the sentence structure.
Due to different timing of connecting pre-verbal phrases, incremental attachment models and the head-driven delay models make a divergent prediction in cases where a syntactic or interpretive relation between pre-verbal phrases is not appropriate. The incremental attachment models force the parser to connect a new phrase to the existing tree, and to interpret the relation(s) among phrases. Crucially, it does so before the parser sees a licensing head. These models predict that a processing difficulty could occur prior to the verb if a syntactic or interpretive relation between pre-verbal phrases is not correct. On the other hand, the head-driven delay models prevent the parser from connecting pre-verbal phrases until it encounters the verb and assigns θ-grids to phrases. Since head-driven delay models force pre-verbal phrases to remain unconnected in a structure, any processing difficulty caused by relations among pre-verbal phrases should not be observed before the verb is processed.
The results from Experiment 4 will suggest that the parser interprets relations among phrases prior to the verb, indicating that it builds structure full-incrementally. This finding favors incremental attachment models, as opposed to head-driven delay models.

3.2.2 Previous Studies

Before Experiment 4 is introduced, this section considers previous studies that were concerned with the competing theories between incremental attachment models and head-driven delay models. In doing so, I distinguish their conclusions from my proposal. In general, their arguments and experimental results suggest that the parser does not seem to wait for an incoming verbal head to build up structures for pre-verbal elements. I fundamentally agree with a conclusion drawn from previous studies that experimental evidence favors incremental attachment parsing models rather than head-driven delay models. However, I will point out that arguments in some of these studies are based upon patterns of difficulty at verbs, and that the findings provided in other studies reflect other possible factors. I also propose that in order to provide a stronger argument for incremental attachment models, it is crucial to demonstrate grammatically constrained formation of relations among noun phrases in advance of the verb. The formation of pre-verbal phrases should not be free from grammatical constraints, but it only occurs under some structural restrictions, such as configurational constraints on binding. Incrementality follows if pre-verbal effects are detected under such circumstances.
A number of studies in the literature have argued that the parser incrementally builds structure even before the lexical head is encountered. I review several of these studies here. Consider an example provided by Inoue and Fodor (1995). They discuss that the three NPs in (2a) are preferentially interpreted as arguments to a single verb, yielding a surprise effect at the mono-transitive verb in (2c), as opposed to at the ditransitive verb in (2b). They attribute this surprise effect to expectation of a different type of verb, not to difficulty understanding the verb. They argue that this example provides evidence that the pre-verbal NPs are analyzed as arguments of a single ditransitive verb, even before the verb is processed.

(2) a. Bob-ga Mary-ni ringo-o

\textit{Bob-nom Mary-dat apple-acc}

b. Bob-ga Mary-ni ringo-o ageta.

\textit{Bob-nom Mary-dat apple-acc gave}

‘Bob gave Mary the apple.’

c. Bob-ga Mary-ni ringo-o tabeta inu-o ageta.

\textit{Bob-nom Mary-dat apple-acc ate dog-acc gave}

‘Bob gave Mary the dog which ate the apple.’

There is an alternative explanation for their surprise effect, however. Head-driven delay models can also explain it by pointing to the fact that, in sentences like (2c), the verb does not use up all of available arguments. When the verb is processed, it still cannot be
attached into a single tree for the entire sentence, and it needs to have a null operator to build the relative clause. This might by itself induce an extra cost of processing.

Bader and Lasser (1994) also provide experimental evidence for the scarcity of garden paths in a German verb-final structure. Compare (3a) and (3b).

(3)  a. … daß sie NOM [CP nach dem Ergebnis zu fragen] tatsächlich erlaubt hat
… that she for the results to ask indeed permitted has
‘that she indeed has given permission to ask for the result.’
b. … daß [CP sie ACC nach dem Ergebnis zu fragen] tatsächlich erlaubt worden ist
… that her for the results to ask indeed permitted been is
‘that permission indeed has been given to ask her for the result.’

(3a) and (3b) are identical and ambiguous until the auxiliaries are encountered at the end of the sentence, since the pronoun, sie is ambiguous between nominative and accusative. If the parser holds decisions until the verb is processed, it analyzes the pronoun sie when the first verb, zu fragen ‘to ask’ is seen. At this point the parser can satisfy grammatical principles by attaching sie as the object of the verb, zu fragen. This predicts that a slowdown effect would be observed at the main verb in (3a), as opposed to that in (3b). However, Bader and Lasser found that the preferred interpretation is for sie to be the subject of the verb erlaubt, ‘permit’ in (3a), as evidenced by x (faster/slower) reading
times in x condition. They reason that this result is expected if the parser is building
structure incrementally. In particular, they claim that the pronoun *sie* will most naturally
be interpreted as the subject of some unseen verb, under an incremental parsing strategy.
Therefore, the pronoun is not available for use as the object of the first verb. Their results
are certainly significant evidence for the idea that the parser builds structure
incrementally. However, notice that the results are based on the reading time patterns on
the final verb. This way of showing processing cost allows alternative interpretations on
the slowdown. For instance, regardless of the parsing decision to attach *sie* as the object
of the verb, *zu fragen*, (3a) might be a preferred reading simply because the final verb in
(3a) is active, not passive as in that of (3b). Alternatively, there might be a general
preference to use *sie* as a subject.14

Several studies have also found evidence for the difficulty of non-canonical word
orders, suggesting that a movement operation at the syntactic level causes an extra

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14 In this regard, Kamide and Mitchell (1999) and Koh (1997) might pose the same problem as Bader and
models by showing reading time patterns of the sentence-final verb in a sentence involving a relative clause,
such as (i).

(i) Kyooju-ga gakusei-ni tosyoukansisyo-ga kasita mezurasii komonjo-o yabutta / miseta.
    *professor-nom student-dat librarian-nom lent unusual ancient manuscript-acc tore/ showed*
    ‘The professor tore the unusual ancient manuscript that the librarian lent to the student.’
    ‘The professor showed to the student the unusual ancient manuscript that the librarian lent to
    someone (pro).’

Kamide and Mitchell show that in Japanese ambiguous configurations like (i) the dative NP is
preferentially interpreted as an argument of the main clause verb. This indicates that when the parser builds
a matrix VP structure, the dative NP (*gakusei-ni* ‘student-dat’) is associated with the incoming matrix verb
(*miseta* ‘showed’), suggesting that structure-building and the parsing decisions are incremental. However,
just as Bader and Lasser’s experiment, their experiment might have an alternative account because the
results are based on reading time patterns on the final verb of the sentence. Regardless of the pre-head
decisions, for instance, it might be dis-preferred for the dative NP in (i) to be interpreted as a scrambled
argument in the relative clause (i.e. embedded clause).
processing cost for the comprehender. Crucially, those studies focus on the structural relations among phrases prior to a verb. Using an eye-tracking technique, Mazuka, Itoh, and Kondo (2002) detected longer reading times at the subject NP in the scrambled sentence (4a), when compared to the accusative NP in the canonical sentence (4b). They concluded that scrambled sentences involve some extra processing load.\(^{15}\)

\[(4)\]

\begin{align*}
a. & \text{ Otooto-o Mariko-ga tooto-o yonda.} \\
& \text{ \textit{brother-acc Mariko-nom called}} \\
& \text{b. Mariko-ga otooto-o yonda.} \\
& \text{\textit{Mariko-nom otooto-acc called}} \\
& \text{‘Mariko called her brother.’}
\end{align*}

As Miyamoto and Takahashi (2002a) point out, the findings of Mazuka et al (2002) may have another possible explanation. Since nominative case-marked NPs can be used as clause boundary markers in Japanese (Inoue, 1991; Miyamoto, 1999), the slowdown for sentences like (4a), observed by Mazuka et al (2002), may be related to the positing of a

\[^{15}\text{ Mazuka et al (2002) also found a slowdown at the subject NP in scrambled conditions in a self-paced reading task when the scrambled clause was further embedded. Their participants read the second argument NP in (ia) significantly more slowly than that in (ib).}\]

\[(i)\]

\begin{align*}
a. & \text{ Mariko-o [soto-de buranko-ni notte-ita]otooto-ga yonda.} \\
& \text{\textit{Mariko-acc outside swinging-on swing brother-nom called}} \\
& \text{‘The young brother, who was swinging on a swing outside called Mariko.’} \\
& \text{b. Mariko-ga [soto-de buranko-ni notte-ita]otooto-o yonda.} \\
& \text{\textit{Mariko-nom outside swinging-on swing brother-acc called}} \\
& \text{‘Mariko called the young brother who was swinging on a swing outside.’}
\end{align*}
new clause which is incorrect for (4a), and not necessarily to extra costs attributed to the scrambling of the accusative NP itself.

Miyamoto and Takahashi (2002a) avoided this possible confounding source, and examined VP-internal scrambling in a ditransitive structure.

(5) a. Ofisu-de syokuin-ga kakarityoo-ni otya-o dasita josei-o
    office-at employee-nom manager-dat tea-acc served woman-acc
teineini hometa-to Aiharasan-ga hanasiteita.
politely praised-Comp Aihara-nom said

b. Ofisu-de syokuin-ga otya-o kakarityoo-ni dasita josei-o
    office-at employee-nom tea-acc manager-dat served woman-acc
teineini hometa-to Aiharasan-ga hanasiteita.
politely praised-Comp Aihara-nom said

‘At the office, Aihara said that the employee politely praised the woman who had served tea to the manager.

They found that the dative-marked NP in scrambled condition (5b) had significantly longer reading times than the accusative-marked NP in canonical condition (5a), and used this result to support their claim that scrambling requires some extra processing effort. However, as Miyamoto and Takahashi (2002a) admit, both their results and those from Mazuka et al (2002) can still be explained by alternative factors. First, since NPs with different case markers were compared, it can be argued that reading time differences at
those points result from intrinsic properties of the different case markers being processed. An accusative-marked NP might require longer reading times than a dative-marked NP, and similarly a nominative marked NP might require longer reading times than an accusative-marked NP. Secondly, because the canonical and scrambled word orders are being directly compared, it is possible that the relative frequency of canonical word order over scrambled word order could have affected reading times. A third potential factor influencing the results might be a preference for direct objects to be placed adjacent to their subcategorizing verbs. If this preference affected readers’ comprehension, a slowdown would be observed immediately after a scrambled accusative NP because the following phrase would not be the expected transitive verb. Although their finding that the slowdown occurs at the NPs preceding the verb seems to be evidence for incremental

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16 In other experiments, Miyamoto and Takahashi (2002a, d) have tried to eliminate the extraneous factors discussed in order to provide a more detailed explanation for the results of their original experiment. They placed a long adjunct phrase (XP) before two object NPs (ia, b) or intervened XP between them (ic, d).

(i) a. Subject XP NP-dat NP-acc ditran-verb.
   b. Subject XP NP-acc NP-dat tNP-acc ditran-verb.
   c. Subject NP-dat XP NP-acc ditran-verb.
   d. Subject NP-acc XP NP-dat tNP-acc ditran-verb.

They found a significant interaction between position of the adjunct and word order, suggesting the presence of processing difficulty over and above a simple adjunct-intervention effect. They interpreted this result as evidence that the distance between trace and antecedent is at least partly responsible for the slowdown, and that the memory load and positing of a gap over a longer distance may not be overridden by other factors.

Other studies of theirs (2002c, d) used a probe recognition task and measured the reaction time to recognize a probe word after the last region of the sentence was read. At the probe, the participants had read a whole sentence including verbs. Therefore, results from this type of task cannot give evidence for computation among NPs in advance of a verb.
parsing, it is still possible that their experimental designs induced the confounding factors discussed above.17


(6) es ist egal ‘it does not matter’

  a. wer vermutlich glücklicherweise den Mann erkannte

     whoNOM presumably fortunately theACC man recognized

     ‘who recognized the man presumably and fortunately.’

  b. wen vermutlich glücklicherweise der Mann erkannte

     whoACC presumably fortunately theNOM man recognized

     ‘who the man recognized presumably and fortunately.’

Comparing indirect German wh-questions with either a subject (6a) or an object (6b) moved to clause-initial position, they observed that increased reading times for (6b) were obtained between the wh-filler and the second NP. They suggest that additional processing time is necessary for a wh-phrase to be kept in memory. However, as discussed in Japanese scrambling studies, one might argue that their findings just reflect

17 Kamide, Altmann, and Haywood (2000, 2003) also found in eye-tracking experiments that Japanese readers were more strongly guided to the direct object argument (e.g. spaghetti-acc) when they encountered an instrumental postpositional phrase (e.g. fork-with) prior to the object NP and a verb, relative to encountering a goal postpositional phrase (e.g. fork-next-to), which could be seen as favoring the pre-head-driven parsing account. However, their finding could also be attributed to intrinsic properties of phrases (instrumental phrases versus locative phrases). The former phrases might induce theme phrase expectations more easily than the latter.
difficulty of the non-canonical word order. It might be a case in which the slowdown occurred in (6b) because of the linearly non-canonical word order of Acc-Nom, not because of the gap-creation at the argument position. In other words, this result does not guarantee the existence of structural relations among phrases prior to a verb.

3.2.3 Present Experiment

I essentially agree with the conclusion drawn from these previous studies that the parser does not seem to wait for the verbal head to decide the interpretation of pre-verbal phrases; incremental attachment models seem best able to capture the processing of head-final sentences. My purpose here is to provide a stronger argument for the incremental full-attachment models. The logic of the argument is this: I will demonstrate the formation of relations such as co-reference among noun phrases in advance of the verb. The formation of these relations does not apply indiscriminately, but only occurs where structural configurations permit. If my claim about such relations is correct, it would be a strong argument for the existence of structural configurations in advance of the verb. Similar arguments are sketched by Bader (1994) and Schneider (1999), who did not, however, provide experimental evidence for them.

Experiment 4 will investigate the circumstances under which a pronoun in a Japanese wh-phrase such as (to) which of his friends may take a subsequent NP in the same clause as its antecedent. Because of the possibility of scrambling, a pronoun inside a sentence-initial NP may take a following nominative NP as its antecedent (7a). In
contrast, a pronoun inside a sentence-initial nominative NP does not take a following dative NP as its antecedent, presumably due to the failure of c-command relation between the pronoun and a potential antecedent NP (7b).

(7) a. Kare\textsubscript{1}-no tomodati-ni sono otoko\textsubscript{1}-ga hotyoo-de osoikakata.

\textit{he-gen friend-dat the man-nom knife-with attacked}

‘His friend, the man attacked with a knife.’

b. ?*Kare\textsubscript{1}-no tomodati-ga sono otoko\textsubscript{1}-ni hotyoo-de osoikakata.

\textit{he-gen friend-nom the man-dat knife-with attacked}

‘His friend attacked the man with a knife.’

An acceptability rating test in Experiment 4 will confirm that when the pronoun is contained within a scrambled dative NP it may take an antecedent in a following clause-mate nominative NP, but that co-reference is less acceptable in an unscrambled word order, when the pronoun is contained within a sentence-initial nominative NP and the antecedent is inside a following dative NP. I assume that this contrast reflects the fact that when the scrambled dative \textit{wh}-phrase in (8a) is associated with a gap in its canonical (unscrambled) position, the antecedent c-commands the pronoun, whereas the pronoun is never c-commanded by its antecedent in the unscrambled word order in (8b). If readers incrementally build structure and actively seek for an antecedent for the pronoun in grammatically licensed positions, then they should be surprised to encounter a gender-mismatched NP only in potential antecedent positions. The prediction from the
self-paced reading study is as follows. In scrambled word-order sentences like (8a) Japanese readers do not expect to see a gender-mismatching NP *oba-ga* ‘aunt-nom’ instead of a gender-matching NP *oji-ga* ‘uncle-nom’ in (8a), and therefore should slow down upon encountering a nominative NP that could not serve as an antecedent to the pronoun due to a gender-mismatch. On the other hand, no such slowdown should be observed when readers encounter a gender-mismatched dative NP (*oba-ni* ‘aunt-dat’ replaced by *oji-ni* ‘uncle-dat’ in (8b)) in non-scrambled word-order sentences, since the dative NP is not a potential antecedent for the pronoun. This pattern will suggest that readers immediately recognize that the pronoun inside the dative wh-phrase in (8a) may take the nominative NP as its antecedent. Thus, the reading pattern for the second NP will be an important way of showing the computation of structural relations among NPs prior to a verb.

(8) a. Kare-no dono-kodomo-ni tyoosyoku-go oji-ga
   *he-gen which-children-dat breakfast-after uncle-nom*
   obento-o watasita-ka titioya-wa oboeteita.
   *lunchbox-acc handed-Q father-top remembered*
   ‘The father remembered to which of his children the uncle handed a lunch box after breakfast.’

b. Kare-no dono-kodomo-ga tyoosyoku-go oji-ni
   *he-gen which-children-nom breakfast-after uncle-dat*
   obento-o watasita-ka titioya-wa oboeteita.
‘The father remembered which of his children handed a lunch box to the uncle after breakfast.’

Note also that the structures in (8) do not bring with them the same problems that Mazuka et al (2002) and Miyamoto and Takahashi (2002a) faced. Since NPs with different case markers were compared in their experiments, it could be argued that reading time differences at those points resulted from intrinsic properties of the different case markers being processed. The present experiment, on the other hand, does not pose this problem, since it compares reading times of the same case-marked NPs: nominatives in scrambled conditions, and datives in unscrambled conditions. Since the same word orders in each condition can be compared, the frequency factor of word orders would also be irrelevant. Finally, it is not necessary to consider the possibility of a preference for direct objects to be placed adjacent to their subcategorizing verbs, because the reading time patterns of primary interest in the present experiment are not at the accusative case-marked NP.

3.2.4 Binding Constraints

The design of Experiment 4 involves binding constraints in reference resolution. If the gender mismatch occurs in (8a), but it does not occur in (8b), it indicates that Japanese readers try to interpret the pronoun as an anaphoric expression which needs to
be bound by an antecedent (necessarily) c-commanding it.\textsuperscript{18} This suggests that co-referential interpretation between a pronoun and its potential antecedent takes place as soon as a gap is created in the c-commanded position. If the results come out as predicted, they will support the model that says binding constraints are applied at the earliest possible stage in processing (Nicol & Swinney 1989; Garrod, Freudenthal, & Boyle, 1994; Clifton, Kennison, & Albrecht, 1997), (which contrasts with the hypothesis that the initial analysis can violate binding theory, cf. Badecker & Straub 1994, 2002; Straub & Badecker, 1994; Runner, Sussman, & Tanenhaus, 2002).

Note that Experiment 4 is not designed to argue for or against a third alternative account that the binding constraints are applied at the earliest stages of processing, but that they may later be violated (Garrod, 1994; Garrod & Sanford, 1994; Garrod & Terras, 2000; Sanford, Garrod, Lucas, & Henderson, 1983; Sturt, 2003). As Sturt (2003) points out, the self-paced reading technique does not have the finer-grained temporal measures provided by the eye-tracking technique (such as second reading pass times and fixation times), so that we do not know whether our results are derived from early or late processing. For the purpose of this discussion, if the gender mismatch effect is observed at the second nominative NP in (8a), it shows at most an attempt to compute co-reference.

\textsuperscript{18} I follow the most common definitions of Binding principle and c-command relation as follows (Chomsky, 1981).

(i) $\alpha$ binds $\beta$ iff
   (a) $\alpha$ c-commands $\beta$;
   (b) $\alpha$ and $\beta$ are co-indexed.

(ii) $\alpha$ c-commands $\beta$ iff
    (a) $\alpha$ does not dominate $\beta$;
    (b) $\beta$ does not dominate $\alpha$;
    (c) the first branching node dominating $\alpha$ also dominates $\beta$. 
It is the selective computation of co-reference that demonstrates the operation of binding constraints. In other words, the current experiment is silent about the third alternative view of processing binding constraints.

Before leaving this section, there is a note on a language-particular property of Japanese overt personal pronouns, *kare/kanojo* ‘he/she’. Since the usage of *kare/kanojo* as personal pronouns has become common in only the last one hundred years, these overt pronouns are often preferred by speakers to be replaced by another bound pronoun, *zibun* ‘self’ or a phonetically null element, i.e., small *pro*, as in (9).

(9) \[\text{Tannin}-\text{-wa kare,}-\text{no / zibun,}-\text{no/ pro, seito-o hometa.}\]

\[\text{Class teacher-top he-gen/ self-gen student-acc praised}\]

‘The class teacher praised (his) student.’

Regardless of the infrequency of *kare/kanojo*,\(^{19}\) it is certain that Japanese readers can comprehend *kare/kanojo* as personal pronouns. More importantly, they can establish an anaphoric relation between these overt pronouns and their c-commanding antecedents. I will therefore assume that all Japanese readers have this grammatical knowledge. In Section 3.3.3, I will also discuss the results in light of this property of overt personal pronouns.

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\(^{19}\) For instance, Hashimoto, Inui, Shirai, Tokunaga, & Tanaka (2001)’s corpus study shows that 1.8% (20/1132) of anaphoric expressions in a Japanese text (news articles) is *kare/kanojo*. Phonetically null pronouns are most frequently found (41.3%), and repetition of a same noun phrase is next most frequent (18.1%).
3.3 Experiment 4

The aim of this experiment is to show that the parser computes structural relations among NPs before a verb is processed. In particular, it focuses on two aspects; whether Japanese phrase structures are built accurately and incrementally, and whether a fronted *wh*-phrase is reconstructed at its canonical position in a simple clause. A pronoun inside a sentence-initial dative NP may take a following nominative NP as its antecedent (8a), since the dative NP can on-line be interpreted as a scrambled NP. Meanwhile, a pronoun inside a sentence-initial nominative NP cannot take a following dative NP as its antecedent, (8b). The gender mismatch effect is used as a diagnostic of the on-line application of structural constraints on binding and movement available before any verb information. If readers build structure incrementally, and actively search for an antecedent for the pronoun in grammatically licensed positions, then they should be surprised to encounter a gender-mismatched NP only in potential antecedent positions.

An additional purpose for this experiment is to investigate whether a *wh*-gap is created in the first clause readers see. Recall that results from Experiment 1 and 2 suggest that a *wh*-gap continues to be posited until it is interpreted. This implies that a gap is eventually posited in the second (embedded) clause, but also that it is posited in the first (matrix) clause. Experiment 4 may provide a piece of experimental evidence supporting this implication if the Gender mismatch effect is indeed observed in a potential antecedent position. This finding will also be important in discussion of the parser’s reanalysis of gap-creation; Chapter 4 will take up this issue.
3.3.1 Method

3.3.1.1 Participants

Forty-four native speakers of Japanese participated in the experiment. All of them were students at the University of Maryland, USA, or at Shizuoka University or Shizuoka Sangyo University, Japan. They were paid $10.00 or its yen equivalent for their participation in the experiment, which lasted about 50 minutes.

3.3.1.2 Materials and Design

This experiment consisted of two tasks. A self-paced reading task was followed by an off-line anaphoric relation judgment task. Recall that this experiment assumes that the c-command position is a grammatically licensed position for co-reference. Therefore, the second task is needed in order to find out whether the grammatical fact we assume to be underlying the mismatch effects is correct.

In the self-paced reading task, twenty-four sets of four conditions each were used in the experiment, in a 2 x 2 factorial design, which manipulated the gender of the pronoun in the wh-phrase (match vs. mismatch) and the word order of the wh-phrase (scrambled vs. unscrambled). The twenty-four sets of items were distributed among four lists in a Latin Square design. Each participant saw exactly one of the lists intermixed
with fifty-six unrelated items in a random order. One full set of experimental conditions is shown in (10). A full set of materials for this experiment can be found in Appendix D.

The differences among conditions involved the word order of the *wh*-phrase which contains a pronoun and the gender type of the potential antecedent of the pronoun. In the scrambled conditions the sentence-initial *wh*-phrase is marked with the dative case morpheme, and it is marked with the nominative case morpheme in the unscrambled conditions. In two conditions, the gender of the second noun phrase (nominative-marked NP in the scrambled conditions and dative-marked NP in the unscrambled conditions) was manipulated either as matched or mismatched with that of the pronoun inside the *wh*-phrase. The target items were also counter-balanced with respect to gender (male vs female). Among twenty-four critical items, the *wh*-phrases in twelve items contain a male pronoun (*kare*), and those in the other twelve items a female pronoun (*kanojo*).

In all four conditions the first clause of the sentence turns out to be a fronted embedded clause. The critical material was always contained in an embedded clause, in order to guarantee that there would always be a potential antecedent for the pronoun in the higher clause, even if no antecedent was available in the same clause as the pronoun. Fronting of embedded clauses is common in Japanese, possibly because it minimizes center embedding and hence reduces complexity. Importantly for my purposes, however, readers have no indication that the opening regions of the sentence form part of an embedded clause at the point when they read these regions.

(10) a. *Scrambled, Mismatch*
‘At the kitchen, the father remembered to which of his children the aunt handed a lunch box in a hurry after breakfast.’

b.  *Scrambled, Match*

‘At the kitchen, the aunt remembered to which of his children the uncle handed a lunch box in a hurry after breakfast.’

c.  *Unscrambled, Mismatch*

‘At the kitchen, the father remembered which of his children handed a lunch box to the aunt in a hurry after breakfast.’

d.  *Unscrambled, Match*

‘At the kitchen, the father remembered which of his children handed a lunch box to the aunt in a hurry after breakfast.’
In the off-line anaphoric relation judgment task, thirty-two sets of four conditions each were used in the experiment, in a 2 x 2 factorial design, which manipulated the noun phrase type (non-wh-phrase vs. wh-phrase) and the word order of the noun phrase (scrambled vs. unscrambled). The thirty-two sets of items were distributed among four lists in a Latin Square design. Each participant saw exactly one of the lists intermixed with thirty-two unrelated items in a random order. Among thirty-two target items, sixteen were materials from the self-paced reading test, and the other sixteen were different from those in the on-line test. One set of experimental conditions is shown in (11). A full set of materials for this experiment can be found in Appendix E. As in the on-line items, all the items were counter-balanced with respect to gender (male vs female). Among sixty-four items including filler items, thirty-two items contain a male pronoun (kare), and the other thirty-two items a female pronoun (kanojo).

(11)  

a.  Non-wh-phrase, Unscrambled

Kare-no gakusei-ga syokudoo-de sensei-ni atta.

He-gen student-nom cafeteria-at teacher-dat met
‘His student met the teacher at the cafeteria.’

b. Non-wh-phrase, Scrambled

Kare-no gakusei-ni syokudoo-de sensei-ga atta.

He-gen student-dat cafeteria-at teacher-nom met

‘His student, the teacher met at the cafeteria.’

c. Wh-phrase, Unscrambled

Kare-no dono-gakusei-ga syokudoo-de sensei-ni atta-no?

He-gen which- student-nom cafeteria-at teacher-dat met-Q

‘Which of his students met the teacher at the cafeteria?’

d. Wh-phrase, Scrambled

Kare-no dono-gakusei-ni syokudoo-de sensei-ga atta-no?

He-gen which- student-dat cafeteria-at teacher-nom met-Q

‘Which of his students, did the teacher meet at the cafeteria?’

3.3.1.3 Procedure

In order to address the possibility that some participants were not familiar with the complex wh-NP, *kare-no dono-kodomo* ‘which of his children’, I added an off-line practice session for the subject-verb matching comprehension task, by using this type of complex NPs, prior to the self-paced reading task. Among the twenty practice sentences, there were ten sentences which included the noun phrase in question. Four of these noun phrases had an animate NP as the head noun. Since the aim of the practice session was
simply to ensure that participants were familiar with the specific noun phrase structure, there were no instances of the sentence structure used in the on-line materials. The self-paced reading procedure and the comprehension task were identical in format to that used in Experiment 1 and 2.

An off-line grammaticality judgment immediately followed the presentation of each item in the self-paced reading task. Participants were asked to judge whether the underlined pronoun and the underlined noun phrase in each item were co-referential and to rate its co-reference with a scale from 1 to 5 (Scale 1 means that co-reference is impossible, while Scale 5 means that it is perfectly grammatical).

3.3.1.4 Data Analysis

Analyses were conducted on comprehension task response accuracy and reading times, by subjects and by items. All data from participants whose comprehension task accuracy was below 80% for target sentences and below 85% in total were discarded. Four participants failed to meet this criterion (9.1%). Reading times longer than 2300ms were discarded. This procedure affected 3.2% of trials. The means and analyses presented below are based on the remaining trials. As for the analyses for the off-line judgment task, the participants excluded in the on-line analyses (n=4) were also excluded from the off-line analyses. Also probably want to say that accuracy for all items fell above your cutoff value.
3.3.2 Results

This section reports the results of the off-line anaphoric relation judgment test (in Section 3.2.2.1) and those of the on-line self-paced reading test (in Sections 3.2.2.2 and 3.2.2.3). In the off-line test, the averages of ratings of anaphoric relation judgment in all the conditions were entered into a repeated-measures ANOVA, with noun phrase (non-\(wh\)-phrase, \(wh\)-phrase) and word order (scrambled, unscrambled) as within-subjects factors. In the on-line test, comprehension accuracy and reading times at each region were entered into a repeated-measures ANOVA, with word order (scrambled, unscrambled) and gender-matching type (gender-match, gender-mismatch) as within-subjects factors.

3.3.2.1 Anaphoric Relation Judgment

Table 2 shows the average of ratings of anaphoric relation judgment in all the conditions. There was a significant main effect of word order type, such that ratings were higher for scrambled conditions than for unscrambled conditions (\(F_1(1,39) = 13.91, \text{MSE} = 1.38614, p < .001; F_2(1,23) = 5.92, \text{MSE} = 2.79947, p < .05\)). There was no significant main effect of noun phrase types (\(F_1(1,39) = 1.5, \text{MSE} = 1.67134, p = .23; F_2(1,23) = 2.23, \text{MSE} = 1.51353, p = .15\)). There was no significant interaction of word order type and \(wh\)-phrase type (\(F_S < 1\)). Pairwise comparisons within each level of the word order manipulation yielded the following results. In the \(wh\)-phrase conditions, the scrambled
condition was rated significantly higher than the unscrambled condition, both in the subjects and items analysis ($F_1(1,39) = 10.98, MSE = 1.04867, p < .005; F_2(1,23) = 4.56, MSE = 2.50215, p < .05$). In the non-wh-phrase conditions, the scrambled condition was rated marginally higher than the unscrambled condition, both in the subjects and items analysis ($F_1(1,39) = 3.67, MSE = 2.15939, p = .06; F_2(1,23) = 2.89, MSE = 20.2069, p = .09$). In the scrambled conditions, there were no significant differences in pairwise comparisons within each level of the wh-phrase type manipulation ($F_S < 1$).

<table>
<thead>
<tr>
<th>Condition</th>
<th>Average</th>
<th>StdDev</th>
<th>StdErr</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non-wh-phrase, Unscrambled</td>
<td>2.92</td>
<td>1.41</td>
<td>0.16</td>
</tr>
<tr>
<td>Non-wh-phrase, Scrambled</td>
<td>3.23</td>
<td>1.34</td>
<td>0.15</td>
</tr>
<tr>
<td>Wh-phrase, Unscrambled</td>
<td>3.05</td>
<td>1.34</td>
<td>0.15</td>
</tr>
<tr>
<td>Wh-phrase, Scrambled</td>
<td>3.53</td>
<td>1.29</td>
<td>0.14</td>
</tr>
</tbody>
</table>

Table 2: Experiment 4, Rating of the off-line anaphoric relation judgment test.

Recall that half of items were cited from the same NPs used in the on-line test and the other half were original. There was no difference in the material type ($F_S < 1$). In addition, there was no interaction among word order type, noun phrase type and material type ($F_S < 1$).

### 3.3.2.2 Comprehension Task Accuracy

Among the forty participants included in the analysis, average comprehension accuracy was 95.7%. The average correct response percentage did not differ significantly
across the four conditions (all $F$s < 1). In addition, there was no significant difference in the comprehension task accuracy between the subjects who live in Shizuoka, Japan (95.0%) and those who live in Maryland, USA (96.3%).

3.3.2.3 Self-Paced Reading

The reading time analysis yielded the following results. Reading times for in-situ conditions are shown in Figure 7, and those for scrambled conditions are shown in Figure 8. At all regions preceding the embedded verb (Region 5), there were no significant differences between reading times in the match and mismatch conditions within each level of the word order factor (all $F$s < 1).

At the second NP (Region 5), which included the critical antecedent which is either matched or mismatched with the pronoun in Region 2, there was a significant main effect of gender match, shown by reading times that were slower for gender-mismatch NPs than for gender-match NPs ($F_1(1,39) = 5.32, MSE = 109279, p < .05; F_2(1,23) = 4.7, MSE = 164470, p < .05$). There was also a significant main effect of word order ($F_1(1,39) = 13.48, MSE = 160597, p < .001; F_2(1,23) = 32.42, MSE = 56059.4, p < .001$), such that, overall the scrambled sentences were read more slowly than the unscrambled sentences. There was an interaction of gender type and word order, but it was only marginally significant ($F_1(1,39) = 3.89, MSE = 85768.4, p = .06; F_2(1,23) = 4.4, MSE = 97631.1, p = .05$). However, pairwise comparisons within each level of the gender-matching manipulation yielded the following results. In the scrambled conditions, the gender-
mismatch condition was read significantly more slowly (102.3msec) than the gender-
mismatch condition, both in subjects and items analysis ($F_1(1,39) = 8.65, MSE = 98366.7, p < .01; F_2(1,23) = 7.43, MSE = 153593, p < .01$). In the unscrambled conditions, there was no significant difference between gender-match and gender-mismatch condition ($F_S < 1$). This indicates that the two main effects were due to a contrast present only in the scrambled conditions.

From Region 6 to Region 8, there were no significant differences between reading times in the match and mismatch conditions across each level of the word order factor (all $F_S < 1$). However, at Region 9 (the matrix subject NP), a main effect in the word order type was observed. This effect was significant in the subject analysis, but not in the item analysis ($F_1(1,39) = 4.26, MSE = 70222.2, p = .05; F_2(1,23) = 1.94, MSE = 155706, p = .18$). There was no significant main effect of gender match ($F_S < 1$). There was an interaction of gender match and word order seen in the subject analysis and not in the item analysis ($F_1(1,39) = 6.94, MSE = 63578.6, p < .05; F_2(1,23) = 3.3, MSE = 120026, p = .08$). Pairwise comparisons within each level of the word order manipulation yielded the following results. In the unscrambled conditions, there was a significant difference between the gender-match and gender-mismatch conditions, both in the subjects and the items analysis ($F_1(1,39) = 4.61, MSE = 100673, p < .05; F_2(1,23) = 6.74, MSE = 68299.6, p < .05$). In the scrambled conditions, there was no significant difference between the gender-match and gender-mismatch conditions ($F_S < 1$).

A similar trend was revealed at the last region, Region 10 (the matrix verb), although a main effect was not observed for either word order ($F_1(1,39) = 1.56, MSE = \ldots$)
60237.2, $p = .21$; $F_2(1,23) = 1.94$, $MSE = 43749.1$, $p = .18$) or gender match ($F_1(1,39) = 1.2$, $MSE = 45774$, $p = .28$; $F_2 < 1$). There was an interaction of gender match and word order, significant in both the subject analysis and the item analysis ($F_1(1,39) = 4.56$, $MSE = 56240.4$, $p < .05$; $F_2(1,23) = 4.37$, $MSE = 55900.2$, $p < .05$). Pairwise comparisons within each level of the word order manipulation (scrambled, unscrambled) yielded the following results. In the unscrambled conditions, there was a significant difference between gender-match and gender-mismatch conditions, both in the subjects and in the items analysis ($F_1(1,39) = 4.96$, $MSE = 55136.6$, $p < .05$; $F_2(1,23) = 4.26$, $MSE = 61015.7$, $p = .05$). In the scrambled conditions, there was no significant difference between gender-match and gender-mismatch conditions ($F_8 < 1$).

![Graph showing reading times per region for the scrambled conditions.](image)

Figure 7: Experiment 4, Reading times per region for the scrambled conditions. (Adverb$_1$ His/Her$_2$ Wh-NP-dat$_3$ Adverb$_4$ NP-nom$_5$ Adverb$_6$ NP-acc$_7$ Verb-Q$_8$ NP-top$_9$ Verb$_{10}$)
One might consider it a possibility that the average reading time of the second NPs (Region 5) is affected by differing word lengths for the matched and mismatched NPs. However, the average number of Japanese characters for the gender-matched noun phrases was 4.27, while that for the gender-mismatch noun phrases was 4.29. Thus, the length of the words used in gender-mismatched NP was only 0.5% longer than that of the words in gender-matched. Given that this difference in word length is not considerable, and that the reading time difference is on the order of 13%, there is no reason to be concerned with any affect on reading time due to phrase lengths of the second NPs.

3.3.3 Discussion
A main finding in the off-line judgment rating task was that Japanese speakers seem to prefer backward anaphoric interpretation on a sentence-initial pronoun when its potential antecedent c-commands it at the argument position. The on-line self-paced reading test found that Japanese readers were surprised to encounter a gender-mismatched NP in the position potentially licensed as the antecedent when the wh-phrase containing a pronoun was fronted, while they were not surprised to encounter a gender-mismatched NP in the same position when the wh-phrase was in a canonical position, i.e. it was not scrambled. Taking the off-line results as evidence of an underlying grammatical fact of Japanese, the on-line results suggest that Japanese readers build structure incrementally and actively seek for an antecedent for the pronoun in a grammatically licensed position; Region 5 was such a position in the scrambled condition but not in the unscrambled condition. Crucially, in the scrambled condition, this anaphoric relation was interpreted prior to a verb which does not appear until Region 8.

As predicted for the off-line anaphoric relation judgment test, there were significant differences in judgment between scrambled and unscrambled conditions. When the pronoun is contained within a scrambled dative NP (i.e. in the scrambled condition), it may take an antecedent in a following clause-mate nominative NP. Meanwhile, that co-reference should be less acceptable in an unscrambled word order, when the pronoun is contained within a sentence-initial nominative NP and the antecedent is inside a following dative NP. This contrast in structure was paralleled by a contrast in grammaticality ratings that was observed both in non-wh-phrase and wh-phrase conditions.
Note, however, that the difference between the ratings for the two word orders was rather small (Mean of ratings for ‘Unscrambled conditions’ was 2.98, versus ‘Scrambled conditions’ which was 3.38). This could reflect the fact that the pronouns used in this experiment cannot be construed as a bound variable (Saito & Hoji, 1983; Hoji, 1991; Noguchi, 1997; among others). English personal pronouns can be bound pronouns, such as (12a) reading in (12), whereas Japanese *kare/kanojo* ‘he/she’ does not seem available for the bound reading (13).²⁰

(12) Who loves his brother?
   a. ‘Who is the person such that x loves x’s brother.’
   b. ‘Who is the person such that x loves his brother.’

(13) Daremo-i-ga [NP [S kare *i/j -ga tukutta] omotya]-o kowasita.

   Everyone-nom he-nom made toy-acc broke

   ‘Everyone, broke the toy that he*i/j had made.’

Hoji (1991) proposes a reason for the unavailability of bound reading of *kare/kanojo*, saying that it is not a pronoun but one of the deictics, equivalent to *are* ‘that (thing)’ meaning the object far from both the speaker and the hearer.²¹ Given this and the fact that many of the experimental materials used potential antecedent NPs that were available for

²⁰ (13) is cited from Hoji (1991) with the judgment reported there. For some native speakers of Japanese, a bound reading is still available, although it is not preferred.

²¹ Thanks go to Ayumi Ueyama, Hajime Hoji, and Teruhiko Fukaya, who provide opportunities of discussing this problem.
generic reading such as ‘college students’ and ‘old women’, the participants may have preferred not to take the pronouns as a bound variable regardless of the word order difference. However, compare (14a) and (14b). When the potential antecedent NP is not available for quantificational readings, the availability of co-reference interpretation is affected by word order of the potential antecedent and the pronoun, presumably due to the need for c-command relation.

(14) a. Kare\(i\)-no gakusei-ni Tanaka sensei\(i\)-ga gakkai-de atta.
   \(he\-gen\) student-dat \(Professor\ Tanaka\)-nom \(the\ conference\)-at \(met\)
   ‘His student, Professor Tanaka met at the conference.’

b. Kare\(i/j\)-no gakusei-ga Tanaka sensei\(i\)-ni gakkai-de atta.
   \(he\-gen\) student-nom \(Professor\ Tanaka\)-dat \(the\ conference\)-at \(met\)
   ‘His student met Professor Tanaka at the conference.’

Hence, I interpret the small, but statistically significant difference in ratings of anaphoric relation judgment as resulting from the fact that the readers respect c-command relation between a pronoun and its potential antecedent NP even if it involves co-reference interpretation, rather than variable-binding of the pronoun.

Note also that the overall answers of the off-line anaphoric relation judgment test were rated relatively low (Mean = 3.23). There are two possible reasons for this low rating result. One is that the participants had a difficulty with the unfamiliar task to rate the grammaticality of co-reference between a pronoun and an NP. The target items in the
experiment were all backward anaphoric relations, but the filler items also contained a forward anaphoric relation. Participants (n=40) rated forward anaphoric relations very high (mean=4.14, n=385 in total. Among them, the mean was 4.92 (n=90), for unambiguous forward anaphors, and 3.9 (n=295) for ambiguous forward anaphors; an equivalent of English example, *John was watching TV with Bill in his room.*). Therefore, the low rating for the backward anaphoric relations may have been due to the fact that participants found interpretation of forward anaphoric relations very easy, leading them to rate the backward anaphoric relations, which presumably require more work, as lower. The second possible reason is that the pronouns, *kare* ‘he’ and *kanojo* ‘she’ are not frequently used as pronouns co-referring to an antecedent in the sentence. Since the target sentences start with these pronouns, a discourse-referent reading of the sentence-initial pronouns might be facilitated. Participants could at that point have created a discourse referent for the pronoun to refer to, rather than associating the pronoun with an antecedent later in the sentence. By contrast, in examples with forward anaphora, they would prefer to associate the pronoun with a potential antecedent they have already seen.

Let us turn to the discussion regarding the self-paced reading task. The results showed that in scrambled conditions Japanese readers slowed down upon encountering a nominative NP (Region 5) that could not serve as an antecedent to the pronoun due to a gender-mismatch. No such slowdown was observed when readers encountered a gender-mismatched dative NP (Region 5) in unscrambled conditions. I assume that the contrast observed in the off-line judgment test reflects the readers’ grammatical knowledge that when the scrambled dative *wh*-phrase is reconstructed in its argument
position, a potential antecedent inside the nominative subject NP c-commands the
pronoun inside the reconstructed dative NP. Therefore, the on-line results suggest that
readers immediately recognized that the pronoun inside the dative \textit{wh}-phrase may take
the nominative NP as its antecedent. In unscrambled word order, on the other hand, since
the pronoun inside the nominative \textit{wh}-phrase subject could never be c-commanded by a
potential antecedent in the same clause, gender-matching in the dative NP was irrelevant
for interpretation of the pronoun. This, in turn, indicates that readers immediately
construct a gap for a fronted dative \textit{wh}-phrase in the clause where the \textit{wh}-phrase appears overtly.

These findings indicate that Japanese readers actively search for the antecedent of
a pronoun in a grammatically sanctioned position. Their interpretation of the co-reference
between a pronoun and its antecedent takes place even before any verb information is
available. This suggests that structure-building for pre-verbal phrases is fully incremental,
and favors the incremental attachment models over head-driven delay models, which
Section 3.4.1 will discuss more detail. This brings us to a discussion of another pair of
competing theories between indirect gap-based models and direct association models. I
will present arguments concerning this issue in Section 3.4.2.

There is another implication of the reading times at this critical region. In the
configuration used in this experiment, gap-creation occurs in the first clause, since
coreference is licensed by positing a \textit{wh}-gap at the argument position of the dative
phrase. By contrast, the results of Experiment 1 and 2 showed that in the sentences there,
the gap is posited in the embedded clause. Taken together, the experimental results
suggest that Japanese readers make successive attempts at positing a gap, first in the main clause and then in an embedded clause. In other words, reanalysis must take place in such configurations. I will take up this issue in Chapter 4.

Slower reading times were also observed in unscrambled conditions at regions 9 and 10. Since the first sentential complement in the material’s structure is fronted from its canonical position which was before the matrix verb, the clause should be interpreted as a complement argument of the matrix verb, as illustrated in (15).

(15)  [ \text{CP} \ldots \text{pronoun} \ldots ] \text{NP}_{\text{<Male/Female>-top}} \text{tCP} \text{Verb}

Given this structure, the fronted clause which includes the pronoun is reconstructed at the canonical position, just as the $wh$-dative phrase locally does. Then, in the reconstructed structure, the topic marked NP can be interpreted as an antecedent of the pronoun due to a c-command relation. Note that the slowdown at the topic-marked NP (Region 9) was observed only in the unscrambled conditions, in which the matrix subject always matches the gender with the pronoun (e.g. (10c) and (10d)). I interpret the slowdown observed only in the gender-match case of the unscrambled conditions as a result of the difficulty the readers confronted with respect to interpretation of the same gender NPs in the matrix clause and the reconstruction configuration (the matrix subject NP and the embedded dative NP). In (10d), for instance, they are ‘father-top’ and ‘uncle-dat’, as opposed to the combination of ‘father-top’ and ‘aunt-dat’ in (10c). In addition, this difficulty yielded a gender-match cost rather than a gender-mismatch cost. Recall that the gender of the
topic-marked subject NP in the unscrambled conditions is always matched with that of the pronoun. After the reconstruction of the first clause as in (15), only the case of gender-match conditions (10d) has a structure in which the three NPs (topic-marked subject NP, pronoun, and its potential antecedent NP) share the same gender. This possibility does not occur in the other case of gender-mismatch conditions (10c), in which the gender is mismatched between a pronoun and its potential antecedent NP, after the first clause is interpreted in the canonical position.

Slower reading times were also observed at the last region, Region 10, in the gender-match structure of the unscrambled condition. It is likely that this reflects the continued cost of the disruption caused at Region 9.

3.4 General Discussion

3.4.1 Incremental Full-attachment Models

Experiment 4 used a structure in which a relation among phrases can be formed only when structural configurations permit co-referential interpretation, i.e. c-command relation of a pronoun and a potential antecedent. The results show that in the scrambled conditions, the antecedent for the pronoun inside the dative \textit{wh}-phrase is actively searched, and the nominative NP is immediately recognized as its antecedent which c-commands the trace of the \textit{wh}-phrase. This allows Japanese readers to obtain an anaphoric interpretation of the pronoun when the subject is a correct antecedent. By
contrast, when the dative NP follows the nominative NP, i.e. the unscrambled conditions, the antecedent for a pronoun inside the nominative \textit{wh}-phrase is not expected to be in the same clause as the pronoun, due to the lack of c-command relation. Crucially, these processes take place among the first two NPs, in advance of the verb. This implies that a structural configuration of the verb’s arguments exists in advance of the verb.

The same logic holds for the results in Experiment 2 (Section 2.5). In that experiment, a Filled Gap effect was observed at the embedded dative NP in the target structure where a fronted dative \textit{wh}-phrase was interpreted in the same clause as the dative referential NP, as opposed to the control structure where the embedded dative NP is the first dative NP in the embedded clause. This effect was observed before a verb is encountered. Notice that the control structure of this experiment used the syntactic constraint that a nominative \textit{wh}-subject cannot be scrambled in Japanese (Haig, 1980; Kuroda, 1983; Saito, 1985). When Japanese readers see a nominative \textit{wh}-subject, they know that it may not be a displaced element. This implies that the formation of the relation among the phrases only takes place where structural configurations permit an operation of scrambling. The finding of Filled Gap effect prior to the verb, therefore, is another indication that structural configurations exist in advance of the verb.

Taken together, the results from Experiment 2 and 4 provide a new, stronger argument for incremental full-attachment models over head-driven and delay models. Both results demonstrated the formation of pre-verbal relations that \textit{only} occurs where structural configurations permit co-referential interpretation and scrambling operation, implying the existence of structural configurations in advance of the verb. Since
incremental full-attachment models build a structure incrementally, they can properly predict pre-verbal formation of structural relation among phrases, evidenced by the pre-verbal Filled Gap effect and Gender Mismatch effect found here. On the other hand, head-driven and delay models have difficulty explaining these pre-verbal slowdown effects. Since these models build a structure only when a licensing verb is encountered, they don’t predict that any pre-verbal phrase will be structurally associated with another phrase prior to encountering the head.

The rest of this section will examine Japanese (non-)garden path effects with respect to the head-driven and delay models which are developed by Pritchett (1991b, 1992) and recently modified by Mulders (2002). They cite as evidence for their models the fact that they can capture Japanese (non-)garden path effects. However, I will point out that the incremental full-attachment models under the grammatical principle-based approach (cf. Chapter 2) also can account for the garden path sentences.

Pritchett (1992: 153) contrasts the following examples. (16a) induces a severe garden path effect, while (16b) is perfectly acceptable.

(16) a. \( \text{GP Frank-ni Tom-ga Guy-o syookaisuru-to John-wa iwaseta.} \)

\( \text{Frank-dat Tom-nom Guy-acc introduce-Comp John-top said-cause} \)

‘John made Frank say Tom introduced Guy.’

b. Frank-ni Tom-ga Guy-o korosu-daroo-to John-wa iwaseta.

\( \text{Frank-dat Tom-nom Guy-acc kill-will-Comp John-top said-cause} \)

‘John made Frank say Tom would kill Guy.’
Under the head-driven and delay models, when the parser encounters the first verb, *syookaisuru* ‘introduce’, all the pre-verbal arguments are licensed. The fronted dative NP, *Frank-ni*, in (16a) is structurally associated with the verbal phrase in the sentential complement. The continuation shown in (16a), however, ends with a causative verb that requires three arguments, including the dative-marked causee. The argument requirements of the verb thus force the fronted dative NP to be reanalyzed as an argument of the matrix clause, removing it from the domain of its original licensor (the embedded verb). This reanalysis violates one of Pritchett’s principles, the On-line Locality Constraint (OLLCC), and thus correctly predicts a severe garden path effect for the sentence in (16a). On the other hand, no garden path effect for the sentence in (16b) can be attributed to the fact that *korosu*, ‘kill’ does not take a dative NP as an argument. The fronted dative NP is consequently licensed as the cause when the matrix causative verb is encountered.

The incremental full-attachment models also predict the difference between (16a) and (16b) with respect to garden-path effects. Since the first phrase is fronted, the parser posits a gap for the scrambled phrase presumably after the nominative subject NP, *Tom-ga*. When the first verb is encountered, the gap is licensed as a goal phrase in (16a), but not in (16b), due to different argument structures of the embedded verbs. When the parser

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22 On-line Locality Constraint (OLLCC) is a constraint on reanalysis, which is defined as follows (Pritchett, 1992: 101).

(i) 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.
encounters the matrix subject, John-wa, in the case of (16a), the parser posits a gap for the fronted sentential complement. Following this, the parser encounters the matrix causative verb, for which the parser licenses two thematic roles to two arguments. However, one argument is missing in the structure, yielding a conscious garden path effect. Meanwhile, in the case of (16b), the parser assumes two gaps for the fronted dative NP and the fronted sentential complement. The parser is successful in assigning two thematic roles of the causative verb to the two gaps. This indicates no processing difficulty interpreting (16b). Thus, Japanese (non-) garden path sentences can be predicted given the incremental full-attachment models.

Mulders (2002) argues that it is necessary to revise the OLLC, so that Mazuka and Itoh (1995)’s counter-example to Pritchett’s system can be also explained. Mazuka and Itoh (1995) present the following contrast.

(17) a. Yoko-ga kodomo-o koosaten-de mikaketa onnnanoko-ni koe-o kaketa.

  Yoko-nom child-Acc intersection-at saw girl-dat voice-acc called

  ‘Yoko called the girl who saw the child at the intersection.’

b. GPYoko-ga kodomo-o koosaten-de mikaketa takusii-ni noseta.

  Yoko-nom child-acc intersection-at saw taxi-dat put-on

  ‘Yoko put the child in the taxi she saw at the intersection.’

Before the noun head of the relative clause is encountered, both sentences are initially analyzed as single clauses. However, when the noun heads of the relative clauses are
encountered, the nominative subject *Yoko-ga* has to be reanalyzed as a phrase in the matrix clause for the sentence in (17a). In (17b), on the other hand, both the nominative subject *Yoko-ga* and the accusative NP, *kodomo-o* have to be reanalyzed. Pritchett (1992) assumes that reanalysis is always unproblematic when it is forced by a non-theta assigner. Given this, in (17a), reanalysis is forced by a non-theta-assigner, *onnanoko-ni*, and no garden path effect is observed. Reanalysis should be applicable to the case of (17b) because it is also forced by a non-theta-assigner, *takusii-ni*. However, (17b) induces a garden path effect. Mulders illustrates more examples with respect to this contrast, and generalizes that the reanalysis is forced in cases where only one argument needs to be reanalyzed when the next phrase is a non-theta-assigner. In (17b), as originally Mazuka and Itoh pointed out, both initial subject and object NPs need to be reanalyzed.²³

The contrast between (17a) and (17b) has also been accounted for without assuming that a theta assigner disallows the parser to reanalyze the current attachment. Weinberg (1993) and Gorrell (1995), for instance, argue that VP lowering is permitted by independently motivated grammatical principles. Hence, the first VP structure both in (17a) and (17b), \[VP \text{child-acc intersection-at saw}\] can be lowered when the parser encounters the noun head of the relative clause. This is how a garden path effect occurs in (17b), in which the accusative NP should be associated in the matrix clause. It does not

²³ Furthermore, Mulders attempts to explain why reanalysis is restricted to only one argument by introducing the notion of the edge of a CP phase. Her hypothesis is as follows.

(i) The human sentence processor is able to reanalyze material from the edge of a phase.
seem necessary to assume Mulders’ generalization that only one argument can be reanalyzed when the next phrase is a non-thematic assigner. 24

Pritchett (1991b, 1992) and Mulders (2002) claim that head-driven delay models account for the (non-)garden path effects seen in Japanese head-final sentences. However, those processing breakdowns can also be predicted under the incremental full-attachment models. Together with the first half of the discussion in this section, which showed that the experimental results strongly support incremental full-attachment models, it is concluded that a sentence structure is built full incrementally and the parser analyzes a structural relation among phrases even when a critical lexical head is delayed. In Chapter 4 I will develop a parsing model based on these conclusions, and in doing so, I will demonstrate more precisely the degree of incrementality used by the parser to build a sentence structure.

3.4.2 Indirect Gap-based Accounts

The pre-verbal gap-creation found in Experiment 2 and 4 also supports ‘indirect gap-based’ accounts for filler-gap dependencies (Stowe, 1986; Frazier & Clifton, 1989; Nicol & Swinney, 1989; de Vincenzi, 1991; Nicol, 1993; Gibson & Hickok, 1993; Nakano et al., 2002), rather than direct association accounts (Pickering & Barry, 1991; 24 See Chapter 4 Section 4.4.2 for demonstration of other reanalysis cases under a parsing model different from the models which assume VP-lowering. See also footnote 47 in Chapter 4 in which I point out that this particular case of reanalysis (17) seems to be captured either by a VP-lowering mechanism or Schneider’s algorithm (Schneider, 1999).

See also Hirose (1999), on thematic and prosodic explanations of the contrast such as (17a) versus (17b).
Indirect gap-based accounts explain filler-gap dependencies under the assumption that the wh-filler is directly associated with the gap, and that the verbal head assigns grammatical requirements through the gap indirectly to the filler. This account corresponds to syntactic proposals which assume a trace / copy of a displaced element (Projection Principle under the Transformational Grammar proposed by Chomsky, 1981, 1986a, and Copy Theory under the Minimalist Program advocated by Chomsky, 1995a). On the other hand, direct association accounts entail a commitment to a mechanism based directly upon the formation of relationships between displaced argument NPs and verbs, without assuming a gap for the filler. Direct association accounts are consistent with syntactic proposals that do not assume traces (Head-driven Phrase Structure Grammar, cf. Pollard & Sag, 1994; Categorial Grammar, cf. Steedman, 2000; and Dependency Grammar such as Functional Grammar, cf. Dik, 1978).

To distinguish these competing theories, behavioral evidence from sentence processing has often been employed in the literature. For instance, Pickering and Barry (1991) correctly point out that processing experiments in English often use structures in which the dependency can be formed at the verb, not at the trace position. For instance, consider the following.

(18) *To which child* did the teacher give [a long speech about the importance of honesty] ___?
The fronted *wh*-phrase in (18) can be reactivated at the verb position, not at its trace position following a complex direct object NP, indicating that the *wh*-filler does not have to be associated to the gap position, but that the verb directly provides the relevant information to interpret the *wh*-phrase. Note, however, that Transformational Grammar also predicts the reactivation of the *wh*-phrase in (18) at the verb. Under the assumptions that the verb has its subcategorization frame such as *give* [NP, PP], and that the parser builds the VP structure in advance of the current processing point in the input word string, Projection Principle or Copy Theory would say that the parser posits a trace of the dative *wh*-phrase when it encounters the verb. Then, the *wh*-filler is indirectly associated with the gap (trace or copy). Thus, Pickering and Barry’s observation is compatible with both theories.\(^{25, 26}\)

The pre-verbal effects observed in Experiment 2 and 4 help to decide among these competing views of whether a gap is posited in interpretation of filler-gap dependencies. Experiment 2 showed that a gap is expected at the embedded argument position in the relevant structure of long-distance *wh*-scrambling, and Experiment 4 demonstrated that a gap is posited at the local argument position where the co-reference constraint is applied. The gap-creation in both cases crucially takes place in advance of the first verb.\(^{27}\)

\(^{25}\) See Pickering (1993), Gibson and Hickok (1993) and Gorrell (1993) for more discussions of these competing theories.

\(^{26}\) In Chapter 4 Section 4, I will derive (18) under the parsing model proposed therein.

\(^{27}\) Clahsen and Featherston (1999) used cross-modal lexical priming tasks with German sentences as in (i), to show psychological reality of the gap, contrary to the claim of the direct association model. They found the significant antecedent priming effect in the positions where a movement analysis of the short scrambling constructions would postulate an empty category, indicating that the antecedent is indeed reactivated at the gap position.
indirect gap-based models can properly capture the pre-verbal effects. Due to the parser’s on-line satisfaction of thematic requirements, the parser explores all possible positions of interpretation, and posits a gap in a clause where the first verb will be encountered. This means that the parser directly associates the filler with its gap, and afterwards it can satisfy grammatical requirements when it encounters a verbal head. Thus, a gap can clearly be posited in advance of the verb.

On the other hand, under a strong version of direct association models (Pickering & Barry, 1991; Pickering, 1993, 1994) a relationship is formed directly between a displaced argument NP and a licensing verb, the first opportunity in Japanese to establish a direct dependency between a fronted phrase and the verb is when the first verb is encountered. This predicts that no slowdown effect (with respect to a fronted phrase) should be detected until the verb is processed. However, this prediction is inconsistent with the pre-verbal effects observed in Experiment 2 and 4. The pre-verbal effects indicate that a fronted phrase is associated with the gap before the verb is processed. Thus, without additional mechanisms, the direct association model has a difficult time accounting for the pre-verbal effects.

(i) Nach zwei Tagen Streit sprach der Richter das Geschäft
      after two days dispute awarded the judge the business
      dem ziemlich überraschten Andreas # zu …
      the dat rather surprised Andreas to …
      ‘After two days of dispute the judge awarded the business to the rather surprised Andreas.’

In their target structure as in (i), the verbal head sprach is immediately followed by the subject NP der Richter due to scrambling both of the sentence-final verb sprach and the indirect object NP dem ziemlich überraschten Andreas. They found the priming effects at the trace position of the direct argument. They claim that the direct association models fail to predict their finding of antecedent priming effects at the argument position since the fronted verb (i.e. subcategorizer) is already associated to the arguments.
Sag and Fodor (1994)’s direct association model uses a different mechanism, couched within the framework of Head-driven Phrase Structure Grammar (Pollard & Sag, 1987, 1994). Following Pollard and Sag (1994), Sag and Fodor (1994: 376) assume a Complement Extraction Lexical Rule,\(^{28}\) which ‘removes an element from a word’s COMPS list, placing that complement instead onto the value (a list) of the feature SLASH. Intuitively, SLASH encodes information about the element(s) that are missing from a phrase (i.e. about the ‘gaps’ that the ‘slashed’ phrase contains).’ Verbs applied by Complement Extraction Lexical Rule may form a filler-gap dependency under the assumption that non-empty SLASH specifications percolate up the tree until an appropriate binding environment is found. In this way, the filler is linked to the relevant position of the argument structure of the verb.

Let us attempt to demonstrate how this system might predict the pre-verbal effects in processing of a verb-final structure. Consider the trees in (19).\(^{29}\) The system assumes that the VP, not the verbal head, collects the SLASH values of the left side of the tree, as in (19a). This assumption guarantees that before the verbal head is encountered, the filler at the top of the dependency is linked to the relevant position of the argument structure of the verb. However, note that this tree shows the filler as being associated to the matrix verb. Compare (19a) with (19b), in which the embedded subject is encountered. If the

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\(^{28}\) This rule is illustrated as follows (Sag & Fodor, 1994: 376).

\(^{29}\) The tree is simplified so that it illustrates only the specifications relevant for the discussion here.
SLASH values are discharged at the matrix VP, there is no chance to establish the filler-gap dependency in the embedded clause; the SLASH list is shown as empty in the embedded clause in (19b). This tree structure is inconsistent with the results from Experiment 1 and 2. In particular, in Experiment 2, the Filled Gap effect was observed in the embedded clause in advance of the verb.

(19)  

To explain these experimental findings, the system might assume multiple phrase structures in which one embedded VP has no SLASH category and the other one has it. In other words, some measure of parallel parsing would be necessary in order to account for the results of both Experiment 2 and 4, with a preference for the analysis whose
SLASH features are first found to be compatible with a lexical verb in the input. Thus, a parsing model based on Sag and Fodor (1994)’s syntactic model needs additional mechanisms and assumptions to account for the pre-verbal effects in head-final structures.

We can conclude from this discussion that the gap-less approach of direct association models at least requires further assumptions and axioms in order to explain the pre-verbal effects obtained in the current studies.30 On the other hand, the pre-verbal effects are consistent with the idea that the parsing mechanism postulates the gap to directly form the filler-gap dependency even before a verb is processed. The parser then just confirms the gap when the verbal head licenses it.

3.5 Summary

30 Another way in which gap-less accounts of direct association models could explain the pre-verbal effects might be to add an assumption that the Japanese parser obeys a requirement of the ‘Case Array’ system, like frequency of canonical word order. A requirement of the ‘Case Array’ system means that the parser has to ensure the canonical sequence of argument NPs’ cases in Japanese: Nominative-Dative-Accusative. Suppose that the parser sees a dative-marked NP first, as in (ia).

(i)

a. NP-dat
b. NP-dat NP-nom
c. NP-dat {CASE_ARRAY NOM DAT ACC}

Under this assumption, the parser should search the canonically-arrayed position, following a nominative case. Then, encountering a nominative-marked NP (ib), the parser can associate the fronted dative NP to the post-nominative position (ic). However, this assumption does not seem to predict the pre-verbal long-distance dependency found in Experiment 2. The ‘Case Array’ system is not likely to require an arrayed NP which has been locally associated to the fronted dative NP to be ‘re-arrayed’ when another nominative-marked NP is encountered in an embedded clause, as illustrated in (ii). Under the ‘Case Array’ story, gap-less accounts still need additional assumptions to capture a long-distance dependency at the pre-verbal position.

(ii) NP-dat {CASE ARRAY NOM DAT} ... {CASE ARRAY NOM DAT ACC}
The experimental evidence supports the claim that a sentence is processed using accurate, incremental structure-building. The experimental results showed the on-line application of structural constraints on anaphoric interpretation of pronouns before verb information is available. This suggests that a structural relation among NPs is formed even before a licensing verb is processed, but only in syntactically-licensed cases.

Along with the results from Experiment 2, these findings favor incremental full-attachment models over head-driven delay models. Although this has been suggested in the previous studies on processing of head-final structures, the present findings provide a stronger argument for the incremental full-attachment models because the pre-verbal slowdown effects were detected by specifically employing a structure in which the formation of pre-verbal structural relations does not apply indiscriminately. The current findings also support gap-based accounts for filler-gap dependencies, as opposed to direct association models. Finally, I pointed out that gap-less accounts of the direct association models need further mechanisms to capture the pre-verbal effects seen in the results. The next chapter will implement a particular type of parsing model, and demonstrate how filler-gap dependencies are formed incrementally.
CHAPTER 4

HOW TO PARSE *WH*-DEPENDENCIES

4.1 Introduction

The aim of this chapter is to implement a parsing model with which I will demonstrate how Japanese *wh*-scrambled interrogatives are parsed. The parsing model developed here involves an explicit left-corner parsing algorithm which is able to capture three properties of sentence processing and sentence structures observed in earlier chapters; full-incrementality of structure-building, head-final phrase structures, and non-canonical word order. By full-incrementality, I mean that all previous words must be incorporated into a single syntactic structure before a new word can be integrated into the parse. All psycholinguistic models of parsing are incremental to one degree or another. However, it is important to present the extent of incrementality when the parser builds a sentence structure out of every single incoming word. This is necessary because the experimental results have given us evidence that the parser incrementally builds structures among phrases before it encounters verbal heads. Second, since the human capacity for sentence-processing is most likely invariant across languages, it is a worthwhile to explore whether it is possible to come up with cross-linguistically
generalizable parsing model. A particular concern here is whether the model can account for processing head-final languages like Japanese. Third, since *wh*-dependencies are a main theme of this thesis, a natural requirement for the parsing model we choose is the ability to deal with non-canonical word order like *wh*-scrambling structures. Thus, I demonstrate how the parsing model handles processing of sentences involving non-canonical word order in head-final structures, without leaving any words unconnected to the existing structure. even when lexical heads are delayed in processing.

Before developing a parsing model, Section 4.2 argues that a reanalysis process is implied by the experimental results (Experiment 1, 2, and 4). These results imply that Japanese readers make successive attempts at positing a gap, first in the main clause and then in an embedded clause. I call this type of reanalysis ‘unforced reanalysis’; a revision that is not licensed by any incompatibility of the initial analysis of the parse with subsequent material. I will address the question of why unforced reanalysis is permitted in the relevant *wh*-scrambling structures. The process seems to contradict a view of reanalysis as a last resort (Fodor & Frazier, 1980; Frazier, 1990; Frazier & Clifton, 1998; Kamide & Mitchell, 1999; Sturt, Pickering, Scheepers, & Crocker, 2001; Schneider & Phillips, 2001). I will compare this view with the theory of unforced reanalysis we have developed for the *wh*-scrambling cases.

Section 4.3 overviews Schneider’s (1999) parsing model, SPARSE, which the model developed here is based on. I adopt SPARSE since it explicitly demonstrates incremental structure-building in both head-initial and head-final sentences. It will be
pointed out, however, that SPARSE needs to add some assumptions and a few relevant steps of the algorithm to deal with non-canonical word order structures.

Section 4.4 illustrates how Japanese \textit{wh}-scrambling structures are parsed under a slightly adjusted SPARSE. The revised model can straightforwardly capture how Japanese \textit{wh}-scrambling constructions are processed incrementally, explain why a gap needs to be posited as soon as possible, and demonstrate how successive attempts to do gap-creation are achieved. I also show how the model deals with the cases where reanalysis is avoided.

The chapter ends with a quick review of previous work fundamental to both the original SPARSE and the current model.

4.2 Unforced Reanalysis

First, I will briefly summarize the implications of the experimental findings with respect to reanalysis in sentence processing. Consider the tree in (1), which illustrates gap-creation patterns based on the current experimental results. The evidence that the parser first constructs a main clause gap site in (1) comes from the results of Experiment 4. This experiment suggests that readers immediately construct a gap for a fronted dative \textit{wh}-phrase in the clause where the \textit{wh}-phrase appears overtly, so that they actively attempt to find a potential antecedent for an anaphor at the grammatically sanctioned position. On the other hand, Experiment 1 and 2 found evidence for an embedded clause interpretation of fronted \textit{wh}-phrases at a later point. In Experiment 1, a Typing Mismatch
effect was observed at the embedded verb when the verb had a declarative complementizer, and not when the verb had a question marker. In Experiment 2, a Filled Gap effect was observed at the second dative-marked NP in the embedded clause, suggesting that the gap for a dative \textit{wh}-phrase is posited in the embedded clause prior to the embedded verb. Therefore, the combination of the evidence from Experiment 4 for construction of local gaps with the evidence from Experiments 1 and 2 above for a non-local (embedded clause) gap suggests that readers make successive attempts to posit a gap for a fronted \textit{wh}-phrase even though they are not forced to do so. By parity of reasoning, Filled Gap Effect observed in Experiment 2 also independently implies that a similar local commitment was made in the main clause before the verb in that clause or any embedded clause material was encountered. If the parser incrementally builds a VP structure after the main clause subject NP, a gap is created for the dative \textit{wh}-phrase in the VP structure. However, the results of Experiments 1 and 2 also show that the parser’s ultimate analysis involves an embedded clause gap. This means that the first gap in (1) must be canceled if it is removed entirely. This indicates that reanalysis takes place in this configuration.
This in turn means that in order to arrive at the ultimate embedded clause gap analysis, Japanese speakers must carry out an *unforced* reanalysis. By unforced reanalysis, I mean a revision that is not licensed by any incompatibility of the initial analysis of the parse with subsequent material. There are grammatical continuations of bi-clausal structures like (1) where the initial *wh*-element remains interpreted in the matrix clause. The reanalysis of the posited gap position is thus unforced, since it would be fully grammatical to maintain the analysis in which the *wh*-phrase is associated with a gap site in the main clause.

In Chapter 2 and 3, I have already discussed at length the force motivating Japanese readers to make successive attempts at positing a gap (first in the main clause and then in the embedded clause). These attempts are undertaken in order to satisfy constraints on thematic and/or scope interpretation as soon as possible. What remains to be explained is both *how* the parser can reanalyze the first commitment of gap-creation,
and why successive attempts at gap sites are even possible. The former question will be answered in Section 4.4, where I implement a model with relevant *wh*-scrambling structures. This section addresses the latter question: why reanalysis is allowed in some cases and avoided in other cases.

The possibility of unforced reanalysis contrasts with the view of reanalysis as a last resort operation (Fodor & Frazier, 1980; Frazier, 1990; Frazier & Clifton, 1998; Kamide & Mitchell, 1999; Sturt, Pickering, Scheepers, & Crocker, 2001; Schneider & Phillips, 2001). Here, I will take up recent studies both in English and Japanese, which provide supporting experimental evidence for this view. Sturt et al. (2001) and Schneider and Phillips (2001) present very similar arguments from English showing that unforced reanalysis is avoided by examining the processing of sentences of like those in (2). In sentence (2a) the parser faces two alternative ways of incorporating the second verb, *likes* into the structure, as illustrated in (2b). One involves a local reanalysis, such that the verb takes the preceding NP, *the woman* as its subject to form an embedded clause (2d). This reanalysis operation is independently known to be easy (Sturt, Pickering, & Crocker, 1999), based on evidence from the processing of structures where the reanalysis is required. The second alternative involves a non-local attachment without reanalysis, such that the second verb becomes the main verb, taking the non-local NP ‘the man’ as its subject (2c). Based on garden path effects observed at the point of disambiguation of local reanalysis examples like (2d), Sturt et al. (2001) and Schneider and Phillips (2001) conclude that non-local analyses that avoid reanalysis are favored over local analyses that require an easy reanalysis. Therefore, they claim that reanalysis is a last resort operation.
The man who knows the woman likes…

(2) a. The man who knows the woman likes…

b. [TP [NP The man [CP who [VP knows [NP the woman]]]] [VP likes the recipe himself…]

c. [TP [NP The man [CP who [VP knows [NP the woman]]]] [VP likes the recipe herself…]

d. [TP [NP The man [CP who [VP knows [CP [NP the woman] [VP likes the recipe herself…

The conclusion that reanalysis is always a last resort option, however, is probably too strong, in light of the evidence from the experimental results presented in Chapter 2 and 3. At least some kinds of unforced reanalysis appear to be possible. The Japanese examples and the English cases in (2) differ in a number of respects. First, in (2) local reanalysis requires giving up an existing commitment that the NP ‘the woman’ is the direct object of the verb knows. This is a structural commitment that already led to the satisfaction of the thematic requirements of the verb and the NP. The change also
requires revising the argument structure of the verb ‘knows’ from an NP-complement analysis to a sentential complement analysis. Neither of these changes is required in the Japanese reanalysis, where a hypothesized gap position is simply moved from one clause to another. Finally, in the English examples the potential reanalysis involves a revision in the analysis of an overt NP *the woman*, whereas in the Japanese examples the reanalysis involves a revision in the position of a phonetically null element. Any of these factors could distinguish those unforced reanalyses that are freely available from those that are available only as a last resort operation.

An alternative possibility would be to simply assume that Japanese and English employ different parsing mechanisms, such that unforced reanalysis is more freely undertaken in Japanese than in English. This would be an elaboration on earlier proposals. Inoue and Fodor (1995) point out that Japanese speakers fare better than English speakers with *forced* reanalyses. Sturt and Crocker (1996) also propose a version of parsing models based on Description Theory (Marcus, Hindle, & Fleck, 1983), and conclude that Japanese and English differ in reanalysis because the representational types the parser minimally changes are different.

However, this alternative seems unlikely in light of strong arguments by Kamide and Mitchell (1999: henceforth, K&M) that reanalysis is a last resort operation in Japanese. Revising Koh (1997)’s experimental study on processing Korean relative clauses, K&M show that in temporarily ambiguous configurations in Japanese like (3), the dative NP is preferentially interpreted as an argument of the main clause verb, (3b).
When the second verb is transitive, readers read the last verb significantly more slowly than they do in the case where the second verb is ditransitive. K&M suggest that this shows an initial attachment of the dative NP as a co-argument of the main clause subject and reluctance to re-associate it with the verb in an embedded clause, resulting in
difficulty when the embedded verb requires a Goal argument. Based on this evidence that reanalysis is avoided, K&M conclude that reanalysis must be a last resort operation in Japanese.

K&M’s examples are more similar than English cases to the present Japanese *wh*-question examples in a number of regards. First, both sets of examples involve dative NPs that at least *could* receive an analysis as a scrambled NP. Second, in both current examples and K&M’s examples, the benefit of reanalyzing the dative NP is earlier confirmation of the thematic role of the NP and, in the case of K&M’s materials, use of the dative NP to satisfy the thematic requirements of the embedded verb. It is therefore interesting that whereas the *wh*-fronting examples show unforced reanalysis in the embedded clause, even before the verb is reached, K&M’s results indicate that reanalysis is avoided, even when the ditransitive embedded verb is reached.

There are a couple of possible reasons why unforced reanalysis may have been possible in *wh*-scrambling cases but not in K&M’s study case. First, it is clear in *wh*-scrambling cases that the dative *wh*-phrase has been scrambled to sentence-initial position. Therefore, the unforced reanalysis that takes place changes one scrambling analysis to another scrambling analysis. In K&M’s materials, on the other hand, the initial analysis of the dative NP is as an in-situ NP in the main clause. The reanalysis that is avoided requires a change from a non-scrambling analysis to a scrambling analysis that requires an additional structural dependency. Therefore, reanalysis may be avoided when it entails the construction of an additional structural dependency, as predicted, for example, by the Minimal Chain Principle (de Vincenzi, 1991). If scrambled NPs are
lexically marked with an additional feature (Miyagawa, 1997, 2001; Sauerland, 1999; Grewendrof & Säbel, 1999; among others), then a revision of this kind would require lexical reanalysis, as in the English examples discussed above. Furthermore, if the analysis of the dative NP in K&M’s study were changed from an in-situ analysis to a scrambling analysis, this would entail reanalysis of the surface position of the dative phrase, from a canonical argument position, to a non-argument position, possibly adjoined to the embedded clause. No such change is required in the present experiments in the analysis of the surface position of the dative $wh$-phrase. Therefore, it is possible that unforced reanalysis is avoided when it entails reanalysis of phonologically overt material. The current results cannot currently choose between any of these interpretations. These possible reasons will also be highlighted in implementing the parsing model on K&M’s structure in Section 4.4.2.

A second possibility is that the critical difference between $wh$-scrambling cases and K&M’s case is that $wh$-scrambling cases examined the processing of $wh$-phrases, whereas K&M focused on referential NPs. I cannot at present exclude the possibility that it is the search for a question marker that was critical in driving the unforced reanalysis in the present studies. This would suggest that early scope assignment plays a special role in processing.31

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31 I have taken Kamide and Mitchell’s study to show that there was no consideration of the embedded clause as a potential site of interpretation. Another possible interpretation is suggested by recent work by Ferreira and her colleagues (Christianson, Hollingworth, Halliwell, & Ferreira, 2001; Ferreira, Christianson, & Hollingworth, 2001). These authors show that in at least some cases interpretive commitments made prior to reanalysis linger after reanalysis, based on English examples like ‘While John was hunting the deer hid in the bushes’, where readers believe that John was hunting deer, although the sentence does not assert this. The reading time difference found by K&M at the main clause verb could be a reflex of this lingering
In sum, the experimental results in this thesis show evidence for unforced reanalysis that contrasts with a number of recent studies that have argued that reanalysis is available only as a last resort operation. Comparison of the structures examined in these different studies leads us towards a finer-grained understanding of when unforced reanalysis is and is not possible, although further studies are required in order to conclusively resolve the issue.

4.3 Incremental Parsing Model for Head-final Structures

Most parsing models build sentence structures incrementally in some way, but they are not likely to be deeply concerned with both incrementality and head-finality. In particular, it is difficult to appropriately handle a significant amount of temporary ambiguity in processing sentences in head-final languages, since heads are not available until the end of the phrase. This temporary ambiguity hinders incremental parsing in many models. In this regard, I have found the model proposed by Schneider (1999), SPARSE, to be one of the most explicit parsing models that take both incrementality and head-finality into consideration. In this section, I will overview the system of this model.

SPARSE builds structures in accord with the principles of the grammar, so that there is no need to submit a structure built by the parser to a separate grammar module to initial analysis. Since K&M’s critical conditions contained verbs that selected a dative argument in both main and embedded clauses, I cannot at present exclude this possibility.

\[32\] See Section 4.5 and Schneider (1999, Chapter 1) for review of previous work in psycholinguistic parsing models.
determine whether or not the sentence obeys the grammar. This aspect of the model is consistent with the claim made in the previous chapters that the parser builds structure to satisfy grammatical requirements.

SPARSE builds ‘Bare Phrase’ structures, similar to the framework proposed by Chomsky (1995b). It assumes that heads are nothing more than a bundle of features. Higher projections of heads do not differ in feature content from the heads themselves. In other words, the projections are completely dependent on the head for all syntactic features. This assumption contrasts with parsing models that are based on phrase structure rules, such as Description Theory. SPARSE prevents the parser from building vacuous projections, since it involves no template to force vacuous projections. Additional levels are only projected in order to achieve additional structural relations.

Features are crucially assumed for integration. Features fall into two types. One is inherent features, which denote properties intrinsic to the heads. The other is licensing features, which are associated with a licensing head. Integration is basically achieved by matching the value of the licensing feature and the value of the licensed head, much the same way as Chomsky (1995a)’s checking relation. If there is null intersection, the parser fails to merge. For instance, consider a case where a verb is merged by a direct object, such as ... know John…. The NP, John can be integrated into the verb, know, because a licensing feature of the verb head, [Case: Acc] can be intersected with an inherent feature of the NP, [Case: Nom; Acc]. Compare this with another case where a word following the verb know is an unambiguously genitive pronoun, such as ... know his .... The pronoun, his cannot be integrated into the verb, know, because intersection is null.
In order to process sentences incrementally, some structure must be predicted. In the previous example, incrementality forces the pronoun *his* to be merged with the verb *know*, but it cannot be merged straightforwardly. Crucial to incremental processing in this model is underspecification of the features of a head. A predicted element occurs in the sentence at some point, but must be posited before the relevant lexical items are processed in the sentence. When a head must be predicted before it is integrated, underspecification allows the parser to posit only the features that can be guaranteed to be part of the eventual head. A predicted head does not need to license all of the features on the word it is attached to. Instead, it needs to license the distinguished feature, the case feature. Case feature is distinguished because this feature must be licensed first, such as the case where a passive subject first needs its case feature [Nom] licensed before other features can be licensed in downstream of parsing. Take again the case of integration, ...

*know his* .... Since this direct integration fails, the parser goes back to the lexicon and searches a head that can license the pronoun. Since the pronoun has an inherent feature [Category: N, Right], a head that can license the pronoun is a predicted head [N]. Now that the predicted head is projected before it is merged, the projected structure of [N [his, N]] can be merged into the verb, since a licensing feature of the verb head, [Case: Acc] can be intersected with an inherent feature of the predicted noun head, [Case: Nom; Acc].

This left-corner predicting system is in particular important in incremental parsing of head-final structures since structure-building and structure-dependent interpretations

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33 [Category N; Right] means that the pronoun can be licensed by a predicted head whose category is noun and occurs on the right side of the pronoun. Schneider adopts this mechanism from Stabler (1994)’s Left Attachment Parsing model.
among phrases may take place in advance of their occurrence in the sentence. For instance, let us sketch how SPARSE analyzes a Japanese simple sentence, *John-ga Mary-ni atta*. ‘John met Mary’. (4a) shows the integration of when *Mary-ni*, ‘Mary-dat’ is encountered after *John-ga*, ‘John-nom’ is encountered. The dative NP cannot be attached directly to the nominative NP. A new head needs to be projected for each NP. The case feature of each NP is used to search in the lexicon for an appropriate head. Tense is a predicted head for the nominative NP *John-ga*, since Tense is assumed to have [Case: Nom] as a licensing head. The T head is projected, and the structure [*John-ga*, [T]] is built. [Case: Dat] is also a predicted head for *Mary-ni*, because of intersection of features of the licensed head. This predicted head is projected, and the structure [*Mary-ni*, [Case: Dat]] is built. The parser attempts to attach the new material, [*Mary-ni*, [Case: Dat]] to the left of the leftmost predicted head in the existing structure, [T]. This integration is achieved because the T predicted head has a feature of selecting a case-assigning head. Accordingly, the case-assigner is attached as the complement for the tense head.
When the verb, *atta* ‘met’ is encountered, as in (4b), morphology provides a V-T complex structure. A predicted head is compatible with a real head if the predicted head can be subsumed by a real head. Once the parser decides that the verb is compatible with a head in the existing tree, the case-assigner [Case: Dat] can be subsumed by *atta*, and the rest of the heads in coming structure are checked to see if they are also compatible with predicted heads in the existing structure. In this case, the features of the two T heads are compatible, so the incoming structure can be incorporated into the existing tree.
A crucial principle of integration under this parsing model is that a new structure must be inserted into the left side of the leftmost predicted head of the existing structure. This guarantees both incrementality and head-finality in parsing head-final structures. Consider the following integration (5). When a lexical head, C is encountered and the parser builds up a predicted head for C, the insertion principle makes the parser to insert the new structure only to the left side of the leftmost predicted head in the existing structure, [Y] in this schema. This integration yields not only a correct order of lexical heads, A, B, and C, but also that of predicted heads, [Z], [Y], and [X], in which the incoming licensing head is expected to license the predicted head, [Z]. Note that this insertion is the only legitimate operation that can produce the exact order of both lexical heads and predicted heads. If the new structure [C, [Z]] is inserted into the right side of the leftmost predicted head [B, [Y]], the output structure produces incorrect sequence of the lexical head; A, C and B. An improper outcome of a sequence of predicted heads; [Y],
[Z], and [X], would also yield if the new structure is merged into the left side of the left side of the predicted head [X]. Moreover, if that new structure is merged into the left side of the [[Y] [X]], the predicted head, [Y] would never be licensed in a later stage of derivation. The correct integration also guarantees that the leftmost predicted head is always licensed first when a licensing head (i.e. a lexical head) is encountered. Furthermore, a structural relation between a lexical head and its licensing head is in configuration proper to provide structure-dependent interpretations.34

(5)

This parsing model should be able to demonstrate how Japanese wh-scrambling constructions are built, since it builds structures in accord with grammatical principles.

34 This way of constructing a structure is similar to several versions of the machinery used in Tree Adjoining Grammar (Frank, 1992, 2002; Sturt & Crocker, 1996).
such as feature-checking requirements, builds structures full incrementally, and seems capable of building head-final structures. The next section attempts to implement this model with Japanese *wh*-scrambling constructions. In doing so, I will point out that the SPARSE system needs to be slightly revised in particular concerning the parse of structures involving non-canonical word order.

4.4 Incremental Parsing Model for Scrambling Structures

In this section, I demonstrate how Japanese *wh*-scrambling sentences are parsed under a slightly modified version of SPARSE. Implementing the parsing model proposed here, the discussion focuses in particular on two points: (i) how the parser builds a structure in which a fronted a *wh*-filler is associated to its gap before it sees any overt element in the verb phrase, such as an accusative NP, and (ii) how the parser can distinguish cases of unforced reanalysis with those of reanalysis as a last reanalysis.

A crucial concept for the parse of an incremental association of a filler and its gap is that the relevant structure involves a non-canonical word order. This is so because the filler is an element displaced in terms of a movement operation, yielding non-canonical word order. Already, in Chapter 2 I discussed at length the idea that satisfaction of grammatical constraints motivates the parser to posit a gap as soon as possible. The

35 For reasons of space, this section cannot include more details of the SPARSE system. Readers must be referred to Schneider (1999) for the entire SPARSE system. See also Figure 9, which shows the entire steps of the parsing algorithm.
current model also explains why a gap is posited as soon as possible. This will be done
without stipulating any additional step of the algorithm for immediate gap-creation.

Furthermore, Section 4.4.2 confirms that the model can capture the cases of
unforced reanalysis which Section 4.2 already discussed, comparing the parse when
reanalysis is possible and that when reanalysis is avoided in Japanese sentence
comprehension.

4.4.1 Parsing Non-canonical Word Order

Successful parsing of Japanese *wh*-scrambling constructions involves three main
properties; (i) building structures incrementally, (ii) handling head-final structures, and
(iii) parsing non-canonical word order. As discussed in the previous section, SPARSE is
successful in dealing with first two properties; incrementality and head-finality. On the
other hand, Schneider (1999) does not clearly show how to parse non-canonical word
order together with incrementality and head-finality. I first point out that his analysis of
English *wh*-movement within SPARSE (Schneider, 1999: Chapter 4) does not
straightforwardly apply to cases where scrambling permutes canonical word order in
Japanese.

Take an example of a simple *wh*-question, *What did Newman deliver?*. When a
sentence-initial *wh*-element is encountered, it is not attached to anything. There is no
need for connection because the parser has not encountered a second word for it to
connect to the *wh*-word yet. When the subsequent word *did* is encountered, the auxiliary
in C head can license the [+wh] feature on the \textit{wh}-element. When this attachment is made, the [+wh] feature on the \textit{wh}-element is checked. However, the rest of the features of the \textit{wh}-element remain unchecked because C head licenses a [+wh] feature but does not license the other features found on the \textit{wh}-element. Schneider assumes that when a \textit{wh}-phrase is encountered, a ‘\textit{wh}-flag’ is set within the parser to indicate that there is an incomplete \textit{wh}-chain in the sentence. Whenever a possible attachment site is encountered during parsing and the \textit{wh}-flag is set, a search is initiated for a c-commanding antecedent that can license the construction of a trace. In this case, as illustrated in (6), when the verb \textit{deliver} is processed, it triggers a search for an accusative argument. In the course of the search it is discovered that \textit{what} has features appropriate for an accusative argument, so a trace is posited as the direct object of the verb.

(6)

\begin{center}
\begin{tikzpicture}
  \tikzset{level 1/.style={sibling distance=60mm, level distance=15mm, level 2/.style={sibling distance=30mm, level distance=10mm}}
  \node (root) {did}
    child {node {what i}
      child {node (did) {did}
        child {node (newman) {Newman
          child {node (t) {T
            child {node (deliver) {deliver
              child {node (i) {i}}}}}}}}}}
    child {node (t) {T
      child {node (t) {T
        child {node (deliver) {deliver}}}}}};
\end{tikzpicture}
\end{center}
Notice that the search is initiated from the verb, and that the trace posited as a result of the search requires an extra projection of the verb. This system reminds us of ‘head-driven’ parsing. Although the parser builds structure incrementally word by word, the search for a *wh*-gap starts when it sees a verb, and the trace is posited to complete a *wh*-chain. This way to capture filler-gap dependencies is compatible with the English *wh*-movement phenomena as illustrated above, but it does not seem to fit with full-incremental structure-building seen in Japanese scrambling cases. Recall in particular that the results from Experiment 2 and 4 suggest that the gap is posited before the first verb is encountered.

A key for pursuing a full-incremental parsing model which can deal with filler-gap dependencies is the fact that filler is an element moved from a thematic position. Furthermore, to encounter a moved element (i.e. filler) is to realize that the canonical word order is permuted. Note, however, that the parser’s decision whether the current word is a moved element should be made only when it sees some subsequent word. This is because a word per se may be ambiguous in case types. For instance, *what* in English can be either a nominative NP or an accusative NP. In addition, concerning pro-drop languages like Japanese, there might appear a phonologically null element before the current word. For instance, even in a case where an accusative NP like *hon-o* ‘a book-acc’ is the first word in a sentence, it is possible that the accusative NP is in canonical word order, such as *pro hon-o yondeiru* ‘Someone is reading a book’. Therefore, the decision must be held off until the parser sees an incoming word which
obtains its own case-feature information. The case relation between the two words may
determine whether the first word is a moved element. If so, it is recognized as a filler.

Let us take an English *wh*-question, *What did Newman deliver?*, as an example
again. When the parser encounters *what* first in the sentence, the parser does not do
anything. When the subsequent word, *did* is encountered, the parsing system allows the
parser to assume accusative case feature in the *wh*-phrase which will be a direct object of
a predicate. Then, the parser recognizes that word order for this sentence is permuted
since English canonical word order is Subject-Verb-Object.

If a parsing model analyzes and interprets a building structure word by word,
incrementally, it must deal with this relation between the case-feature of the current
element and the word order incrementally. However, the original SPARSE system
incorrectly assumes that the licensing of the case-feature of *wh*-phrase (along with the
other inherent features, except the *wh*-feature) is suspended until the parser sees a real
verb head, as illustrated above.

Thus, SPARSE has a system of providing the parser with word order information
because of the assumption that case-feature is a feature to be presented on the licensing
head. However, the original algorithm needs added steps in order to give the parser
information about word order incrementally, without waiting for a subcategorizing
lexical head. In particular, the model needed must incrementally parse sentences in
non-canonical word order so that it can account for filler-gap dependencies which are
formed before a verbal head is processed. The rest of this section will develop SPARSE
in a way which will allow this incremental parse of non-canonical word order. To do so,
let us illustrate step-by-step how the SPARSE parses the following Japanese

*wh*-scrambling sentence. Note that this example involves a structure similar to some of
the materials in Experiment 1. See example (11c) in Chapter 2.

(7) Dare-ni John-ga Mary-ga keeki-o ageta-ka sitteiru.

*Who-dat* John-*nom* Mary-*nom* cake-*acc* gave-*Q* know

‘John knows who Mary gave cake to.’

When a sentence-initial *wh*-element, *dare-ni* ‘who-dat’ is encountered, it is not
attached to anything, since there is no need to connect it to any other elements. The dative
*wh*-phrase independently has mainly three types of inherent features, \([0]\), \([\text{dat}]\), and \([+\text{wh}]\).
The \([+\text{wh}]\) feature on the *wh*-phrase allows it to be licensed by a *wh*-scope marker.

When the nominative subject NP *John-ga* is encountered, it cannot be attached
directly to the *wh*-element, because the *wh*-element does not assign the nominative case
that the subject NP requires, and because the nominative NP must have its licenser on the
right. Since no direct attachment is possible, a new head is predicted and attached to the
incoming word. In the result of the search in the lexicon, a Tense head is posited as the
licenser for the nominative subject NP, *John-ga*, because the T head can assign
nominative case to the NP. This process is illustrated in (8).
As the output representation in (8), this [John-ga, [T]] structure cannot be integrated into the existing structure, which is still a bare *wh*-phrase, *dare-ni*. If integration is not successful, it is possible for the parser to take advantage of the scrambling possibility. Then, categories are marked as potential scramblers which involves establishing a filler-gap relation. Crucially different from Schneider’s assumption, the parser does not wait to establish a filler-gap dependency until a relevant element is encountered. Instead, it builds a predicted structure in order to guarantee that the downstream structure forms a filler-gap dependency. (9) describes a mechanism that creates scrambling structures. (9a) is the step of building a predicted structure for the potential scrambler. Since the parser knows to form a filler-gap dependency with the potential scrambler, (9a) allows the parser to build a predicted structure which corresponds to a *wh*-gap. This predicted head shares all the features which the *wh*-phrase has. The main shared features are [θ], [dat], and [+wh]. (9b) is the step of assigning the syntactic feature to the potential scrambler. Given the widely-asserted view that a scrambled element is an adjunct (Saito, 1985, 1992; Tada, 1993; Murasugi & Saito, 1994;
among others), the potential scrambler has a status of adjunct which contains the licensing features, *[Category, T, Right]. Following SPARSE’s denotation, the licensing features for an adjunct has an asterisk in front of them. The feature means that it is licensed if the licenser whose category is Tense is on the right side of it.

(9)  

a. Build a predicted structure whose head is a possible licenser if the current element is recognized as a potential scrambler.

b. Add a feature on the potential scrambler, *[Category, T, Right].

(10) is a scheme when both of (9a) and (9b) are applied to the wh-phrase, *dare-ni*. Since the wh-phrase is a dative NP, the search of the lexicon ends up finding a case-assigner head. According to the parsing step (9a), the parser builds the predicted structure based on the case-feature of the wh-phrase, and attaches it to the wh-phrase. Note that the lower wh-phrase, [dare-ni] is also a predicted head as well as a predicted case-assigner, [Case: Dat]. According to the other step (9b), the wh-phrase itself is assigned a feature *[Category, T, Right]. Note also that the wh-phrase and the predicted structure are not connected at this point.
Recall that the SPARSE system guarantees both incrementality and head-finality by integration of new material into the left side of the leftmost predicted head. As repeated in (11), new material consisting of a real word and its predicted licenser can be inserted into left side of the leftmost predicted head. In this structure, the structure for the new material is inserted to the left of [Y], which is the leftmost predicted head. This is designed to ensure that predicted heads will be available to be filled when overt material arrives.

(11)

Applied this into the \textit{wh}-scrambling case, as illustrated in (12), the [John-ga, [T]] structure for the new material, \textit{John-ga} can be inserted to the left of a predicted head, [dare-ni], which is the leftmost predicted head. In this case, the [John-ga, [T]] structure is integrated into the predicted structure for the \textit{wh}-phrase. Furthermore, the \textit{wh}-phrase is
adjoined to the T structure and licensed by the T head. Since the wh-phrase is an adjunct, it does not project up to head the new constituent.\textsuperscript{36}

\begin{figure}[h]
\centering
\includegraphics[width=\textwidth]{algorithm.png}
\caption{The revised parsing algorithm.}
\end{figure}

Figure 9 shows the revised parsing algorithm, in which I added (9) into the original algorithm that Schneider (1999; Figure 4, pp. 99) summarizes. The additions are shown in the last list of algorithm, as shown in italics.

\begin{itemize}
\item \textsuperscript{36} Note that the entire output structure is headed by a predicted T head. This structure is consistent with the structure derived under syntactic analyses in that it has been widely assumed that Japanese clause-internal and long-distance scrambling is TP adjunction (Saito, 1985, 1992; Tada, 1993; Murasugi & Saito, 1994; among others). See Chapter 1 Section 1.2 for relevant examples and description of long-distance wh-scrambling. Notice also that the fronted wh-phrase is under T in this configuration. This representation is also consistent in an overt syntactic analysis of Japanese wh-interrogative structure. Unlike English wh-movement, Japanese wh-phrase has been assumed to overtly land at the TP-adjunct position (Nishigauchi, 1986; Saito, 1994; Saito & Murasugi, 1994; Richards, 1997, 2001; among others). A different view of wh-scrambling in Japanese is proposed by Takahashi (1993). He claims that some types of Japanese wh-scrambling are a species of English type of wh-movement. Chapter 5 will take up his observation based on the claim, and provide an intensive discussion of his view.
\end{itemize}
1. Search unchecked features on the right edge of the existing structure for an argument attachment for the incoming material.

   - If a subsumption relation is found between all heads in the incoming item and predicted heads in the existing structure, integrate the entire new item into the existing tree.

   - If subsumption is found between some (but not all) heads in incoming item and heads in the existing tree, remove from the existing tree the portion that is compatible with the heads in the incoming item. Integrate the new item into the just-removed structure. Return to step 1 with the just-integrated new item.

2. Search the right edge of the existing structure for an adjunct attachment of the new material.

3. Build a new licenser for the new material:
   
   3.1. If requirements must be satisfied on the new item before structure can be built above it, build the minimum structure necessary to satisfy the requirements and continue to 3.2.

   3.2. Search the lexicon for all possible licensers of the new material.
   
   A possible licenser is either a head with appropriate left-pointing features or a null head with appropriate right-pointing features.

   3.3. Attach to the new material the intersection of all heads returned by the lexicon search.

      - If the intersection is null and the new material is headed by a predicted licenser, search for an argument attachment using all heads compatible with the head of the new constituent. If successful, make the attachment using the head of the new constituent (not the subsuming head that licensed the attachment).

      - If the intersection is null and the new material is not headed by a predicted licenser, no new licensing heads can be predicted continue on to 4, otherwise return to step 1 with the just-built constituent.

4. Search all feature (checked and unchecked) on the right edge of the existing structure for an argument attachment for the incoming material.

   4.1. If an attachment is found, remove existing element from the tree, attach it to the new material, and start over with newly-expanded constituent at step 1.

5. If the current element is recognized as a potential scrambler, build a predicted structure whose head is a possible licenser, add a head with appropriate right-pointing features on the current element, and return to step 1.

Figure 9: Revised Version of SPARSE Parsing Algorithm
Notice that the output in (12) predicts gap-creation prior to a lexical head, which has been extensively discussed in the previous chapter. In particular, recall that in Experiment 4 the gender mismatch effect at the subject NP was in scrambled conditions, as opposed to non-scrambled conditions. I reasoned that the parser posits a gap for the scrambled phrase right after the nominative subject NP. Re-consider the following pair of examples.

(13)  a. Kare-no dono kodomo-ni hahoya-ga ringo-o ageta-no?

*He-gen which children-dat mother-nom apple-acc gave-Q*

‘Which of his children did the mother give an apple to?’

b. Kare-no dono kodomo-ga hahoya-ni ringo-o ageta-no?

*He-gen which children-nom mother-dat apple-acc gave-Q*

‘Which of his children gave an apple to the mother?’

If the results of Experiment 4 are correct, I predict that the second NP in (13a) is the place where Japanese readers will be surprised at the gender different from that in the fronted dative NP, while the second NP in (13b) exhibits no surprise effect. In Chapter 3, I explained this contrast by assuming that the fronted dative NP containing the pronoun in (13a) is reconstructed to the argument position, but the nominative NP in (13b) is not. The c-command relation between a pronoun and a potential antecedent allows us to interpret the pronoun as an anaphoric expression. Here let us examine whether the
parsing model can predict the c-command relation between an anaphoric expression and the antecedent.

Consider the following diagram, (14) for (13a). The derivation involved here is almost the same as that in (12). When the nominative NP, *hahaoya-ga* ‘mother-nom’ is encountered, the parser marks the already existing element, *kare-no dono kodomo-ni*, ‘which of his children’ as a potential scrambler since a simple integration of the nominative NP failed. Taking the step (9a), the parser builds a predicted structure, [[kare-no dono kodomo-ni] [Case, Dat]]. By the step (9b), the parser also assigns a licensing feature to the dative *wh*-phrase. The *[hahaoya-ga, [T]]* structure for the new material, *hahaoya-ga*, can be inserted into the left of a predicted head, [kare-no dono kodomo-ni]. The dative *wh*-phrase is adjoined to [hahaoya-ga, [T]] to get its feature licensed, yielding the output tree in which the predicted structure, [[kare-no dono kodomo-ni] [Case, Dat]] is a complement of T. Notice in this output configuration that the predicted head, [kare-no dono kodomo-ni] is c-commanded by the nominative subject NP, *hahaoya-ga*. This indicates that the subject NP is a potential antecedent for the pronoun inside of the dative *wh*-phrase. The system allows the parser to seek a potential antecedent in grammatically possible positions (i.e. c-commanding position) for the anaphoric interpretation of pronoun. Since a noun is assumed to have a gender feature such as [masculine] and [feminine] as an inherent feature, after the search of the potential antecedent in c-commanding position for the masculine pronoun, *kare* ‘he’, the parser finds the pronoun’s gender feature mismatched from that of the potential antecedent,
[feminine]. This is how the second NP in (13a) is predicted as the place where Japanese readers will be surprised at the gender different from that in the fronted dative NP.

\[(14)\]

In contrast, the structure for (13b) starts with the nominative NP which contains a pronoun, as shown in (15). After integration of the nominative wh-phrase to the genitive pronoun, kare-no ‘he-gen’, the parser posits a T head in order to check a nominative case. When the dative NP, hahaoya-ni is encountered, a new head needs to be projected. After the lexicon search, the parser posits [Case: Dat] head. The [Dat, Case] structure is attached to the left of the leftmost predicted head of the existing structure, [T]. Notice that this dative NP cannot be an antecedent for the pronoun inside of the subject NP due to lack of the c-command relation. The parser fails to find a potential antecedent in this grammatically sanctioned position for the pronoun. This accounts for why it is predicted that the second NP in (13b) be processed without any difficulty regarding anaphoric interpretation of the pronoun.
Back to the parsing analysis of (7), the next step is interesting in that it implies a process of successive attempt for gap-creation. Consider the schema in (16). When the second nominative NP-nom, Mary-ga is encountered, the new word starts the basic attachment process again. After the lexicon search for the nominative feature, a T head is posited. It still cannot be attached into the existing tree, because there are still no heads that can select a TP. The next step is to build more structure above TP. The only head returned by the lexicon search is either a null C head or a predicted C head. The C head still fails to be attached into the existing tree. Given the principle of insertion rule, the C headed structure has to be merged to the left side of the leftmost predicted head, [dare-ni].

This merge, however, failed because the T head in the matrix structure does not have a feature for selecting C head. The parser searches the lexicon for the head that can

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37 Recall that this predicted head [dare-ni] is postulated due to the step of (9a) for a scrambling structure. More concretely, this predicted head is not waiting subsumption of overt phonological material, but confirmation as a licit gap.
be selected by T head. The only head returned by the next search is a verb that selects for
Complementizer. This head is selected by Tense, so that it is merged to the existing
structure. The new structure is inserted to the left side of the leftmost predicted head,
[dare-ni], the entire predicted structure. As a result, [[dare-ni] [Case: Dat]] is detached
and re-merged into the bottom of the new tree.

Without any additional steps for the parser’s algorithm, this integration accounts
for three important implications drawn from the experimental results of Experiment 1, 2
and 4. First, notice that this integration does not leave the predicted structure [[dare-ni]
[Case: Dat]] behind in the previously merged position. Following the regular insertion
rule for new material, the output structure contains the predicted structure under the embedded clause. Since the predicted head [dare-ni] is on the leftmost predicted head in the existing structure, the insertion rule forces the parser to always merge an incoming material to the left side of it. As a result, the predicted structure [[dare-ni], [Case: Dat]] is under the most deeply embedded clause. This process corresponds to successive gap-creation, which was implied by the experimental results of Experiment 1, 2 and 4, and discussed in Section 4.2. Second, consider again the nature of the insertion rule, illustrated in (11). Merging a new material to the left of the leftmost predicted head predicts that the parser always satisfies the leftmost predicted head first by merging its real head. In the current case, the leftmost predicted head [dare-ni] should be first licensed. Since the predicted head [dare-ni] corresponds to a gap, this system predicts that the gap is always posited as soon as possible without any additional steps specific for this processing property. Third, the achievement of the integration without any additional steps to the parser’s algorithm also indicates that unforced reanalysis is allowed without any incompatibility of the initial analysis of the parse with subsequent material. In the next section, I will compare this with cases of reanalysis as a last resort.

Let us finish the parsing of (7). When NP-acc, keeki-o is encountered, this head by itself cannot be either subsumed by an existing predicted head, or attached into the existing structure, so that a predicted head [Case: Acc, Left] is posited. To integrate this structure into the existing structure, the following assumption is needed.38 If a predicted head shares a feature-property of the predicted head in the existing structure, the

38 I thank Janet Fodor for bringing this observation to my attention.
predicted heads can be combined. In the present case, the predicted head for the new material [Case: Acc, Left] is a case assigner, which is the same type of that of the predicted head [Case: Dat] in the existing structure. Given this new assumption, both heads are combined, yielding the new predicted head represented as [Case: Dat, Acc]. As a consequence, the accusative NP is inserted to the right to the predicted head [dare-ni].

In order to keep the canonical word order of dative (gap)-accusative in a ditransitive predicate structure, this additional assumption is needed for the insertion principle (cf. (11)). Without this assumption, the new structure might have been inserted to the left to the predicted structure for the dative, yielding an incorrect word order. Note, however, that this assumption does not destroy the spirit of the insertion principle which normally aims to avoid any lexical insertion to the right of a predicted head. The parser as a rule inserts new material into the left side of the leftmost predicted head if the parser builds a new licenser for the new material and the predicted head is different from the leftmost predicted head in the existing structure. In this special case, on the other hand, the parser inserts new material to the right of the leftmost predicted head because the leftmost predicted head corresponds to the gap. Notice also that the combination of [Case: Acc] with [Case: Dat] prevents an ill-formed derivation in which each predicted head, [Case: Dat] and [Case: Acc], ends up being confirmed by different heads, such as *John-ga Mary-ni keeki-o tabe atta, ‘(Lit.) *John met and ate Mary a cake.’ In other words, the combination process guarantees that the predicted head [Case: Dat, Acc] is replaced by a ditransitive verbal head which licenses both dative and accusative argument phrases.
When Verb-Q, *ageta-ka* is encountered next, as the original SPARSE assumes, the structure for this new material is a V-T complex. In addition, this verb has an interrogative marker, *-ka*. This bound morphology provides the complex structure:
V-T-C. The multi-headed structure is integrated into the existing structure by subsuming each of head one by one from the lowest to the highest. These predicted heads are instantiated by a corresponding real head. This integration is successful in licensing features, since every feature of the predicted head is also in the real head, and the intersection of the feature values for each feature in the predicted head is non-null. In particular, note that this merge satisfies the grammatical requirements not only of the verb but also of the C head as a *wh*-scope marker. In this way, the C head licenses the *wh*-feature of the *wh*-phrase. The entire process is illustrated in (18).

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39 Koizumi (1995: 168) runs a cleft test and proves that this morphological complex V-T-C can be syntactically unified (ii).

(i) Mary-ga Nancy-ni John-ga ringo-o 3-tu katta-to itta.
   *Mary-nom Nancy-dat John-nom apple-acc 3-cl bought-that said*
   ‘Mary said to Nancy that John bought three apples.’

   *Mary-nom Nancy-dat [bought-that] said-nl-top John-nom apple 3-cl be*
   Lit. ‘It is [John three apples] that Mary said to Nancy that bought.’
The interpretation of the output structure in (18) contrasts with that of a case where a declarative complementizer, -to attaches to the embedded verb. For instance, (19) is a counterpart of (7).
When the parser integrates the complex structure, V-T-C for *ageta-to* ‘gave-Comp’, into the existing structure in (18), it confirms that all the features on the predicted head [dare-ni] are licensed by the V head, but it fails to confirm that the *wh*-feature is checked by the C head. This is so because the real head of C is a declarative complementizer that does not contain the licensing *wh*-feature. This failure of feature-confirmation is consistent with the experimental results from Experiment 1 that show the slowdown at the embedded Verb-Comp, opposed to the Verb-Q.40 Note that just as in (18) the integration of the multi-head structure V-T-C is achieved even though the C head fails to

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40 Under this analysis, a prediction can be made that just as a fronted *wh*-phrase, a fronted referential NP is preferred to be associated to a most deeply embedded clause. Even though there is no *wh*-feature involved in a referential NP scrambled phrase, the element is recognized as a displaced element at a sentence-initial position. Then, the parser creates a predicted structure like [[NP-dat] [Case: Dat]]. As in a case of *wh*-scrambling sentences, this structure is lowered until the real verb is encountered. If all the features of the scrambled phrase are licensed by the first verb, there should be no parsing difficulty at this point. (i) is an example. I predict that Japanese readers prefer to interpret the fronted dative NP, *sono seito-ni* ‘that student-dat’ as an argument of the embedded verb, rather than as that of the matrix verb. The first English translation would be preferred to the second one. This contrasts with (ii), in which the embedded verb, *neteiru* ‘sleeping’ cannot take a dative argument. The parser should fail to license all the features of the scrambled phrase at this point, if it associates the fronted NP in the embedded clause, just as (i).

(i) Sono seito-ni sisyo-wa kootyoo-ga tosyositu-de ehon-o yondeiru-to itta.

*that student-dat librarian-top principle-nom library-at picture book-acc reading-Comp told.

‘The librarian said that the principal was reading a picture book for that student at the library.’

‘The librarian said to that student that the principal was reading a picture book at the library.’

(ii) Sono seito-ni sisyo-wa kootyoo-ga tosyositu-de neteiru-to itta.

*that student-dat librarian-top principle-nom library-at sleeping-Comp told.

‘The librarian said to that student that the principal was sleeping at the library.’
license the \textit{wh}-feature. All other features of not only the predicted head but also the accusative NP, such as case-features and \textit{\texttheta}-features, can be licensed by the verbal head. In addition, those same features of the nominative NP can be licensed by integration of that multi-head structure. In this sense, the system prefers to let licensing heads license as many features as possible, but it is not likely that the system requires all the features to be checked. Therefore, the parser expects the \textit{wh}-feature to be licensed by the C head as well as other features by the V head and/or the T head.

At the final stage the last verb of (7), \textit{sitteiru}, ‘knows’ is encountered. The parser builds V-T complex structure for this verb. When it is merged into the main structure, each head in the complex structure is subsumed by the real head. All the inherent features in each phrase are checked by a real head. This process is illustrated in (20).
This process again contrasts with the integration of the final verb in (19). When the final verb *omotteiru-no* ‘think-Q’ is encountered, the parser projects a multiple-headed structure which contains both T and C heads. This is because this verb *omotteiru-no* ‘think-Q’ has a Question marker on it. When it is merged into the main
structure, each head in the complex structure is subsumed by the real head, and all the inherent features in each phrase are checked by a real head. This process is straightforwardly achieved with both V and T heads in (21). On the other hand, the C head failed to be subsumed, remaining as a predicted head. When the parser notices that this integration is the last stage of processing this sentence, the parser ends the parse with changing the predicted C head to a licensing head. Once this C head becomes a licensing head, it can license the \textit{wh}-feature of the \textit{wh}-phrase. This is plausible under the assumption that the predicted head \textit{[dare-ni]} shares the same features as those of the \textit{wh}-phrase, \textit{dare-ni}. Recall also that the parser left the \textit{wh}-feature of \textit{[dare-ni]} unconfirmed when the first verb, \textit{ageta-to} ‘gave-Comp’ was merged. No feature-conflict occurs when the matrix C head licenses the \textit{wh}-feature to the \textit{wh}-phrase. Therefore, this integration does not induce any processing difficulty at the point of processing the final verb.\footnote{One might be considering a case where the final verb has a question marker on it and the first verb does so as well. The discussion in the next chapter focuses on this case.}
An interesting property regarding this process is seen in contrasting cases where the matrix verb obligatorily takes a dative argument, such as a causative verb *iw-asetano*, ‘tell-caused-Q’, and where the verb only prefers to take a dative argument, such as a verb...
osieta-no ‘told-Q’. (22) shows both cases. Intuitively, the former case yields a severe
garden path effect, while the latter case does not.

(22) Dare-ni John-ga Mary-ga keeki-o ageta-to iwaseta-no / osieta-no?
    *Who-dat John-nom Mary-nom cake-acc gave-Com tell-caused-Q / told-Q
    ‘Whom did John force to say that Mary gave cake?’
    ‘To whom did John say that Mary gave cake?’

The verb complex V-T-C structure for the matrix verbal head contains the relevant
licensing features of [θ], [dat], and [+wh]. The integration of V-T-C is not successful,
however, in the case of the causative verb in (22). There is no dative argument available
for obligatory case-feature licensing of the causative verbal head. Even though wh-feature
of the predicted head [dare-ni] was not licensed by the embedded verb, the status of
unlicensed wh-feature does not override a strong demand for a dative argument of the
matrix causative verb. This correctly predicts the intuition of a severe garden path effect
in this case. On the other hand, compare the intuition of this case with that of the other
case in which a matrix verb prefers to take a dative argument, such as osieta, ‘told’ in
(22). In this case, it does not seem to induce garden path effects. Instead, since Japanese
allows a null object, this sentence becomes ambiguous between ‘who is the person x such
that John told x that Mary gave someone a cake’ and ‘who is the person x such that John
told someone that Mary gave x a cake. Intuitively, the former matrix-gap interpretation is
preferred. To explain this preference, I assume that the unlicensed wh-feature overrides
the licensed other features, in such a case where the licensing head does not obligatorily need to license the other features. As a result, all the features of the matrix \textit{wh}-phrase can be licensed by the dative-taking matrix verb. Nonetheless, this argument concerning (22) certainly calls for experimental evidence that the intuition of (22) is correct.\textsuperscript{42, 43}

Next let us consider the following sentence structure, in which I predict that the parser induces Filled Gap effect at the second dative-marked NP, based on the experimental results from Experiment 2 (see Chapter 2).

(23) Dare-ni John-ga Mary-ga Tom-ni keeki-o ageta-to iimasita-ka?

\textit{Who-dat John-nom Mary-nom Tom-dat cake-acc gave-Comp said-Q}

‘To whom did John say that Mary gave Tom a cake?’

The following tree diagram (24) demonstrates the integration of the second dative NP into the existing structure. Notice in the existing structure that the parser has already associated the dative \textit{wh}-phrase to the embedded clause. When the second dative-marked

\textsuperscript{42} Although the main effects documented in the experiments provide plenty of evidence that the embedded gap appears, they do not provide clear empirical evidence on whether the matrix gap remains or disappears. If experimental evidence suggests the existence of the matrix gap as well as the embedded gap, the multiple-gap system will ultimately be needed as opposed to the current analysis that the matrix gap disappears when unforced reanalysis occurs. This would provide another way of parsing the matrix verb with a question marker in cases as in (19) and (22).

\textsuperscript{43} Experiment 1 (see Chapter 2) in fact used dative-taking verbs for the matrix verb, such as \textit{osiemasita}, ‘told’. However, it is not possible to be confounded regarding this ambiguity, because all the conditions have a second dative NP following the embedded verb, so that the matrix verb can license relevant features of the second dative NP, not those of the first dative NP in the embedded clause. The relevant example is as follows.

(i) Dono seito-ni tannin-wa kootyoo-ga hon-o yondeiru-to sisyo-ni osiemasita-ka?

\textit{Which student-dat class teacher-top principal-nom book-acc reading-Comp librarian-dat told-Q}

‘Which student did the class teacher told the librarian that the principal was reading a book for?’
NP is merged into this existing structure, the parser has to interpret two noun phrases which contain same type of syntactic and semantic features. Since the parser works both for structure building and interpretation, consecutive phrases sharing almost the same features gives the parser difficulty in parsing. For instance, a simple causative sentence such as (25) is grammatical, but there is a clear processing difficulty when the second dative NP is encountered. This is because the parser first attempts to handle two dative-marked person noun phrases under the same case-assigner. When these cases arise, the parser is forced to try the costly process of raising the first dative NP to save the parse.44

44 Notice that the morpheme,-ni is ambiguous. For instance, this morpheme is quite often used for expressing a direction, specific time, and a passive subject, as in (i) respectively. See Sadakane and Koizumi (1995) an intensive examination of the syntactic behavior of –ni.

(i) a. Tom-ga Tokyo-ni itta.
   *Tom-nom Tokyo-to went*
   ‘Tom went to Tokyo.’

b. Kaigi-ga sanji-ni hajimatta.
   *Meeting three o’clock-at started*
   ‘The meeting started at three.’

   *John-gen paper-nom Tom-by criticized-Passive*
   ‘John’s paper was criticized by Tom.’

Note also that a sequence of two person NPs with this morpheme seem to bring difficulty in processing at the second NP, as opposed to cases in which one of them does not express a person, as in the contrast between (a) and (b). Reading at the second dative NP in (b) seems more difficult relative to reading that in (a).

   *Jon-nom Tom-dat Tokyo-to went-Causative*
   ‘John made Tom go to Tokyo.’

b. John-ga Tom-ni Mary-ni awaseta.
   *John-nom Tom-dat Mary-dat met-causative*
   ‘John made Tom meet Mary.’

(iii) a. Jonn-ga Tom-ni sanji-ni atta-to itta.
   *Jon-nom Tom-dat three o’clock-at met-Comp said*
   ‘John said that he met Tom at three.’

b. John-ga Tom-ni Mary-ni atta-to itta.
(25) 約翰が　マリーに　トムに　親しい　話しました。

Jon-nom Tom-dat Mary-dat met-Comp said
‘John said that he met Mary.’

(iv) a. 約翰が　トムに　ジャーナル　批評された　論文　示しました。
Jon-nom Tom-dat journal-by criticized-Passive paper-acc showed
‘John showed Tom the paper that was criticized by the journal.’

b. 約翰が　トムに　マリー　批評された　論文　示しました。
Jon-nom Tom-dat Mary-by criticized-Passive paper-acc showed
‘John showed Tom the paper that was criticized by Mary.’
An additional advantage is that this parsing system can build English
wh-questions in exactly the same manner. Take a simple wh-question again such as what
did Newman deliver?. When the parser encounters the auxiliary, did, it realizes the
wh-phrase, what can be a moved category. The algorithm allows the parser to build the
predicted structure, [[Case: Acc] [what]], as illustrated in (26a). The C head cannot be
integrated directly to the existing structure. After the lexicon search, the parser builds a
predicted head of T as a complement of the C head, by virtue of tense-selection on the
complementizer. The structure is integrated into the left side of the leftmost predicted
head [[Case: Acc] [what]]. This integration is successful because the predicted T head
can take a case-assigner as a complement. In addition, the auxiliary did is merged with
the wh-phrase since the wh-feature can be licensed by this head. Only different from
Japanese wh-scrambling cases, the real C head, did can license [+wh] feature of English
wh-phrase. When the subject NP, Newman is encountered, the predicted [Newman, [T]]
structure in (26b) is merged into the left side of the leftmost predicted head, [what].
When the verb deliver is processed as in (26c), all predicted heads are subsumed, and
license features.
In contrast to Schneider’s original assumption, this new way to parse wh-movement in English does not have to assume that when a wh-phrase is encountered, a ‘wh-flag’ is set within the parser to indicate that there is incomplete wh-chain in the sentence. More importantly, this model can handle preferences of movement structures for both head-initial and head-final languages.45

Next, let the model parse the following example, which is already taken up in Chapter 3, Section 4.2 as an example of a construction that has been used to argue for the direct association models of Pickering and Barry (1993).

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45 The derivation seen in (26) is similar to Richards (1999, 2002)’s demonstration of how A’-dependencies are created in an incremental (left-to-right) derivation, which is developed by Phillips (1996, 2003a).
To which child did the teacher give [a long speech about the importance of honesty] __ ?

When the verb give is processed, all predicted heads are replaced by the verbal head, yielding the confirmation of the head for the wh-phrase. When the first word of the direct argument NP, a in ‘a long speech about the importance of honesty’, is processed, it fails to be inserted by itself at the first attempt. When an N head is predicted and projected, represented as [a, [N]], this predicted structure is ready to be integrated. An interesting question is where it should be inserted. The insertion principle normally inserts a new material to the left of all the predicted heads. In this case, the principle needs a slight modification without abandoning the spirit of the original principle. The insertion principle requires that new material be inserted to the right of all ‘overt’ confirmed elements. This leaves it open to the parser to decide whether to insert new material to the left or to the right of the confirmed gap. The surface word order is always guaranteed if the new structure is inserted to the right of the overt verb, not of the wh-gap. In this way, the current parsing model can predict the English cases as in (27) as well as the direct association models.46

This section used the SPARSE parsing model and demonstrated how the modified parsing model can handle wh-scrambling sentences in Japanese. This model is successful

46 A similar proposal is provided by Gibson and Hickok (1993). Their theory also allows the direct argument in (27) to be processed after the gap is interpreted. Theirs and the present model both share the spirit of the ‘first resort’ model of gap-finding (Fodor, 1978).
in capturing three main properties that Japanese \textit{wh}-scrambling constructions involve; (i) incremental structure-building, (ii) handling head-final structures, and (iii) parsing non-canonical word order. To successfully deal with (iii), one step was added to the original algorithm of the SPARSE system. The crucial modification is that the system allows the parser to build a predicted structure whose head is a possible licenser if the parser sees a moved element. It was shown that the model can capture one of the important implications from the experimental results: a successive attempt to posit a gap. Furthermore, this model not only captures the parsing of \textit{wh}-scrambling in Japanese but also of \textit{wh}-movement in English. We are still left with a question of how the model manages to explain the difference between when cases where reanalysis is allowed and cases where reanalysis is avoided. The next section will discuss this issue.

\subsection*{4.4.2 Parsing Attachment and Reanalysis}

This section demonstrates how the current parsing model deals with cases in which reanalysis is avoided. For English cases with the structure of (28a), repeated from (2), Schneider (1999) already provides an intensive explanation (under his original SPARSE) for why reanalysis is avoided. In doing so, he attempts to guarantee that reanalysis is \textit{always} avoided. However, as discussed in Section 4.2 and demonstrated in Section 4.3.2, Japanese sometimes allows unforced reanalysis. Therefore, it is worthwhile to examine how reanalysis is avoided in the English cases under the current model. As discussed earlier, in sentence (28a) the parser faces two alternative ways of incorporating
the second verb, *likes*, into the structure. One involves a local reanalysis, such that the verb takes the preceding NP, *the woman* as its subject to form an embedded clause (28c). The second alternative involves a non-local attachment without reanalysis, such that the new verb becomes the main verb, taking the non-local NP ‘the man’ as its subject (28b). Sturt et al. (2001) and Schneider and Phillips (2001) provide empirical evidence that non-local analyses that avoid reanalysis are favored over local analyses that require an easy reanalysis.

(28) a. The man who knows the woman *likes*…
   
   b. [TP [NP The man [CP who [VP knows [NP the woman]]]] [VP *likes* the recipe himself …
   
   c. [TP [NP The man [CP who [VP knows [CP [NP the woman]]] [VP *likes* the recipe herself …

Due to the head-initial structure of English, a verb appears before its argument. In (28a), the first verb, *knows* is encountered before its object *the woman*. This indicates that the parser can first access a licensing head, not a predicted head. This is opposite from what has been seen in many Japanese parsing cases. When the determiner, *the*, is encountered, it can be attached directly to the existing tree, because the verb, *knows* assigns case.

Likewise, when the noun *woman* is encountered, it can also be attached directly to the existing tree, because the determiner can select a noun as a complement (cf. Abney, 1987). All the features of each head are licensed in each step of integration. When the
Second verb *likes* is encountered, the parser builds the T head above the verb as a usual procedure. The structure [*likes, T*] is subsumed into the predicted head for the subject NP, *the man*: [the man [T]]. This means that the non-local attachment of the second verb is chosen, predicting that the structure of (28b) is favored over that of (28c). Hence, reanalysis is avoidable since the parser in English can take advantage of a structure in which a licensing head is followed by its licensed head. By contrast, Japanese has to bear with a predicted head before the licensing head is processed.

The rest of this section concentrates on the Japanese cases where reanalysis is avoided. I will point out that the difference in Japanese reanalysis between when unforced reanalysis is possible and when it is avoided seems attributable to the status difference of the phrase between a predicted head versus a licensed head. The status difference is straightforwardly derived from the insertion principle. As already illustrated in (16), reanalysis may occur only when the phrase remains as a predicted head until its licensing head is processed. A new material is inserted to the left side of that predicted head which is always the leftmost predicted head in a structure. As a result, the predicted head is reanalyzed in a different position of the structure. Notice that this derivation takes place only for predicted categories. If the phrase is not a predicted head but a real licensed head, there is no need for the parser to insert a new material to the left side of it. In this case, the phrase remains in the original position in the structure. In other words, reanalysis is avoided.
As one case in which reanalysis is avoided, I take up the structure that Kamide and Mitchell (1999, henceforth, K&M) used in their experiment. If K&M’s finding is correct, parsing difficulty is induced in the case of transitive matrix verb, *yabutta* ‘torn’ in (29), relative to ditransitive matrix verb, *miseta* ‘showed’. This indicates that it is preferred that the dative NP, *kodomo-ni* ‘child-dat’ be associated to the matrix verb.

(29) John-ga kodomo-ni Mary-ga kasita hon-o miseta / yabutta.

An important difference between *wh*-scrambling cases and this type of relative clause cases is that the former unambiguously involves movement but the latter does not have to.

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47 Chapter 3 Section 3.4 discussed another difficult reanalysis case regarding ‘head-driven’ analysis. This case is also discussed by Schneider (1999, Chapter 3). The relevant example is as follows.

(i) a. Yoko-ga kodomo-o koosaten-de mikaketa takusii-ni noseta.
   *Yoko-nom child-acc intersection-at saw taxi-dat put-on*
   ‘Yoko put the child in the taxi which she saw at the intersection.’

b. Yoko-ga kodomo-o koosaten-de mikaketa onnanoko-ni koe-o kaketa.
   *Yoko-nom child-acc intersection-at saw girl-dat called*
   ‘Yoko called the girl who saw the child at the intersection.’

Mazuka and Itoh (1995) report that Japanese readers experience a conscious processing difficulty when the relative head in (ia) is encountered, relative to when the one in (ib) is encountered. To explain this difficult reanalysis, Schneider assumes that the search of the tree for reanalysis sites only considers maximal projections, except for the projection immediately below the root of the tree. In (ia), only [child-acc intersection-at saw] can be removed from the existing structure when the relative head, taxi-dat is encountered. This assumption excludes a possibility to remove [intersection-at saw], because this is not a maximal projection. This analysis is very similar to VP-lowering analysis of D-Theory (Weinberg, 1993; Gorrell, 1995; Sturt & Crocker, 1996). See Schneider (1999, Chapter 3) for his attempt to distinguish these analyses by using a German case.
The dative NP in (29) can be either in-situ or originally scrambled from the argument position of the relative clause verb phrase. Keeping this in mind, let us illustrate the parse of this sentence.

The crucial integration steps start when the second nominative NP (Mary-ga, Mary-nom in (29)) is encountered. Consider the schema in (30). The T head is attached to the nominative NP. The nominative NP-Tense complex cannot still be attached to the existing structure. By virtue of the tense-selecting feature on complementizer, the parser projects a C head and attaches the [Mary-ga, [T]] complex to C. The C head is assumed to have a case-type feature, [Category: Verb], which may be a sentential complement if a downstream head confirms it. It is ready for integration. The leftmost predicted head in the existing structure is [Case: Dat], so that the new material is inserted into the left of it, as the dot line in (30) indicates. Importantly, this insertion leaves the dative NP, kodomo-ni in the matrix clause. As a consequence, reanalysis of the dative phrase in this configuration is avoided. This is consistent with K&M’s finding that it is preferred that the dative NP be associated with the matrix clause. The current parsing model can thus predict a Japanese case of reanalysis as a last resort operation. Recall that this model can also predict cases of the unforced reanalysis, (16), in which the insertion rule forces the parser to always merge an incoming material to the left side of it, As a result, the predicted structure for a moved phrase is reanalyzed from the first inserted position to the more deeply embedded position. Hence, the same principle of insertion can predict both cases of unforced reanalysis, and cases of reanalysis as a last resort.
Let us see how the parsing breakdown occurs at the matrix verb. After the first verb, *kasita* ‘lent’ is encountered, the verb is directly attached to the leftmost Tense head. When the next word, *hon-o* ‘book-acc’ is encountered, as in (31), it cannot be attached directly to the existing tree. A search for predicted heads is therefore initiated. The head returned by the search is a null C head for a relative clause along with the associated operator, as the original SPARSE assumes. SPARSE also has rules to allow for reanalysis. The parser is allowed to consider reattaching an existing node to the new

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48 Note that these rules are ordered in the algorithm, so that they will only be performed as a last resort. See Step 4 in Figure 9.
material. Because the C head needs to license a finite Tense, the Tense structure is removed from the existing tree and attached as the complement of the relative clause. At this point, the entire structure of the relative noun phrase can be attached to the left side of the leftmost predicted head in the existing structure; [Case: Dat, Acc].

(31)
As illustrated in (32), if the matrix verb which is encountered at next parsing phase is ditransitive, *miseta* ‘showed’, the parser easily subsumes the V-T complex of the verb into the existing tree. On the other hand, if the incoming verb is a transitive verb, *yabutta* ‘torn’, the parser is forced to reanalyze the current structure since the transitive verb fails to license all the arguments needed to be licensed for. The model can in this way predict the parsing breakdown that K&M reported in their experiment.
In sum, the current parsing model demonstrates how to parse both cases in which reanalysis is avoided (e.g. (29)) and in which unforced reanalysis is allowed (e.g. (7)). In \textit{wh}-scrambling cases, since the \textit{wh}-phrase is unambiguously interpreted as a moved element, the parser posits a predicted case-assigning structure which can be integrated into an embedded clause when the second subject NP is processed. The relative clause
case as in (29), on the other hand, does not have to analyze the dative NP as a moved element. Thus, there is no need for positing a predicted case-assigning structure. It is preferred that the dative NP initially appearing at an argument position remains there because the subsequent parsing process does not need to remove it from the structure it was first attached to.

The difference between when reanalysis in Japanese is possible and when it is avoided seems attributable to the status difference of the phrase between a predicted head versus a licensed head. In the former case, the scrambled phrase keeps itself as a predicted head until its licensing head is processed, since the parser always inserts a new material to the left side of that predicted head which is always the leftmost predicted head in a structure. This situation is called unforced reanalysis. In the latter case, on the other hand, the reanalysis is avoided because there is no need for the parser to insert a new material to the left side of it, since the phrase is not a predicted head, but a real licensed head. As a result, reanalysis is avoided in this structure.

Although I have presented this discussion in terms of reanalysis in a serial model of parsing for ease of exposition, the same issues may be viewed from the perspective of a parallel model of parsing that replaces reanalysis with re-ranking of alternative parses. For example, the parallel, principle-based model of processing filler-gap dependencies in Gibson, Hickok and Schütze (1994) could probably be elaborated in such a way that it could handle the Japanese findings discussed here, since it shares the assumptions of incremental creation of gap positions, driven by the need to satisfy grammatical requirements. Since re-ranking of alternative parses is available by default in such models,
the finding of unforced reanalysis in Japanese wh-questions could be handled straightforwardly. The challenge for such models, on the other hand, is to prevent free re-ranking of alternative parses in those cases in English and Japanese where unforced reanalysis has been shown to be unavailable. It is certain that a full account along these lines remains to be worked out, but Vosse and Kempen (2000) propose a promising parallel account that uses a lateral inhibition mechanism to suppress competing analyses when an individual analysis is highly supported. However, their model does strictly head-driven parsing. Phrasal nodes (S, NP, PP, etc.) are introduced by their heads, so that the parser postpones attachment of pre-head constituents until the head word arrives. If we adopt this type of head-driven models, the question arises once more of how such a model can explain the experimental evidence for pre-verbal structure-building. Under the explanation presented here, this question is answered by rejecting the assumption that the parser waits building structures until it sees lexical heads. Thus, at present the parallel account represented in Vosse and Kempen’s model is not applicable straightforwardly to parse head-final structures.

4.5 Previous Work

This section gives a brief overview of three different incremental parsing models that have provided some basic ideas for the original SPARSE and the current model. I discuss them mainly with respect to what assumptions and mechanisms SPARSE is based
on and how much these mechanisms achieve the level of incrementality and flexibility to head-final structures.

### 4.5.1 Theta Attachment Model

From Pritchett’s Theta Attachment model (Pritchett, 1988, 1991a, b, 1992), SPARSE incorporates the assumption of the need to maximally satisfy grammatical principles. In particular, when a licensing head is integrated, all the features of a phrase are assumed to be maximally checked.

Pritchett’s model accounts for the general preference to attach incoming constituents as arguments rather than adjuncts even when the argument is attached less locally than an adjunct. For instance, the preferred reading in (33) is that the PP *with binoculars* is interpreted as an instrument of the verb rather than as a modifier of the more recent NP *the thief* (Frazier & Fodor, 1978).

(33) The policeman saw the thief with binoculars.

Argument attachment is preferred because it allows for more θ-roles to be satisfied. The parser must satisfy as many grammatical principles as possible at the existing structure. Importantly, this maximal satisfaction of principles implies that a ditransitive use of a
particular verb is preferred over a transitive use, because it satisfies more grammatical principles.\textsuperscript{49}

Although Pritchett does not formalize the principle-based theory into a parsing model, he provides the basis for a parsing theory of initial identification of parses. That is, the parser’s task is to satisfy as many grammatical constraints as possible at each stage of the parse. However, notice that this theory requires that the parser builds structures based only on the lexical properties of confirmed heads. As discussed a length in Chapter 3, a head-driven and delay parsing system does not provide an incremental account of parsing in head-final languages like Japanese. In particular, it is difficult to account for full-incremental structure-building before a verbal head is encountered.

4.5.2 Competitive Attachment Model

Stevenson (1994) presents the design and implementation of a hybrid connectionist model for parsing. It integrates simple symbolic processing with numeric

\textsuperscript{49} This implication also predicts that a number of Japanese relative noun phrases induce no breakdown. Since the maximal satisfaction of principles allows the verb in the relative clause in each case of (i) to license as many θ-roles as possible in the structure, the incoming relative head is easily interpreted as a member of the VP in the relative clause without demonstrating any cue of being a relative noun phrase.

(i) a. John-ga kujira-o mita soogankyoo
    \textit{John-nom} \textit{whales-acc} saw \textit{binoculars}
    ‘binoculars with which John saw whales’

b. John-ga karaoke-de ryuukooka-o utatta baa
    \textit{John-nom} \textit{karaoke-with} \textit{popular song-acc} sang \textit{bar}
    ‘a bar where John sang a popular song with karaoke’

c. John-ga koi-ni otita natu
    \textit{John-nom} \textit{love-dat} fell \textit{summer}
    ‘the summer when John was fallen in love’
spreading activation within nodes that incrementally represent pieces of syntactic structure that compete with one another for activation until such time as the network settles on a set of relations that compose a single parse tree. Symbolic feature processing determines the grammaticality of potential phrase structure attachments, based on the transformational and phrase structure grammar (Chomsky, 1981; Rizzi, 1990). Numeric spreading activation weighs the relative strengths of the valid attachment alternatives and focuses activation on the preferred structure. Competition for spreading activation is the crucial mechanism for resolving ambiguity. Because of this competitive attachment, the model can handle a variety of parsing effects without needing to resort to heuristic parsing strategies such as the Minimal Attachment (Frazier & Fodor, 1978) and Late Closure (Frazier, 1978).

Schneider (1999: 13) evaluates this model as one which provides an explicit account of how structures are built and how possible attachment sites are identified. SPARSE uses Stevenson (1994)’s idea of only instantiating nodes in the presence of overt evidence by changing the definitions of overt evidence and syntactic head.

Crucially, in Stevenson’s system, no phrase can be built before the phrasal head has been encountered in the input. Like Pritchett’s head-driven and delay system, this cannot achieve full-incrementality in head-final constructions. Because all attachments

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50 Contrasting his model with their own, Vosse and Kempen (2000: 107) point out that Stevenson only deals with the resolution of syntactic attachment ambiguities. The model cannot handle effects of linguistic complexity, for instance, the contrast between center-embedded and right-branching nesting of relative clauses.
cannot be intuited from any information other than features of a head, no attachment can be made if the head is not present in the structure.

4.5.3 Combinatory Categorial Grammar

Within the framework of Combinatory Categorial Grammar (henceforth, CCG), Steedman (1993, 1996, 2000) develops an approach which allows multiple derivations for combination of the words in a given sentence. The basic idea is that words are associated with one or more categories (alternatively called types), and that the syntactic rules frequently allow a given set of words to be combined in several different orders. Schneider (1999, Section 1.2.2.4) discusses one of the consequences drawn from one of the CCG’s device, type-raising. It can be applied to arguments to turn them into functions. Without this device, incrementality could not be straightforwardly achieved, because the entire VP would need to be completed before the subject could be attached. The addition of type-raising and function composition rules make it possible to combine a given set of terminal categories in incremental word order. For example, consider the derivation of the sentence in (34).
(34)  John ate cookies

NP (S\NP)/NP NP
-------- TR
S/(S\NP)
----------------------- FC
S/ NP
-------------------------->
S

The NP John can be type-raised to S/(S\NP), which means that it will combine with a VP(=S\NP) on its right to form an S. Through a function composition operation, this NP can combine with the verb. In this way, the subject can combine with the verb, to form a constituent that will be an S when it combined with an object NP.

SPARSE applies this flexibility of the status of each word into the system of projecting a grammatically legitimate head on a word. When a nominative subject noun is encountered, for instance, SPARSE can change the noun into the structure projected by a

\[
\begin{align*}
(1) & \quad \text{Forward application (\(\triangleright\))} \\
& \quad X/Y \rightarrow X \\
(2) & \quad \text{Backward application (\(\triangleleft\))} \\
& \quad Y \ X\ Y \rightarrow X
\end{align*}
\]

The general form of each application is formalized as follows.

\[
\begin{align*}
(1) & \quad \text{Type raising (TR)} \\
& \quad X \rightarrow Y/(Y\ X) \\
(2) & \quad \text{Forward function composition (FC)} \\
& \quad X/Y \quad Y/Z \rightarrow X/Z
\end{align*}
\]

51 In reading these derivations, one should know that each of the categories is a syntactic and semantic type that defines its combinatory possibilities. If the type is a function, it specifies what it combines with. A forward slash / combines with a category on the right, (i), and a backslash \ means that the type combines with something on the left, (ii).

52 See Phillips (1996, 2003a) and Schneider (1999) who address whether the descriptive power of the CCG also makes different predictions about incrementality and constituency.
predicted T head. A crucial difference between CCG and SPARSE, however, is that the type-raising rule of CCG also changes the category itself whereas the projection system of SPARSE does not. For instance, in (34), typing-raising rule alters the category of the subject from NP into the S/(S\NP). On the other hand, SPARSE maintain a subject noun and a predicted T head, both of which can be projected to the subsequent stages of integration.

4.6 Summary

This chapter has demonstrated how Japanese wh-scrambled interrogatives are parsed. The parsing model slightly revised from the original SPARSE has three properties: incremental structure-building, accessibility to both head-final and head-initial structures, and dealing with non-canonical word order. Without any additional steps for parser’s algorithm, this model accounts for three important implications drawn from the experimental results of Experiment 1, 2 and 4. First, the principle of insertion rule ensures successive gap-creation. Since the predicted head for a scrambled category is always on the leftmost predicted head in the existing structure, the insertion rule forces an incoming material to be merged to the left side of it. As a result, the predicted head continues to be embedded more and more deeply until a verbal head licenses the features of the head. Second, this model also explains why the gap is always posited as soon as possible. Since the predicted head for a scrambled category is always the leftmost predicted head, it is expected to be first licensed by its licensing head in the next
integration stage. Regarding the third property, I first discussed why unforced reanalysis is permitted in the relevant *wh*-scrambling structures. In addition, the parsing model developed here can deal with cases of reanalysis as a last resort in Japanese and English.

Finally, the last section provided a quick review of previous work that are fundamental to the original SPARSE and the current model. They were evaluated with an eye towards their similarities and differences with respect to incrementality and flexibility to head-final structure.
5.1 Introduction

The results from the on-line studies of Experiments 1 and 2 indicate that sentence-initial \textit{wh}-phrases are preferentially interpreted in the most deeply embedded clause during on-line processing. Recall the results from Experiment 2, for instance. They showed that Filled Gap effects are observed at the embedded dative-marked NP in (1a), as opposed to that in (1b).

(1) a. Dono-syain-ni senmu-wa syatyoo-ga

\textit{Which employee-dat managing director-top president-nom}

kaigi-de katyoo-ni syookyuu-o yakuksamita-to

\textit{meeting-at assistant manager-dat raise-acc promised-DeclC}

iimasita-ka?

told-Q

‘To which employee did the managing director tell that the president promised a raise to the assistant manager at the meeting?’
b. Dono-syain-ga senmu-ni syatyoo-ga

Which employee-nom managing director-dat president-nom

kaigi-de ktyoo-ni syookyuu-o ykusokusita-to

meeting-at assistant manager-dat raise-acc promised-DeclC

iimasita-ka?

told-Q

‘Which employee told the managing director that the president promised a raise to the assistant manager at the meeting?’

The slowdown at the second dative-marked NP in (1a) arises because readers do not expect to encounter a second dative NP in the embedded clause after they interpret the wh-phrase in the embedded clause. This effect could only arise if readers create a gap position in the embedded clause before they reach the embedded verb.

The findings from Experiment 1 and 2 raise the question of whether the embedded wh-scope reading is always available in long-distance wh-scrambling structures where the wh-phrase is overtly in sentence-initial position. In fact, Takahashi (1993) specifically uses the unavailability of the embedded wh-scope reading in certain contexts as one of the key observations in his argument that Japanese wh-scrambling is equivalent to English wh-movement. ⁵³ Focusing on sentences in which both the main

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⁵³ Takahashi (1993) also provides the other argument that Japanese has an English type of overt wh-movement. That is, some type of Japanese wh-scrambling exhibits the Superiority Effect (Chomsky 1973), as witnessed by (ib), contrasting with grammaticality of referential NP-scrambling in (ia).

(i) a. Piza-o John-ga dare-ni [Mary-ga t, tabeta-to] itta-no?
clause and the embedded clause contain a question marker (2), Takahashi argues that the scrambled wh-phrase can only take matrix scope (2b), and does not allow embedded scope (2a). 54

(2) Nani-o Taro-wa [Hanako-ga t_nani-o tabeta-ka] siritagatteiru-no?

What-acc Taro-top Hanako-nom ate-Q wants-to-know-Q

a. 'Does Taro want to know what Hanako ate?'

b. 'What does Taro want to know whether Hanako ate?'

He compares this with Baker (1970)’s observation that in (3), what can have either matrix or embedded scope, whereas who has only matrix scope and where only embedded scope.

(3) Who wonders where we bought what?

Lit. ‘Pizza, did John tell whom that Mary ate?’

b. ??Nani-o John-ga dare-ni [Mary-ga t_t tabeta-to] itta-no?

Lit. ‘What did John tell whom that Mary ate?’

54  The question marker ka is ambiguous between being a scope marker for a wh-phrase and an interrogative complementizer corresponding to whether in English.
Following Lasnik and Saito (1992) and Epstein (1992)’s economy principle that economy prohibits unnecessary steps, Takahashi explains the scope-fixing effect observed in (3) by making the assumption that the overtly moved $wh$-phrases cannot move in LF and must have scope in their surface positions. Applying English cases such as (3) to Japanese $wh$-scrambling cases as in (2), he suggests that some instances of Japanese scrambling resist LF undoing, in particular when a $wh$-phrase undergoes long-distance scrambling from an embedded clause headed by a question marker to the sentence-initial position of a clause headed by another question marker which can be [+wh] COMP. The generalization he reaches is as follows (Takahashi, 1993: 659).

(4) Long distance movement (A’-movement) of a $wh$-phrase to the initial position of a clause headed by a [+wh] Comp counts as $wh$-movement.

If scrambling can be freely reconstructed in LF, as Saito (1989) argues, the $wh$-phrase in (2) could have the embedded scope construal. Under Takahashi’s judgments of the sentences in (2), however, the embedded scope interpretation (2a) is not available. He analyzes the $wh$-phrase in (2) as moved from the embedded clause directly to the matrix Spec-CP, as in the case of $wh$-movement in English, concluding that the long-distance $wh$-scrambling in (2) is counted as a species of $wh$-movement.

If Takahashi’s analysis of (2) is correct, it would indicate that the experimentally-demonstrated embedded scope preference might sometimes turn out to be
ungrammatical.\(^{55}\) This is so because those findings specifically show that a fronted \(wh\)-phrase in (2) can be interpreted as an argument in the embedded clause. In on-line reading, Japanese readers even *preferred* to have the embedded \(wh\)-scope reading in (2) when they encountered the embedded verb with a question marker.

The next section shows that an off-line questionnaire study (Experiment 5) provides evidence that both scope possibilities in (2) are available, once semantic context is appropriately controlled.\(^{56}\) This result is compatible with the preferences obtained from the results in the previous experiments (Experiment 1, 2, and 3). This also suggests that Japanese \(wh\)-scrambling constructions such as (2) do not exhibit a scope-fixing effect, contrary to Takahashi’s analysis.\(^{57}\) Furthermore, Section 5.3 discusses the syntactic analysis of long-distance \(wh\)-scrambling. In this section, I provide an answer to the question of why preferences differ between on-line and off-line reading of (2).

### 5.2 Experiment 5

This experiment was designed to examine whether Japanese readers accept both scope possibilities in (2). To facilitate natural judgments, a semantically appropriate context was given before the \(wh\)-sentences such as (2) were read. If readers reject the

\(^{55}\) I thank Edson Miyamoto for first bringing this point to my attention.

\(^{56}\) Takahashi's judgment is in fact controversial. As Maki and Ochi (1998) and Kuwabara (1999) note, some native speakers of Japanese can take (2) as a yes-no question as well as a \(wh\)-question. Deguchi and Kitagawa (2002), Ishihara (2002), and Kitagawa and Fodor (2002) also argue that ambiguity of the \(wh\)-scope readings can be obtained in specific prosodic structures. See Section 5.2.3 for discussion of Maki & Ochi and Kuwabara on Takahashi’s analysis.
embedded scope reading under the context biased in favor of the embedded $wh$-scope reading, it will support the idea that the embedded scope preference indicated by the results in Experiment 1 and 2 represents an ungrammatical structural analysis. If they prefer the embedded scope reading under such a context, on the other hand, we will take the results as evidence that the embedded $wh$-scope reading and gap in the embedded clause is possible in Japanese, contrary to Takahashi’s claim.

5.2.1 Methods

5.2.1.1 Participants

Eighty native speakers of Japanese participated in the experiment. All of them were students at Shizuoka University or at Shizuoka Sangyo University, Japan. They were paid 500 Japanese yen for their participation in the experiment, which lasted about 30 minutes.

5.2.1.2 Materials and Design

Experimental materials consisted of sixteen sets of eight conditions each, in a 2 x 2 x 2 factorial design, which manipulated the distribution of the position of the dative $wh$-phrase (scrambled vs. in-situ), the distribution of the answer types (matrix vs. embedded), and the distribution of the embedded clause types (non-island vs. island).
Each test item consisted of three parts: Context, Question, and Answer. The participant’s task was to judge whether the Answer was an appropriate response to the Question. The question-answer pairs highlighted different scope readings. Participants first read two sentences in the Context, which was biased in favor of the embedded wh-scope reading. The Questions were all double question marker questions as in (2), with either a scrambled or an in-situ wh-phrase. The embedded clause was either a complement clause (‘non-island conditions’), which allows long-distance scrambling, or a relative clause, which is an island that blocks scrambling (‘island conditions’) (Haig, 1976; Harada, 1977; Saito, 1985). The island conditions were included in order to show that the effect of context is not so strong as to make ungrammatical readings possible. Answer sentences highlighted either matrix or embedded scope readings for the questions. Participants rated appropriateness of an answer sentence under a given context and question sentence (Rate 1 = least appropriate, Rate 5 = most appropriate). Furthermore, the number of items was counter-balanced in terms of types of wh-phrases: ‘bare wh-phrase’ such as dare-ni ‘who-dat’ and ‘Discourse-linked wh-phrase’ (henceforth, D-linked, cf. Pesetsky, 1987) such as dono tomodati-ni ‘which friend-dat’. This distinction was included because Takahashi uses the former type of wh-phrases while Experiments 1 - 4 of the present study used the latter type.

(5) and (6) show one set of conditions used in the experiment, Non-island conditions and Island conditions, respectively. A full set of materials for this experiment is available in Appendix F.
(5) **Non-island Conditions**

**Context**

Taro-wa    Hanako-ga     enkai-de  dare-ni   atta-ka sitteiru.

*Taro-top Hanako-nom party-at who-dat met-Q knows.*  
‘Taro knows who Hanako met at the party.’

Tomoko-mo  Hanako-ga    enkai-de dare-ni  atta-ka sitteiru.

*Tomoko-also Hanako-nom party-at who-dat met-Q knows.*  
‘Tomoko also knows who Hanako met at the party.’

**Question**

a.  **In-situ Condition**

Demo, Jiro-wa  Hanako-ga  enkai-de dare-ni   atta-ka sitteiru-no?

*But, Jiro-top Hanako-nom party-at who-dat met-Q knows-Q*

‘But, does Jiro know who Hanako met at the party?’

‘But, who does Jiro know whether Hanako met at the party?’

b. **Scrambled Condition**

Demo, dare-ni    Jiro-wa  Hanako-ga  enkai-de  atta-ka sitteiru-no?

*But, who-dat Jiro-top Hanako-nom party-at met-Q knows-Q*

**Answer**

c. **Matrix Answer**

Saburo-ni    da-yo.

*Saburo-dat Copula-Aff*

‘(It’s) Saburo.’
d. **Embedded Answer**

Un, Jiro-mo sitteiru-yo.

*Yes Jiro-also knows-Aff*

‘Yes, he does.’

(6) **Island Conditions**

*Context*

Taro-wa Hanako-ga enkai-de dare-ni atta-ka sitteiru tomodati-no

*Taro-top Hanako-nom party-at who-dat met-Q knows the friend-gen* koto-o hanasita.

*things-acc talked*

‘Taro talked about the friend that knows who Hanako met at the party.’

Tomoko-mo Hanako-ga enkai-de dare-ni atta-ka sitteiru tomodati-no

*Tomoko-also Hanako-nom party-at who-dat met-Q knows the friend-gen* koto-o hanasita.

*thing-acc talked*

‘Tomoko also talked about the friend that knows who Hanako met at the party.’

*Question*

a. **In-situ Condition**

Demo, Jiro-wa Hanako-ga enkai-de dare-ni atta-ka sitteiru

*But, Jiro-top Hanako-nom party-at who-dat met-Q knows tomodati-no koto-o hanasita-no?*

*friend-gen things-acc talked-Q*
‘But, did Jiro talk about the friend that knows who Hanako met at the party?’

b. **Scrambled Condition**

Demo, dare-ni Jiro-wa Hanako-ga enkai-de atta-ka sitteiru

But, who-dat Jiro-also Hanako-nom party-at met-Q knows tomodati-no koto-o hanasita-no?

friend-gen things-acc talked-Q

‘But, to who did Jiro talk about the friend that knows whether Hanako met at the party?’

**Answer**

c. **Matrix Answer**

Saburo-ni da-yo.

Saburo-dat Copula-Aff

‘(It’s) Saburo.’

d. **Embedded Answer**

Un, Jiro-mo hanashita-yo.

Yes Jiro-also said-Aff

‘Yes, he did.’

The sixteen sets of items were distributed in a Latin Square design, creating eight lists. Each participant saw one of the lists intermixed with sixteen unrelated filler items in a random order. The filler items (n = 16) were all multi-clausal. Half of them included an
in-situ *wh*-adjunct such as *naze* ‘why’ and *itu* ‘when’ in the embedded clause, while the embedded clauses of the other half were either a declarative complement or a yes/no question complement using *kadooka*, ‘whether’. In addition, they were balanced on which answer-type should have been preferred.

### 5.2.2 Results

Appropriate answer ratings for all conditions are shown in Figure 10, and those for comparison between *wh*-phrase types (bare *wh*-phrase vs. D-linked *wh*-phrase) in the Scrambled conditions are shown in Figure 11.

I first show the rating results for the non-island conditions, which are the most important for the purpose of this experiment. If the embedded *wh*-scope reading in (2a) is grammatically possible, then speakers should rate the embedded scope reading significantly higher than the matrix scope reading in the non-island conditions, independent of the surface position of the *wh*-phrase. This prediction is since the context was set up to strongly bias readers to the embedded scope reading. This prediction was confirmed. Within the non-island conditions, there was a significant main effect of answer type, such that ratings were higher for embedded answers than for matrix answers (the average rating = 3.6)\(^{57}\), \((F_1(1,79) = 145.9, \text{MSE} = 3.6, p<.0001)\). However, a marginal main effect of word order type was observed \((F_1(1,79) = 3.05, \text{MSE} = 1.28, p\)

\(^{57}\) Note that the average rating of 3.6 for the non-island/scrambled/embedded condition represents a high rating for sentences of this complexity.
An overall interaction of answer type and word order type was also observed, 
\((F_1(1, 79) = 39.14, \text{MSE} = 2.19, p < .0001)\). Pairwise comparisons within the non-island manipulation for each level of the word order type manipulation yielded the following results. In the scrambled conditions, the embedded answer was rated significantly higher than the matrix answer \((F_1(1, 79) = 26.9, \text{MSE} = 3.46, p < .0001)\). In the in-situ conditions, the embedded answer was also rated significantly higher than the matrix answer \((F_1(1, 79) = 222.74, \text{MSE} = 2.32, p < .0001)\).

Recall that the island conditions were included in order to show that the effect of context is not so strong as to make ungrammatical readings possible. Results in these conditions confirmed that when the \(wh\)-phrase was in-situ, only the embedded scope was rated highly, and when the \(wh\)-phrase was in sentence-initial position, only the matrix scope was rated highly.\(^{58} \) Within the island conditions, there was a marginal main effect of answer type, \((F_1(1, 79) = 3.19, \text{MSE} = 2.61, p = .08)\), but there was no significant main effect of word order type \((F_S < 1)\). An overall interaction of answer type and word order type in island conditions was also observed, \((F_1(1, 79) = 224.19, \text{MSE} = 2.48, p < .0001)\).

Pairwise comparisons within the island manipulation for each level of the word order

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\(^{58} \) The high rating of the Scrambled/Island/Matrix condition seems to indicate that Japanese readers easily insert a null pronoun in the argument position of the most deeply embedded clause, and interpret the fronted dative NP as a matrix argument. Compare the following interpretation with the question sentence in (6b).

(i) Dare-ni Jiro-wa Hanako-ga enkai-de pro atta-ka sitteiru tomodati-no koto-o hanasita-no?  
\(\text{who-dat} \) Jiro-top Hanako-nom party-at \(\text{met-Q} \) knows friend-gen thing-acc said-Q  
‘To whom did Jiro talk about the friend that knows whether Hanako met someone at the party.’

The matrix answer for (i) can be associated not to the embedded clause, but to the matrix answer, i.e. ‘who is the person x such that Jiro talked to x about the friend that knows whether Hanako met someone at the party’.
type manipulation yielded the following results. In the scrambled conditions, the matrix answer was rated significantly higher than the embedded answer ($F_{1}(1,79) = 76.7$, $MSE = 2.79$, $p < .0001$). In the in-situ conditions, the embedded answer was rated significantly higher than the matrix answer ($F_{1}(1,79) = 153.0$, $MSE = 2.29$, $p < .0001$).

Since we counterbalanced the materials with two types of $wh$-phrases (bare-phrase type and D-linked type, so within the non-island conditions we performed a 2 x 2 x 2 ANOVA with $wh$-phrase type, word order type (scrambled vs. in-situ), and answer type (matrix vs. embedded) as factors. As shown in Figure 11, there was a significant main effect of $wh$-phrase type, such that the average rating for D-linked $wh$-phrases was significantly higher than the average rating for bare $wh$-phrases ($F_{1}(1,79) = 12.53$, $MSE = 0.84$, $p < .001$). There was no interaction of answer type and $wh$-phrase type ($F_{s} < 1$), while there was a significant interaction of word order type and $wh$-phrase type ($F_{1}(1,79) = 11.1$, $MSE = 0.73$, $p < .005$). Planned comparisons within each word-order condition (scrambled and in-situ) yielded the following results. Within the scrambled conditions, there was a significant main effect of $wh$-phrase type ($F_{1}(1,79) = 20.1$, $MSE = 0.92$, $p < .0001$), and of answer type ($F_{1}(1,79) = 26.9$, $MSE = 3.46$, $p < .0001$). Meanwhile, within the in-situ conditions, the effect of $wh$-phrase type was not significant ($F_{1} < 1$), but there was a significant main effect of answer type ($F_{1}(1,79) = 222.7$, $MSE = 2.32$, $p < .0001$). There was no interaction of answer type and $wh$-phrase type ($F_{s} < 1$) for either condition.
Figure 10: Experiment 5, Ratings of appropriate answer judgment.

Figure 11: Experiment 5, Comparison of ratings of appropriate answer judgment between Bare-*wh*-phrases and D-linked *wh*-phrases in Non-island Conditions.
5.2.3 Discussion

These results show that it is possible to obtain the embedded *wh*-scope reading in (2), repeated in (7). Japanese speakers rated the embedded scope reading significantly higher than the matrix scope reading in (non-island) sentences like (2), independent of the overt position of the *wh*-phrase. This suggests that the embedded *wh*-scope reading in (7a) is grammatically possible, and that when Japanese readers are given an appropriate semantic context, they prefer to interpret (7) as (7a) rather than (7b).

(7) Nani-o Taro-wa Hanako-ga tabeta-ka siritagatteiru-no?

*a* 'Does Taro want to know what Hanako ate?'

*b* 'What does Taro want to know whether Hanako ate?'

The argument that this reading is genuinely grammatically available is reinforced by the finding that context fails to yield an embedded scope reading in conditions where this would require violation of an island constraint. In island conditions, only the embedded scope was rated highly when the *wh*-phrase was in-situ. This result shows that context did not help to make available the scope reading in which the sentence-initial *wh*-phrase is associated with a gap and with scope inside the syntactic island. In addition, results showed that the difference of ratings in *wh*-phrase types does not induce any
inconsistency with overall results of ratings. Independent of the type of the *wh*-phrase, the embedded scope reading was rated significantly higher than the matrix scope reading.

Thus, the off-line judgments in this experiment are compatible with the embedded reading preference observed from the results in on-line self-paced reading task (Experiment 1 and 2). Since the embedded *wh*-scope reading is grammatically available in (7), the fronted *wh*-phrase can be interpreted as an argument in the embedded clause.

Although the results of this experiment challenge Takahashi’s claim that the embedded *wh*-scope reading in (7) is impossible, I agree with Takahashi that the matrix *wh*-scope reading in (7b) is preferred in off-line reading in the absence of biasing context. It seems that there is a difference in preferences between when readers interpret (7) on-line and when they do so off-line. In on-line reading, Japanese readers prefer to have the embedded *wh*-scope reading in (7) as (7a) when they start reading the embedded clause and confirm it with the embedded verb with a question marker. Crucially, at this point in on-line reading, they do not see the matrix verb with another question marker. On the other hand, they prefer to interpret (7) as (7b) when they read the entire sentence of (7) and interpret it off-line. In the next section, I examine syntactic properties of relevant *wh*-scrambling constructions, and provide a principle capturing these preferences which can be reversed between in on-line reading and in off-line reading of *wh*-scrambling constructions like (7).

### 5.3 Syntactic Analysis of *Wh*-scope Interpretation
5.3.1 Reconstruction

The experimental evidence for availability of the embedded scope reading in (7) indicates that the *wh*-scope is not fixed at the matrix clause, but that the *wh*-phrase can be interpreted at a position in which a scope marker c-commands it. This has been called a ‘reconstruction’ effect in LF, as Saito (1989) argues. Maki and Ochi (1998) and Kuwabara (1999) show evidence that there is a LF undoing in (7). Here we take a look at Kuwabara (1999)’s argument.

Kuwabara (1999) relates the argument to the fact that a *wh*-phrase cannot be c-commanded by the negative polarity item (henceforth, NPI) *sika* (‘only’ when combined with negation), as illustrated by the contrast between (8a) and (8b). In (8c), *wh*-scrambling circumvents the ungrammaticality of (8b). The grammaticality of (8c) shows that the clause-internal scrambling is not reconstructed.

\[(8)\quad \begin{align*}
a. & \quad \text{Dare-ga sono hon-sika yomanakatta-no?} \\
& \quad \text{*wh-nom that book-SIKA read-not-Q} \\
& \quad \text{‘Who read only that book?’}
\end{align*}
\begin{align*}
b. & \quad \text{*Taro-sika nani-o yomanakatta-no?} \\
& \quad \text{Taro-SIKA *what-acc read-not-Q} \\
& \quad \text{‘What did only Taro read?’}
\end{align*}
\begin{align*}
c. & \quad \text{Nani-o Taro-sika yomanakatta-no?} \\
& \quad \text{what-acc Taro-SIKA read-not-Q} \\
& \quad \text{‘What did only Taro read?’}
\end{align*}\]
Kuwabara points out that long-distance scrambling into a clause headed by a [+wh] Comp over an NPI in the matrix clause is ungrammatical (9a), while long-distance scrambling renders the sentence grammatical if the NPI is in the embedded clause (9b). He also observes that the same contrast obtains for cases where the matrix and embedded clauses are headed by a question marker (10).

(9)  a. *Dare-ni Taro-sika [Hanako-ga t\textsubscript{dare-ni} atta-to] omotteinai-no?
   \textit{who-dat Taro-SIKA Hanako-nom met-Comp think-not-Q} \\
   ‘Who does only Taro think that Hanako met?’

 b. Dare-ni Taro-wa [Hanako-sika t\textsubscript{dare-ni} awanakatta-to] omotteiru-no?
   \textit{who-dat Taro-top Hanako-SIKA met-not-Comp think-Q} \\
   ‘Who does Taro think that only Hanako met?’

(10) a. *Dare-ni Taro-sika [Hanako-ga t\textsubscript{dare-ni} atta-ka] siranai-no?
   \textit{who-dat Taro-SIKA Hanako-nom met-Q know-not-Q} \\
   ‘Does only Taro know who Hanako met?’
   ‘Who does only Taro know whether Hanako met?’

 b. Dare-ni Taro-wa [Hanako-sika t\textsubscript{dare-ni} awanakatta-ka] sitteiru-no?
   \textit{who-dat Taro-top Hanako-SIKA met-not-Q know-Q} \\
   ‘Does Taro know who only Hanako met?’
   ‘Who does Taro know whether only Hanako met?’
(9a) and (10a) indicate that the *wh*-phrase must be undone into a position c-commanded by the NPI, leaving the sentence ungrammatical just as (8b). This confronts Takahashi’s analysis with an empirical problem. (9b) and (10b) also show that the *wh*-phrase cannot be put back into the argument position of the embedded VP, otherwise the NPI c-commands the *wh*-phrase. Hence, Kuwabara concludes that the fronted *wh*-phrase involving long-distance *wh*-scrambling must be undone to the first position which a scope marker c-commands the *wh*-phrase from. Therefore, the relevant site for undoing in (9) and (10) is the embedded TP position, given the assumption that the *wh*-phrase has stopped by the embedded TP adjoined position. This means that long-distance *wh*-scrambling as in (7) is another case of scrambling and not an equivalent of English *wh*-movement.59

59 Maki and Ochi (1998) are concerned about the fact that contrary to the interrogative complementizer in Takahashi’s example, *ka*, the interrogative complementizer, *kadooka* ‘whether’ cannot license a *wh*-phrase, as in (i).

(i) *John-ga Mary-ga nani-o katta kadooka siritai.
    *John-nom Mary-nom what-acc bought whether want-to-know
    ‘John wants to know whether Mary bought what.’

The *wh*-phrase can be long-distance scrambled to the clause-initial position headed by the interrogative complementizer.

(ii) Bill-ga nani-o John-ga Mary-ga katta-ka sitteiru kadooka sirabeteiru.
    *Bill-nom what-acc *John-nom Mary-nom bought-Q know whether investigating
    ‘Bill is investigating whether John knows what Mary bought.’

If *wh*-scrambling in (ii) would count as *wh*-movement, this example should be ungrammatical, as its English equivalent; ‘*Bill is investigating what whether John knows Mary bought.’ In addition, the *wh*-phrase takes embedded scope, indicating that the scrambled *wh*-phrase can be undone. Thus, this example also exemplifies the fact that analyzing long-distance *wh*-scrambling into an interrogative clause is not counted as an English type of *wh*-movement.
It is widely assumed that a long-distance scrambled phrase in Japanese lands at a TP adjunct position (Saito, 1992; Tada, 1993; Murasugi & Saito, 1994; among others). Since the long-distance \(wh\)-scrambling in question, (7) is a case of scrambling, it is naturally assumed that the \(wh\)-phrase in (7) is placed in the TP position, as illustrated below.

\[
\text{Scrambling}
\]

\[\text{[CP2 [TP2 \(wh\)-phrase, [TP2 \ldots [CP1 \ldots [TP1 \ldots t_i \ldots] Q_1] \ldots]] Q_2]}\]

Kuwabara also assumes with Watanabe (1992a, b) that the phonetically null element inside \(wh\)-phrase is overtly moved to the Spec CP position to take \(wh\)-scope there. Since he attempts to reconcile Takahashi’s scope-fixing interpretation and his own argument for reconstruction, he has to account for the fact that \(wh\)-feature movement cannot take place prior to application of scrambling. However, it is not necessary to explain the scope-fixing effect, because the relevant \(wh\)-scrambling construction is in fact ambiguous in \(wh\)-scope readings, as exemplified in the results from Experiment 5. What needs to be explained, instead, is a preference for the matrix \(wh\)-scope reading in (7) when any biasing context is unavailable, and why there is an asymmetry in preference of \(wh\)-scope interpretation between in off-line reading and on-line reading of (7). In the next section, I will discuss these issues.

5.3.2 Off-line Preference and On-line Preference
This section first observes off-line *wh*-scope interpretation of *wh*-questions which involve double question markers such as (12) repeated from (7). By off-line interpretation, it is meant that readers simply read a sentence at their own pace and at the end judge whether it obtains an intended meaning. In the previous sections, it is already pointed out that when they read (12) in order to judge whether it has a *wh*-scope interpretation, in a null context, readers prefer to take the matrix *wh*-scope reading (12b) rather than the embedded reading (12a).

(12) Nani-o Taro-wa Hanako-ga tabeta-ka siritagatteiru-no?

  *what-acc  Taro-top  Hanako-nom  ate-Q wants-to-know-Q*

  a. 'Does Taro want to know what Hanako ate?'
  b. 'What does Taro want to know whether Hanako ate?'

(12) can be schematized as (13), in which the *wh*-phrase is adjoined to the matrix Spec TP position (TP2), and the question markers Q₁ and Q₂ are the C heads of the CPs (CP₁ and CP₂, respectively).

(13) \([\text{CP}_2 [\text{TP}_2 \text{wh-phrase}_i [\text{TP}_2 \ldots [\text{CP}_1 \ldots [\text{TP}_1 \ldots t_i \ldots] Q_1] \ldots]] Q_2]\)

(13) simply indicates that the off-line preference might be captured by a principle that it is preferred that the head of the *wh*-phrase chain (*wh*-phrase, tᵢ) take the scope of its closest scope marker. Since the *wh*-phrase in (13) is overtly placed at the matrix TP
position, it is closer to the matrix scope marker $Q_2$ than the embedded scope marker $Q_1$.

This might be why Japanese readers have a preference to the matrix $wh$-scope reading in (12). To examine whether this first generalization of the $wh$-scope preference is on the right track, let us test the following center-embedding structures (14), and corresponding examples (15), which are originally observed by Takahashi (1993: 660).

\begin{align*}
(14) & \quad a. [CP_3 \ldots [CP_2 \ldots [CP_1 [TP_1 \ldots \text{wh-phrase} \ldots ] Q_1 ] \text{Comp}_2 ] Q_3 ] \\
& b. [CP_3 [CP_2 [TP_1 \text{wh-phrase}_1 [CP_1 [TP_1 \ldots t_i \ldots ] Q_1 ] \text{Comp}_2 ] Q_3 ] \\
& c. [CP_3 [TP_1 \text{wh-phrase}_1 [CP_2 \ldots [CP_1 \ldots [TP_1 \ldots t_i \ldots ] Q_1 ] \text{Comp}_2 ] Q_3 ] \\
(15) & \quad a. [CP_3 [TP_3 \text{you-top} [CP_2 [TP_2 \text{John-nom} [CP_1 [TP_1 \text{Mary-nom} \text{what-acc ate} –Q sitteiru] –to ] \text{omotteiru} ] –no]]]
\\& \quad \text{know –Comp think –Q} \\
& \quad ‘\text{Do you think that John knows what Mary ate?}’ \\
& \quad ‘\text{What do you think that John knows whether Mary ate?}’ \\
& \quad b. [CP_3 [TP_3 \text{you-top} [CP_2 [TP_2 \text{what-acc John-nom Mary-nom tabeta} –ka ] \text{t}_{\text{what-acc}} \text{Mary-nom} \text{tabeta} –ka ] \text{sitteiru} ] –to ] \text{omotteiru] –no}]]]
\\& \quad \text{ate –Q know –Comp think –Q}
\end{align*}

\footnote{Note that Takahashi’s representations of structures in (14) and (15) are different in that the $wh$-phrase is in the Spec CP, consistent to his claim that this type of $wh$-scrambling is a type of English $wh$-movement. However, this option has been excluded, since the results from Experiment 5 conclude along with Kuwabara (1999) and Maki and Ochi (1998) that this type of $wh$-question is another example of TP adjunction of scrambling.}
In (15a), *nani-o* stays in its argument position, and it can take scope over either the most deeply embedded clause or the matrix clause, though the latter reading is very marginal. In (15c), *nani-o* is scrambled long-distance into the sentence-initial position, and this is strongly preferred to take the matrix scope. Takahashi (1993) and Abe (1997: 44) judge that this sentence takes only matrix scope reading. However, my informants permit themselves to interpret (15c) as a yes/no question, although they have a strong preference for the matrix scope reading. The crucial case is (15b) schematized in (14b), in which *nani-o* is scrambled into the TP position of the intermediate clause (TP2), which is headed not by a question marker but a declarative complementizer (Comp2). Takahashi’s off-line reading of this sentence is that the *wh*-phrase takes not only the matrix scope but also the most deeply embedded scope. Abe (1997: 44) agrees with one of the reviewers of Takahashi’s paper (Takahashi, 1993: footnote. 4) in that the *wh*-phrase only takes the matrix scope in (15b). The majority of my informants judged it as ambiguous, but relatively preferred to interpret it as a *wh*-question, i.e., with matrix scope. Although the judgment is too subtle to make a definite decision on the acceptability of this reading, no readers/informants prefer to have the embedded scope reading for (15b).

From this survey, the preference is generalized as follows.
(16) A *wh*-phrase is preferred to take scope of the scope marker which it is closest to and c-commands the head of the *wh*-phrase chain.

(16) can capture the preferred reading in the interesting case, (15b). The matrix question marker c-commands the *wh*-phrase, and is the closest one to the *wh*-phrase. As for the preference in (15a), (16) restricts only the embedded question marker to be a preferred scope marker. This prediction seems correct because the matrix reading is strongly marginal. For (15c), the c-command relation is available to both question markers, but the closest one is the matrix question marker. This is borne out, since the matrix reading is strongly preferred in (15c).

Let us test the second case, shown in the following schematic structures. (18) shows examples which corresponds to (17a-c) respectively.

(17) a. \[ CP_3 \ldots [CP_2 \ldots [CP_1 [TP_1 \ldots [wh-phrase \ldots [Comp_1] Q_2 ] Q_3 ] \]

b. \[ CP_3 [CP_2 [TP_2 \ldots [wh-phrase_i [CP_1 [TP_1 \ldots [i \ldots [Comp_1] Q_2 ] Q_3 ] \]

c. \[ CP_3 [TP_3 \ldots [TP_2 \ldots [TP_1 \ldots [Comp_1] Q_2 ] Q_3 ] \]


\[ think–Q know–Q \]

‘Do you know what John thinks that Mary ate?’
‘What do you know whether John thinks that Mary ate?’

b. \[ [\text{CP}_3 [\text{TP}_3 \text{kimi-wa} [\text{CP}_2 [\text{TP}_2 \text{nani-o} [\text{TP}_2 \text{John-ga} [\text{CP}_1 [\text{TP}_1 \text{Mary-ga} \text{ t}_\text{nani-o} \text{ you-top} \text{ what-acc} \text{ John-nom} \text{ Mary-nom}] \text{ tabeta}] \text{ to} [\text{omotteiru}] \text{ ka} [\text{sitteiru}] \text{ no}]]]? \text{ ate-Comp} \text{ think-Q} \text{ know-Q}]

c. \[ [\text{CP}_3 [\text{TP}_3 \text{nani-o} [\text{TP}_3 \text{kimi-wa} [\text{CP}_2 [\text{TP}_2 \text{John-ga} [\text{CP}_1 [\text{TP}_1 \text{Mary-ga} \text{ t}_\text{nani-o} \text{ what-acc} \text{ you-top} \text{ John-nom} \text{ Mary-nom}] \text{ tabeta}] \text{ to} [\text{omotteiru}] \text{ ka} [\text{sitteiru}] \text{ no}]]]? \text{ ate-Comp} \text{ think-Q} \text{ know-Q}

In (18a), the \textit{wh}-phrase remains in its base-generated position. Abe (1997: 45)’s judgment is that this sentence can have both the intermediate scope reading and the matrix scope reading, although the matrix reading is hard to get. On the other hand, Tanaka (1999: 377), presenting a similar example with the same structure corresponding to (17a), judges that the \textit{wh}-phrase can only be associated with the intermediate question marker. My informants agreed with Abe’s judgment, which is the strong preference to interpret it as a yes/no question. The judgment is again not straightforward, but the preference can be captured by (16). The intermediate question marker is closest to the \textit{wh}-phrase, which is c-commanded by the scope marker. Likewise, the preference in (18b) can be predicted by (16), since (18b) has both readings, but is preferred to be read as a yes/no question. The \textit{wh}-fronted case in (18b) has a preference for the matrix scope reading. This is also predictable under (16). For (18c), the c-command relation to the \textit{wh}-phrase is available
for both question markers, but the closest one is the matrix question marker. This is borne out, since the matrix reading is strongly preferred in (18c).

Thus, a relative relation of locations between a *wh*-phrase and a question marker decides the off-line preferences of either the matrix or embedded *wh*-scope reading in *wh*-scrambling constructions which involve two –*ka*, question markers. A *wh*-phrase is preferred to take the scope of its closest scope marker which c-commands it. Lastly let us confirm the preference of the scope reading in a *wh*-in-situ counterpart of Takahashi’s original *wh*-scrambled cases as in (12).

(19) Taro-wa Hanako-ga nani-o tabeta-ka siritagatteiru-no?

* Taro-top Hanako-nom what-acc ate-Q wants-to-know-Q

a. 'Does Taro want to know what Hanako ate?'

b. 'What does Taro want to know whether Hanako ate?'

Takahashi observes that this sentence is ambiguous, but many researchers point out that the matrix scope reading is hard to get (Nishigauchi, 1990; Abe, 1997; Maki & Ochi, 1998; Kuwabara, 1999).61 This is confirmed with my informants that it is strongly preferred to interpret (19) as (19a). (16) captures this preference since the embedded question marker is closest to the *wh*-phrase.

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61 Hirotani (2003) also presents an experimental result that the matrix reading of (19) was not significantly improved even when the prosodic structure was biased to interpret it as a *wh*-question.
The other question that yet remains unanswered is why it is that there is a difference in preferences in *wh*-scope interpretation between on-line reading and off-line reading. For instance, in (12), the embedded scope reading is preferred when readers comprehend a sentence starting with a fronted *wh*-phrase on-line. In contrast, the matrix reading is preferred when they read it in the off-line situation. I point out that the same principle drives both of the on-line and off-line preferences. In both cases, readers prefer to confirm that a dependency between a *wh*-phrase and a scope marker (i.e. Wh-Q dependency) is established as soon as possible. Consider the following schema, in which the parsing model developed in Chapter 4 demonstrates on-line derivation of *wh*-scrambling structure. Recall also the notation that a node inside the brackets indicates a predicted head.
(20)

(20a) is the structure which the parser builds when the embedded subject is processed. Notice that the first opportunity to confirm the wh-Q dependency is inside the embedded clause where the predicted structure of a scrambled wh-phrase [[Wh] [V]] will be in a wh-Q relation to the predicted C head. When the lexical C head, a question marker –ka, is
encountered, readers confirm that the wh-Q dependency in the embedded clause. (20b) is the structure which the parser builds when it encounters the third subject. In this configuration, the most deeply embedded C head is the first opportunity for readers to confirm the wh-Q dependency. This predicts that the on-line preference of wh-scope reading is the most deeply embedded scope reading. In other words, readers who have encountered a wh-phrase expect a wh-scope marker to come with the first verb they see.62

Under the same principle, the off-line preference can be differentiated from the on-line preference. While on-line readers do not confirm a wh-Q dependency until the first question marker is encountered, off-line readers have the first opportunity to confirm the wh-Q dependency when they see a wh-phrase. This is so because in an off-line configuration, a matrix C head may be confirmed as a head for scope marker. Suppose for instance, that off-line readers are asked to judge whether matrix wh-scope reading is available in a relevant sentence like (12). Since the matrix C head has already been confirmed off-line, the readers can first regard it as a scope marker. The locality of the scope marker to the overt wh-phrase allows the readers to interpret the matrix wh-scope reading as a preferred one. To see this difference, compare (20a) with (21), the output structure for (12). The on-line structure in (20a) shows that the lower C head is the one that gives readers the first opportunity to confirm wh-Q dependency, predicting that the embedded scope interpretation is preferred in on-line reading. On the other hand, the matrix question marker appears as a confirmed C head in the off-line structure as in (21).

62 Note that this expectation is consistent with Miyamoto and Takahashi (2000, 2001, 2002c)’s original intuition used for Typing Mismatch effect as a diagnostics for filler-gap dependencies in Japanese.
This realized head allows off-line readers to confirm the wh-Q dependency, predicting that the matrix scope reading is preferred.
Likewise, (22), the off-line structure of (15b), illustrates that the matrix question marker is available to confirm the wh-Q dependency, resulting in a preference for the matrix reading in (15b). Notice that this principle does not need to specify a wh-phrase as being c-commanded by the preferred scope marker as observed in (16). A preferred C head always c-commands the wh-phrase which off-line readers first see and confirm the wh-Q dependency.

Accordingly, both preferences in the on-line reading and the off-line reading are attributable to the same principle, that it is preferred to confirm wh-Q dependency between the (predicted) wh-phrase and an available C head as soon as possible. The differing preferences for on-line and off-line readings straightforwardly stems from the timing of when a question marker can be counted as a confirmed head.

5.4 Summary

This chapter considered syntactic and performance properties of a particular structure of Japanese wh-scrambling. The wh-scrambling structure which has multiple question markers is interesting in that it shows a discrepancy in preferred scope interpretation between on-line and off-line reading. The experimentally-demonstrated embedded scope preference is sometimes incompatible with the off-line scope preference. First an off-line questionnaire study (Experiment 5) was conducted to ensure that the relevant structure is ambiguous in scope readings, contrary to Takahashi (1993)’s
observation. The results provided evidence that both scope possibilities in the relevant structure are available, once semantic context is appropriately controlled. This result is compatible with the preferences obtained from the on-line results (Experiment 1 and 2). This also suggests that Japanese \textit{wh}-scrambling constructions do not exhibit a scope-fixing effect, contrary to Takahashi’s claim. Furthermore, I discussed the syntactic analysis of long-distance \textit{wh}-scrambling, and pointed out a preference principle that can capture both preferences between on-line and off-line. The difference of preferences between the readings is attributed to the timing when a question marker is counted as a confirmed head.
CHAPTER 6

WHY LOCALITY MATTERS TO SCRAMBLING

6.1 Introduction

This chapter turns from a psycholinguistics discussion of wh-dependencies to a proper account of syntactic restriction on wh-scope interpretation in Japanese. My focus is on syntactic properties in the scope construal process in the wh-in-situ questions and their relations with scrambling operations.

It is widely assumed that the wh-phrase in the in-situ position covertly moves in order to be licensed by the scope marker (Chomsky, 1973; May, 1977; Huang, 1982; Lasnik & Saito 1984, 1992; among others). In (1a), for instance, in order to receive a wh-scope interpretation, the wh-in-situ phrase, *dare* ‘who’ crosses the clause boundary and reaches the matrix Spec CP, (1a’). In the wh-scrambled questions, (1b), the wh-phrase is overtly moved to the matrix Spec TP (Saito, 1992; Tada, 1993; Saito 1994; Saito & Murasugi, 1994; among others). Furthermore, I assume that the scrambled

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63 More precisely, covert movement (also known as LF movement) means that an element is moved between S-Structure (Pre-Spell-out, in the Minimalist term) and LF component. Overt movement means that a relevant operation occurs between D-Structure and S-Structure. Furthermore, the choice of a movement analysis or a feature-agreement analysis is irrelevant for this discussion. I use a movement approach.
*wh*-phrase in (1b) is raised covertly to the matrix Spec CP for *wh*-scope licensing, illustrated in (1b’).

(1) a.  
John-wa [Mary-ga dare-ni atta-to] omotteiru-no?

*John-top Mary-nom who-dat met-Comp think-Q*

‘Who does John think Mary met?’

a’.  
[CP dare-ni [TPJohn-wa [VP[CP[TPMary-ga t_dare atta]-to]omotteiru]-no]]

b. Dare-ni John-wa [Mary-ga t_dare-ni atta-to] omotteiru-no?

*who-dat John-top Mary-nom met-Comp think-Q*

‘Who does John think Mary met?’

b’ [CP dare-ni [TP t_dare-ni [IPJohn-wa [VP[CP[TPMary-ga t_dare atta]-to] omotteiru]]-no]

Given assumptions that both *wh*-in-situ questions and *wh*-scrambled questions in Japanese involve ‘long-distance’ *wh*-movement at S-Structure or LF, a question naturally arises about the relation between this long-distance *wh*-movement and Subjacency.64

Section 6.2 surveys how Subjacency applies to *wh*-movement. For instance, a well-known contrast is illustrated in (2a) and (2b), which shows an asymmetry in island

64 There has been much discussion regarding a notion of bounding nodes (Chomsky 1973, 1977, 1981, 1986b; Rizzi 1978; among others). I take the following definition of Subjacency.

(i) In the following configuration, where \( \alpha \) and \( \beta \) are bounding nodes, \( X \) cannot be moved to the position of \( Y \):

\[
... Y ... [\alpha \ldots [\beta \ldots X \ldots ] \ldots ] \ldots Y ...
\]
effects between \( \textit{wh}-\text{in-situ} \) questions and \( \textit{wh}-\text{scrambled} \) questions. \( \textit{Wh}-\text{in-situ} \) questions do not exhibit Complex NP island effects (2a) (Nishigauchi, 1986, 1990; Richards, 2000), while \( \textit{wh}-\text{scrambled} \) questions do (2b) (Haig, 1976; Harada, 1977; Saito 1985).

\[(2)\]

a. John-wa [Mary-ga dare-ni atta-to yuu mondai-o] kentoositeiru-no?

\(\textit{John-top Mary-nom who-dat met-that say problem-acc investigating-Q}\)

‘Who is the person x such that the John is investigating the problem that Mary met x?’

b. ?*Dare-ni John-wa [Mary-ga t\text{dare-ni} atta-to yuu mondai-o]

\(\textit{who-dat John-top Mary-nom met-that say problem-acc investigating-Q}\)

‘?*Who is the person x such that John is investigating the problem that Mary met x?’

Along the lines of Huang (1982) and Lasnik and Saito (1984), I assume that the differences seen in the \( \textit{wh}-\text{in-situ} \) questions and the \( \textit{wh}-\text{scrambled} \) questions have to do with the point in the derivation at which \( \textit{wh}\)-movement takes place.\textsuperscript{65} There are two competing approaches to Subjacency constraints: Subjacency as a constraint on overt

\textsuperscript{65} Cole and Hermon (1994), Tsai (1994), and Reinhart (1995) propose another approach in which some or all cases of \( \textit{wh}-\text{in-situ} \) are interpreted in-situ, without assuming an operation of LF movement. This chapter does not present a theoretical comparison between LF movement and non-LF movement approaches. Because the cases governed by Subjacency would be classified as movement by all approaches, the discussion here considers the level at which this movement should occur.
movement only and so applying only to S-Structure phrasal movements (Huang, 1982; Lasnik and Saito, 1984; among others) or Subjacency as a constraint on the movement operation per se and governing operations at the both S-Structure and LF levels (Nishigauchi 1986, 1990; Choe, 1987; Pesetsky, 1987). In Section 6.3, I briefly overview how each approach applies to the asymmetries in Japanese wh-in-situ questions among island types. Sharing the spirit of Ochi (1999)’s work, I argue that the locality effects seen in LF are not constrained by Subjacency conditions at all but only by minimality constraints (Rizzi, 1990; Chomsky, 1993).

Once Subjacency effects observed in LF are reduced to the minimality conditions, it follows that Subjacency holds only on the S-Structure level, as Huang (1982) and Lasnik and Saito (1984) argue. This conclusion leads us to re-examine the radical view of scrambling recently proposed by Bošković and Takahashi (1998). In Section 6.4, I point out that their hypothesis that scrambling is an LF lowering operation is not compatible with the current account of the Subjacency effects witnessed in Japanese scrambling constructions. I will also argue that although there exist apparent similarities between Bošković and Takahashi’s theory and the parsing theory I have developed in previous chapters, the two theories do not reach the same predictions and conclusions regarding real-time formation of wh-dependencies.

6.2 Subjacency Effects in Japanese Wh-questions
Focusing on the wh-island constraint and the Complex NP constraint, this section surveys how Subjacency applies to Japanese wh-questions, and observes two types of asymmetry in locality effects. The first asymmetry that has been discussed in the literature (Nishigauchi 1986, 1990; Richards, 2000) is that LF movement of the wh-in-situ element in wh-questions is subject to the wh-island condition but not to the Complex NP condition. I point out that there is also another asymmetry, which is that LF movement of wh-in-situ element is generally free from the Complex NP condition, but it is not when it takes place in a structure which wh-island is embedded by a nominal complex clause.66

66 There is in fact a third asymmetry in which multiple wh-phrases are involved. LF movement of the wh-in-situ element from wh-in-situ questions is usually free of the Complex NP constraint (i), but the movement is subject to the Complex NP constraint when the wh-question involves scrambling of another wh-phrase (ii).

(i) Kootyoo-wa [Tanaka sensei-ga dare-ni dasita syukudai-ni] nani-o tukekuwaeta-no? Principal-top Prof Tanaka-nom who-dat assigned homework-dat what-acc added-Q
‘Who is the person x and what is the thing y such that the principal added y to the homework who Prof. Tanaka assigned to x?’

*Who is the person x and what is the thing y such that the principal added y to the homework who Prof. Tanaka assigned to x?’

As seen in (2a), Japanese wh-in-situ phrases can be extracted from a relative clause in LF, so that (i), while having another wh-in-situ phrase, is a perfectly grammatical sentence. It also must obtain a pair-list reading, implying an answer such as ‘He added a math assignment to the homework that Prof. Tanaka assigned to John, a writing assignment to the homework that Prof. Tanaka assigned to Mary, and a reading assignment to the homework that Prof. Tanaka assigned to Tom.’ However, the wh-scrambled counterpart as in (ii) is unacceptable. It cannot receive a pair-list reading.

This contrast seems quite interesting, since local scrambling induces the CNP island effect in LF. Island constraints matter in (ii), because (iii), in which no island constraints are involved, is as grammatical as (i).

(iii) Dare-ni kootyoo-wa [Tanaka sensei-ga dare-ni syukudai-o dasita-to] tani-o iituketa-no? who-dat principal-top Prof Tanaka-nom who-dat homework-acc assigned-Comp told-Q
‘Who is the person x and who is the person y such that the principal told y that Prof Tanaka assigned the homework to x?’
Before examining these asymmetries, let us briefly consider cases in which the *wh*-island constraint of Subjacency is involved. Japanese *wh*-questions obey *wh*-island constraints at LF. For instance,\(^{67}\)

(4) ??John-wa [Mary-ga nani-o tabeta kadooka] oboeteiru-no?

\[\text{John-top Mary-nom what-acc ate whether remember-Q}\]

«??What is the thing x such that John remembers whether Mary ate x?»

(5) * Nani-o John-wa [Mary-ga t\text{\_nani-o} tabeta kadooka] oboeteiru-no?

\[\text{what-acc John-top Mary-nom ate whether remember-Q}\]

«??What is the thing x such that John remembers whether Mary ate x?»

In (4) and (5), the *wh*-phrase inside the embedded *wh*-clause necessarily takes matrix scope. However, moving it across the question complementizer *kadooka* ‘whether’ induces a *wh*-island effect, while the question marker does not. The unacceptability in (4), in particular, follows if LF movement is subject to the *wh*-island condition as Huang (1982) argues.

\(^{67}\) Lasnik and Saito (1984, 1992) regard (4) as a grammatical sentence, but in later literature, (4) is judged as a degraded sentence (Nishigauchi, 1986; Watanabe, 1992a, b; among others). I follow the latter judgment in this discussion.

Unfortunately, the relevant data such as (ii) are not stable in that it might be affected by other factors such as prosodic effects, case-(mis)matching, and inanimate versus animate relative heads. In the current discussion, therefore, I will focus only on cases of simple *wh*-questions. I leave interactions between *wh*-scrambling such as (ii) and island effects as future research. I also thank Masaya Yoshida and Tomohiro Fujii for sharing a lot of time to discuss this data.
Now let us turn to another example of \textit{wh}-movement; extraction of a \textit{wh}-phrase from a complex NP island (Ross, 1967) (henceforth, CNP-island). As already seen in (2a), Japanese \textit{wh}-in-situ phrases can be extracted in LF, from a relative clause (6) and from a ‘pure’ nominal complex clause (7), repeated from (2a).

(6) John-wa [dare-o hihansita ronbun]-o yondeiru-no?
\textit{John-top who-acc criticized paper-acc reading-Q}
‘Who is the person x such that John is reading the paper that criticized x?’

(7) John-wa [Mary-ga dare-ni atta-to yuu mondai-o] kentoositeiru-no?
\textit{John-top Mary-nom who-dat met-Comp say problem-acc investigating-Q}
‘Who is the person x such that the John is investigating the problem that Mary met x?’

(6) is an example of the cases where a \textit{wh}-phrase inside the relative clause can be moved to the matrix Spec CP to receive the scope. In (7), the \textit{wh}-phrase inside a ‘pure’ complex NP clause can also be moved to the matrix CP for the same reason. In both cases, \textit{wh}-movement at LF is immune to a complex NP island constraint.

However, CNP-island effects are observed in the overt movement of \textit{wh}-phrase as already seen in (2b). Just as in the English counterparts (10) - (11), Japanese \textit{wh}-in-situ
phrases cannot be overtly extracted, from a relative clause (8) and from a ‘pure’ nominal complex clause (9) repeated from (2b).68

(8)  *Dare-o  John-wa [tdare-o  hihansita  ronbun]-o  yondeiru-no?
    who-acc  John-top  criticized  paper-acc  reading-Q

   ‘*Who is the person x such that John is reading the paper that criticized x?’

(9)  ?*Dare-ni  John-wa [Mary-ga  t_dare-ni  atta-to  yuu mondai-o]
    who-dat  John-top  Mary-nom  met-Comp  say problem-acc
    kentoositeiru-no?
    investigating-Q

   ‘?*Who is the person x such that John is investigating the problem that Mary met x?’

(10)  *Whom is John reading the paper that criticizes?

(11)  ?*Whom is John investigating the problem that Mary met?

(12) is a summary table of the observations on wh-island and complex NP island effects. The numbers in parentheses correspond to the examples cited above.

68 As originally noted by Haig (1976), the CNP-island effect on long-distance scrambling is exactly like that on wh-movement in English in that it is strong in the case of extraction out of relative clauses but varies in strength in the case of extraction out of ‘pure’ CNP clause as in (9).
(12) *Does movement of the wh-phrase obey the island constraint?*

<table>
<thead>
<tr>
<th>Application Level</th>
<th>Types of Island</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Wh</td>
</tr>
<tr>
<td></td>
<td>Relative</td>
</tr>
<tr>
<td>a. wh ... [island... ( t_{wh} ) ...] at LF</td>
<td>Yes (4)</td>
</tr>
<tr>
<td>b. wh ... [island... ( t_{wh} ) ...] at S-Str</td>
<td>Yes (5)</td>
</tr>
</tbody>
</table>

Now let us complicate the situation in the *wh*-island cases by placing a *wh*-phrase in the *wh*-island into a CNP-island. Consider the following such examples. All of them are unacceptable. Their unacceptability should stem from a violation of *wh*-island constraint, since CNP-island constraints cannot exclude the cases as we saw in (7). This is the second asymmetry, that LF movement of *wh*-in-situ element is free from the complex NP conditions, but it is not when it takes place in a structure which *wh*-island is embedded by a CNP-island. Thus, while the first asymmetry was an asymmetry between the overt and covert forms of *wh*-movement, the second asymmetry is an asymmetry within the covert movement cases.

(13) *John-wa [[Mary-ga dare-ni atta-kadooka] to yuu mondai-o] kentoositeiru-no?*

*John-top Mary-nom who-dat met-whether Comp say problem-acc investigate-Q*

*‘Who is the person x such that John is investigating the problem whether Mary met x?’*

(14) *Dare-ni John-wa [[Mary-ga t_{dare-ni} atta-kadooka] to yuu mondai-o]*

*Who-dat John-top Mary-nom met-whether that say problem-acc kentoositeiru-no?*

*investigate-Q*
‘Who is the person x such that John is investigating the problem whether Mary met x?’

A summary of the entire observation is as follows.

(15)  *Does movement of the wh-phrase obey the island constraint?*

<table>
<thead>
<tr>
<th>Application Level</th>
<th>Types of Island</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Wh</td>
</tr>
<tr>
<td></td>
<td>Relative</td>
</tr>
<tr>
<td>a. wh … [island… twh …] at LF</td>
<td>Yes (4)</td>
</tr>
<tr>
<td>b. wh … [island… twh …] at S-Str</td>
<td>Yes (5)</td>
</tr>
</tbody>
</table>

The table shows two types of asymmetry in locality effects. First, LF movement of *wh*-phrase is subject to the *wh*-island condition but not to the CNP-island conditions. Secondly, *wh*-movement in cases like (13) is banned when it takes place in a structure which a *wh*-island structure is embedded by a CNP-island, as opposed to a lack of to the CNP-island effects in the structures in (6) and (7).

A number of approaches have been proposed to explain first type of asymmetry. The next section briefly reviews two major approaches to explain this asymmetry. In Section 6.3.2, I attempt to incorporate both types of asymmetry into a general account.

6.3 Subjacency and Minimality

6.3.1 Two Approaches
One class of approaches maintains that LF *wh*-movement is subject to Subjacency. This immediately explains the presence of *wh*-island violations for *wh*-movement in LF. Meanwhile, a lack of the CNP-island in Japanese has been argued for by assuming that the entire complex NP containing a *wh*-phrase is covertly moved to the Spec CP without crossing bounding nodes. Accounts of this type have been developed by Nishigauchi (1986, 1990), Choe (1987), and Pesetsky (1987). Thus, they claim that LF movement is also subject to Subjacency, taking the cases involved in *wh*-island effect as manifesting a Subjacency violation, and CNP-island cases like (16), repeated from (6), as involving only apparent violations of the CNP-island effect of Subjacency.

(16) John-wa [dare-o hihansita ronbun-o] yondeiru-no?

\[ \text{John-nom who-acc criticized paper-acc reading-Q} \]

‘Who is the person x such that John is reading the paper that criticized x?’

To deal with (16), they propose that the entire complex NP be pied-piped to Spec CP of the matrix clause at LF. The CNP-island may in this way be circumvented by LF movement of the entire complex NP to the Spec CP without crossing bounding nodes. Nishigauchi (1990) suggests that *wh*-movement occurs only inside the relative clause, and that this movement has the effect of marking the entire complex NP a *wh*-phrase by virtue of a device called feature percolation. The *wh*-feature is percolated through the Spec positions, as illustrated below.
Since the entire DP is identified as a *wh*-phrase, it can now move to Spec CP of the matrix clause.

(18) \[ \text{CP [DP [dare-o hinansita] ronbun-o] [IP John-ga t yondeiru] no] \]

Since movement of the complex NP itself does not cross an island in (18), (16) is grammatical.\(^{69}\)

Empirical evidence that has been offered for the pied-piping account considers the ways to answer *wh*-questions. Japanese *wh*-questions such as (19a) are in general able to be answered by means of an expression filling in the value for the *wh*, followed by a copula as in (19b).

\(^{69}\) There are languages such as Sinhala (Kishimoto, 1992) which have the device of obligatorily indicating the size of *wh*-phrases so that large-scale pied-piping is overtly marked. Pesetsky (1987) discusses a similar device for explaining the Japanese asymmetry.
(19)  a.  Dare-ga katta-no?

*who-nom won-Q*

‘Who won?’

b.  John desu.

*John copula*

‘(It’s) John.’

An answer for (16) can be either of a short answer (20a) or a long answer which includes
the relative clause (20b).

(20)  a.  Chomsky desu.

*Chomsky copula*

‘(It’s) Chomsky.’

b.  Chomsky-o hinansita ronbun desu.

*Chomsky-acc criticized book copula*

‘(It’s) a paper that criticized Chomsky.’

Nishigauchi (1990) points out that a long answer like (20b) corresponds to the portion
which occupies the operator position as in the CP position in (18), as a result of
pied-piping in the LF representation.\textsuperscript{70, 71}

The second class of approaches maintains that LF movement of a \textit{wh}-phrase is simply not subject to the relevant island constraints. Huang (1982 and much subsequent work) claims that Subjacency holds only of overt movement.\textsuperscript{72} First consider English cases (21) - (23).

\textsuperscript{70} Fiengo, Huang, Lasnik, and Reinhart (1988) and Lasnik and Saito (1992) argue against this evidence for the LF pied-piping account. Lasnik and Saito (1992) point out that the pied-piping hypothesis has to deal with the fact that certain adjuncts do not allow large-scale pied-piping. Consider the ill-formed sentence as below.

(i) *John-wa Mary-ga naze kaita hon-o yondeiru-no?

\textit{John-top Mary-nom why wrote book-acc reading-Q}

Lit. ‘Is John reading a book that Mary wrote why?’

If LF pied-piping is possible, (i) should be grammatical, since there would be no extraction from an island. It must be assumed that this type of pied-piping is not possible with adjuncts like \textit{naze}, ‘why’. In the framework of Chomsky (1986) and Lasnik and Saito (1984, 1992), the ungrammaticality of (i) has been analyzed as an ECP effect, which is stronger than an ordinary Subjacency violation. See also von Stechow (1996) for a counter-argument in the light of the interpretation derived by LF pied-piping.

\textsuperscript{71} Note also that this account has difficulty capturing the CNP-island effects seen in cases where one \textit{wh}-phrase is clause-internally scrambled and the other \textit{wh}-in-situ phrase in a relative clause needs to be moved to the matrix CP for scope-licensing, (i), as introduced in footnote 61. The feature percolation device incorrectly turns (i) into an acceptable sentence. Under this assumption, \textit{wh}-movement occurs only inside the relative clause, and this movement has the effect of marking the entire complex NP as a \textit{wh}-phrase. If this feature percolation device is applied to the relative clause in (i), this sentence should obtain a pair-list reading just as a simple case of multiple \textit{wh}-questions such as (ii) does. The assumption of feature percolation crucial for the pied-piping analysis of LF Subjacency improperly predicts that the \textit{wh}-scrambled questions violating CNP-island constraint are grammatical.

\textsuperscript{72} Reinhart (1995) and Cole and Hermon (1994, 1998) also maintain that the \textit{wh}-phrases in CNP-island are simply not subject to the relevant island constraints, but they have a different reason for it. They argue that the lack of CNP-island is attributable to no \textit{wh}-movement at any point in the derivation.
(21) Who remembers where John bought what?

(22) Who is reading a book that criticizes whom?

(23) Who praised the plan that Mary meets who?

It has been observed that *wh*-in-situ in English has a lot of freedom with respect to the *wh*-island condition. Baker (1970) observes that (21) can be ambiguous with respect to scope. One reading is that *what* has the same scope as *where*, and the other one is that *what* has the matrix scope and is paired with *who*. This fact has been taken to indicate that LF movement in English is free from *wh*-island effects. Likewise, LF movement in English is immune to CNP-island conditions, (22) and (23). Just as the English cases, according to this approach, LF *wh*-movement in *wh*-in-situ languages should not be constrained by Subjacency.

A natural question is then why LF movement of Japanese *wh*-phrase displays obedience to *wh*-island effects. One possible answer proposed by Watanabe (1992a, b) is to assume that *wh*-in-situ questions in Japanese in fact involve movement in overt syntax, not LF movement. He proposes that a phonologically invisible operator undergoes overt movement. (24a) is associated with the representation (24b) in overt syntax.


*John-top Mary-nom what-acc bought-Q want-to-know*

‘John wants to know what Mary bought.’

The empirical evidence Watanabe offers is a contrast between (25a) and (25b).

(25)  a. *? John-wa [Mary-ga nani-o tabeta kadooka] Tom-ni osieta-no?

\[ \text{John-top Mary-nom what-acc ate whether Tom-dat told-Q} \]

‘*? What is the thing x such that John tell Tom whether Mary ate x?’

b. ?John-wa [Mary-ga nani-o tabeta kadooka] dare-ni osieta-no?

\[ \text{John-top Mary-nom what-acc ate whether who-dat told-Q} \]

‘? Who is the person x is what the thing x such that John tell x whether Mary ate y?’

In (25a), the only way for the operator of \( wh \)-phrase in the embedded clause to take matrix scope overtly is to move directly out of the \( wh \)-island headed by \textit{kadooka}, ‘whether’. This is a violation of Subjacency. In contrast, in (25b), it is possible to apply overt movement of the operator out of \textit{dare-ni}, ‘who-dat’ a \( wh \)-phrase in the matrix clause. Subsequently at LF, the \( wh \)-phrase in the embedded clause may be moved to the matrix Spec CP. This is doable because LF \( wh \)-movement is not affected by Subjacency. This accounts for the acceptability of (25b). Thus, the \( wh \)-island effects shown by Japanese \( wh \)-questions are no longer due to LF movement, but are attributed to overt movement. Therefore, Japanese \( wh \)-questions behave just as English \( wh \)-questions with respect to Subjacency.
Let us turn to the cases of CNP-island effects. If LF movement of a *wh*-phrase is simply not subject to the relevant island constraints, this approach explains straightforwardly cases lacking CNP-island effects in Japanese *wh*-movement at LF. To capture cases where CNP-island effects should be predicted, but are not observed, Watanabe (1992a, b) claims that it is possible to have the operator originating in the spec position of the complex NP containing the *wh*-phrase. The operator moves to Spec CP overtly. Under this explanation, (26a) is associated to (26b) for the representation at the S-Structure. This process is very similar to the LF pied-piping approach.


   *John-nom who-acc criticized paper-acc reading-Q*

   ‘Who is the person x such that John is reading the paper that criticized x?’

   b. [CP Op₃ [IP John is reading [DP t₃ [that criticized [t₃ whom]] book]]Q]

This section overviewed two major approaches to an asymmetry of Subjacency effects which was observed in Section 6.2. In the next section, I point out that the other asymmetry cannot be captured by the former view that LF *wh*-movement is subject to Subjacency. I argue with Ochi (1999) that LF *wh*-movement is not constrained by the Subjacency condition, but in fact by the minimality condition.

### 6.3.2 Minimality Condition
In this section, I suggest following Ochi (1999) that both *wh*-island and CNP-island effects observed in LF fall under Relativized Minimality effects (henceforth, RM effects). As a consequence, Subjacency holds only of overt movement, as Huang (1982) originally claimed, but locality effects at both the S-Structure and LF levels are also governed by minimality.

Although there are several versions of the relativized minimality condition (Rizzi, 1990; Chomsky & Lasnik, 1993; Chomsky, 1995a), I simply assume the Minimal Link Condition under an Attract F hypothesis (Chomsky, 1995a: Chapter 4). Under this hypothesis, movement is triggered solely by the need for the target K to check off its formal feature(s) by attracting the closest relevant feature F. The Minimal Link Condition is defined as follows.

(27) Minimal Link Condition (MLC: Chomsky, 1995a: 331)

\[ K \text{ attracts } \alpha \text{ only if there is no } \beta, \beta \text{ closer to } K \text{ than } \alpha, \text{ such that } K \text{ attracts } \beta. \]

Under the MLC, the matrix interrogative C attracts the closest relevant feature. The *wh*-feature of *what* in (28b) is not the closest relevant feature; rather that in *whether* is the closest, yielding ungrammaticality in (28b), as opposed to (28a) in which there is no closest relevant feature.

(28) a. What did John think that [Mary ate t]?

b. *What did John wonder [whether Mary ate t]?
Now let us examine how this hypothesis can account for the asymmetries in Subjacency effects observed in Section 6.2. (29) is the summary table, repeated from (15).

(29)  Does movement of the wh-phrase obey the island constraint?

<table>
<thead>
<tr>
<th>Application Level</th>
<th>Types of Island</th>
<th>Wh</th>
<th>CNP</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Pure</td>
</tr>
<tr>
<td>a. wh … [island… twh …] at LF</td>
<td>Yes (4)</td>
<td>No (6)</td>
<td>No (7)</td>
</tr>
<tr>
<td>b. wh … [island… twh …] at S-Str</td>
<td>Yes (5)</td>
<td>Yes (8)</td>
<td>Yes (9)</td>
</tr>
</tbody>
</table>

As discussed in Maki (1995) and Ochi (1999), the wh-island effects follow from the definition of Attract as restricted by the Minimal Link Condition. Since the wh-feature of kadooka ‘whether’, is closer to the matrix C than that of the wh-phrase, the latter cannot be attracted by the matrix C. (30) illustrates this analysis. 73

(i) Who remembers where John bought what?

The relevant feature of what in (i) does not have to be moved, since the morphological requirement of the matrix C is satisfied by the closest wh-feature of who.

However, note Ochi (1999: 40-41). He discusses the fact that the movement analysis can be distinguished from the pure unselective binding approach (Aoun & Li, 1993 for Chinese, Saito, 1998 and Shimoyama, 2001 for Japanese) in particular in cases where an additional wh-phrase outside the island improves the sentence (iib), as opposed to (iia).

(ii) a. ?*John-ga Mary-ga nani-o tabeta kadooka Tom-ni tazuneta-no?
   John-nom Mary-nom what-acc ate whether Tom-dat asked-Q
   ‘?*What did John ask Tom whether Mary ate t?’

   b. John-ga Mary-ga nani-o tabeta kadooka dare-ni tazuneta-no?
   John-nom Mary-nom what-acc ate whether who-dat asked-Q
   ‘Who did John ask t whether Mary ate what?’

73 The lack of LF wh-island effects in English is explained by assuming with Chomsky (1995a), Tsai (1994), Reinhart (1995), and Ochi (1999), that argument wh-in-situ in English is licensed in-situ via unselective binding.
Next, let us consider one of the asymmetry cases in which LF movement of $wh$-phrase is immune to the complex NP conditions whereas that movement is banned from the combined island of CNP-island + embedding $wh$-island. First compare (31) with (32), repeated from (6) and (7) respectively.

(31) John-wa [[dare-o hihansita] ronbun-o] yondeiru-no?

John-nom who-acc criticized paper-acc reading-Q

‘Who is the person x such that John is reading the paper that criticized y?’

(32) John-wa [Mary-ga dare-ni atta-to yuu mondai-o] kentoositeiru-no?

John-top Mary-nom who-dat met-that say problem-acc investigating-Q

‘Who is the person x such that the John is investigating the problem that Mary met x?’

He also discusses the fact that the improved status is expected under the movement analysis, but not under the pure unselective binding analysis. There is no need for the C to attract the feature of $nani-o$, because a feature either of $kadooka$ or $dare-ni$ is attracted. The pure unselective binding account, on the other hand, has to explain why the presence of $dare-ni$ outside of the island in (ib) makes a difference for unselective binding.
(31) and (32) both show that LF movement of the relevant feature of the \textit{wh}-phrase is free from the CNP-island. The structure of (32) does not instantiate any RM effects, just as that of (31). There is no potential \textit{wh}-feature closer to the matrix C head.

Now consider (33), repeated from (13).

(33) *John-wa [[Mary-ga dare-ni atta-kadooka] to yuu mondai-o] kentoositeiru-no?

\textit{John-top Mary-nom who-dat met-whether that say problem-acc investigate-Q}

*‘Who is the person x such that John is investigating the problem whether Mary met x?’

In (33), a question complementizer, \textit{kadooka} ‘whether’ is inside the complex NP clause. The unavailability of the matrix \textit{wh}-scope reading in (33) indicates that the \textit{wh}-feature cannot be moved out of the complex NP clause. LF movement of the \textit{wh}-phrase is banned by some locality condition at LF. Subjacency cannot explain this fact, because (32) is perfectly grammatical. However, the minimality condition, MLC makes a sharp distinction between the grammaticality of (32) and the ungrammaticality of (33). (32) is grammatical because there is no closer \textit{wh}-phrase, so the RM condition does not apply. On the other hand, (33) is ungrammatical because the question complementizer \textit{kadooka} is closer to the scope marker. Thus, the contrast between (32) and (33) indicates that in some cases, Subjacency is insufficient to rule out the matrix \textit{wh}-scope reading.

Taken together, all the cases examined as Subjacency effects at LF are captured by RM effects on the \textit{wh}-feature. Island effects regarding \textit{wh}-movement at LF are
attributed to the minimality condition. Notice that this conclusion favors the second type of approach to explain Subjacency effects: Subjacency is a constraint only for overt syntactic operations. This is so because overt \( wh \)-movement is constrained by both the Subjacency condition and the minimality condition, whereas LF \( wh \)-movement is constrained not by Subjacency but only by the minimality condition.

6.4 Implications for Views of Scrambling Operation

The conclusion drawn from the discussion in the previous sections is that the Subjacency condition does not apply to \( wh \)-movement in LF. In this section, I will argue that this consequence favors one of two views of the scrambling operation: (i) the ‘traditional’ view of scrambling as an overt movement (Harada, 1972; Haig; 1976; Saito, 1985; among others), rather than (ii) the ‘radical’ view of scrambling as an LF lowering operation (Bošković and Takahashi, 1998). Based on the argument made in the previous sections, I point out that the former analysis of scrambling is compatible with the conclusion that Subjacency holds only on overt movement, but that the latter account of scrambling is problematic if Subjacency cannot be applied at LF.

74 There are also two major subtypes of approaches to scrambling as an overt movement. First, that scrambling is driven by licensing a feature specifying the scrambling operation (Miyagawa, 1997, 2001, Grewendorf & Sabel, 1999; Sauerland, 1999; among others). This has an advantage of complying with the economy principle in the minimalist program. The second type of approach maintains optionality of the scrambling operation, and seeks to develop a theory of optionality compatible with minimalist tenets (Fukui, 1993; Saito 1994, 2002; Saito & Fukui, 1998; Agbayani, 1998, 1999; among others). This discussion is silent about differences between these approaches. Readers are referred to the literature cited above.
The radical view of scrambling alluded to was recently proposed by Bošković and Takahashi (1998), and followed by Oku (1998) and Stepanović (1999). Bošković and Takahashi (henceforth, B&T) claim that the ‘scrambled’ element is overtly base-generated in its surface position (see also Kitagawa (1990)), and undergoes an LF process of lowering into its argument position to check θ-roles. Under B&T’s framework, an example of ‘long-distance’ scrambling (34) is analyzed as in (35).

(34) sono hon-o John-ga [Mary-ga t_{sono hon-o} katta-to] omotteiru.

\textit{That book-acc John-nom Mary-nom bought-Comp think}

‘That book, John thinks that Mary bought.’

(35) Numeration $\Rightarrow$ (a) before Spell-out $\Rightarrow$ (b) at LF

\begin{enumerate}
\item a. sono hon-o John-ga [Mary-ga katta-to] omotteiru
\item b. t [John-ga [Mary-ga sono hon-o sono hon-o katta-to] omotteiru]
\end{enumerate}

In (34a), the accusative NP \textit{sono hon-o} ‘that book-acc’ is base-generated at the sentence-initial position. At LF as in (34b), the NP is obligatorily lowered to the θ-position, given the assumption that θ-roles in Japanese are weak features capable of driving LF movement as a last resort. This analysis has an advantage of eliminating the optional property of scrambling and complying with Chomsky (1986a, 1995a)’s notion of movement as last resort.
Following Saito (1992) and Tada (1993), B&T present the fact that a scrambled phrase cannot bind into an anaphor constrained in the matrix clause where the phrase has been long-distance scrambled.

\[(36) \quad \* [\text{Mary to Pam}-ni \ [\text{otagai}-\text{no hahaoya}- ga] \ [\text{John-ga} \ \text{t}; \ \text{atta to}] \ \text{omotteiru.} \]

*Mary and Pam-dat each other-gen mother-nom John-nom met that think*

‘Mary and Pam, each other’s mothers think that John met.’

In contrast, a scrambled anaphor can be licensed by a binder which does not c-command it at S-Structure, if scrambling obligatorily reconstructs and binding takes place at LF. Thus, B&T’s framework straightforwardly accounts for the necessary undoing of scrambling.

\[(37) \quad \text{Otagai}-ni [\text{John-no hahaoya}-ga \ [[\text{Mary to Pam}]-ga t; \ atta to] \ \text{omotteiru.} \]

*each other-dat John-gen mother -nom Mary and Pam-nom met that think*

‘Each other, John’s mother thinks that Mary and Pam met.’

Now consider the following examples in which the phrase is scrambled out of the complex NP clause (38) and (39), repeated from (8) and (9) respectively.

\[(38) \quad \* \ [\text{Dare-o John-wa} \ [\text{t_dare-o hihansita ronbun}]\text{-o yondeiru-no}? \]

*who-acc John-top criticized paper-acc reading-Q*

250
\[ (*\text{Who is the person } x \text{ such that John is reading the paper that criticized } x?*) \]

(39)  
\[ \text{Dare-ni John-wa [Mary-ga t\text{dare-ni} atta-to yuu mondai-o]} \]
\[ \text{who-dat John-top Mary-nom met-that say problem-acc} \]
\[ \text{kentoositeiru-no?} \]
\[ \text{investigating-Q} \]
\[ (*?*\text{Who is the person } x \text{ such that John is investigating the problem that Mary met } x?*) \]

Unacceptability of (38) and (39) can be attributed to violation of the CNP-island constraint. This account is consistent with the conclusion that overt movement (i.e. scrambling in this case) is constrained by Subjacency only if scrambling is assumed to be a type of overt movement. On the other hand, it is problematic if scrambling is assumed to be an LF lowering operation, since Subjacency is not a constraint for LF operations. I am assuming that minimality can still apply at LF, but that it is irrelevant unless an element legitimately intervenes blocking the lowering of a ‘scrambled’ phrase. In (38) and (39), under B&T’s framework, nothing prevents the phrases from LF lowering to its \( \theta \)-position since there is no potential feature relevant to blocking of lowering of the phrases. Therefore, the minimality constraint does not block LF lowering in this case. This wrongly predicts the sentence is grammatical. The Subjacency condition does not
solve this problem, since it does not apply at LF. Thus, B&T’s view of scrambling cannot account for CNP-island effects on *wh*-scrambling.  

In contrast to the radical view of scrambling as LF lowering, the traditional view of scrambling as overt movement has the advantage of explaining unacceptability of (38) and (39). The explanation of these cases is straightforward. Since Subjacency is a constraint of overt movement, extraction of a phrase from the CNP-island is prohibited. Given Saito (1989, 1992)’s assumption, the necessary undoing in cases of (36) and (37) takes place in LF. Thus, the claim that Subjacency holds only at the S-Structure favors the traditional view of scrambling operation.

In the remainder of this section, I would like to discuss two apparent similarities between B&T’s theory and the parsing theory I have developed in previous chapters and show why, despite these apparent similarities, the two theories do not reach the same predictions and conclusions. In order to interpret a long-distance scrambled *wh*-phrase in (40), both theories perform a left-to-right search to look for the argument position of the *wh*-phrase in (40). Under B&T’s framework, as discussed above, the *wh*-phrase is lowered to the argument position in LF. The parsing model I developed in Chapter 4 also builds the sentence structure incrementally so as to ultimately posit the gap in the embedded argument position.


Bailyn (2002) and Boeckx (2002) also point out empirical and theoretical problems with B&T’s analysis of scrambling.

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75 Bailyn (2002) and Boeckx (2002) also point out empirical and theoretical problems with B&T’s analysis of scrambling.
Furthermore, both theories assume that feature-licensing is the motivation for thematic interpretation of the scrambled *wh*-phrase. B&T assume that the θ-feature is a trigger for interpretation of the *wh*-phrase in the complement position of the embedded verb at LF. The current parsing model also assumes that features trigger the parser to merge a predicted head to the argument position of the embedded VP structure (cf. Chapter 4 Section 4.2).

However, note that B&T have to assume that in contrast to long-distance scrambling like (40), so-called clause-internal scrambling such as (41) permits the scrambled phrase to remain in its overt position at LF. In (41), the scrambled NP antecedes an anaphor (cf. (36)). They assume with Saito (1992) and Tada (1993) that V-to-I movement is the key factor that allows a clause-internally-scrambled phrase to remain in the TP-adjoined position at LF. Then, V-to-head movement provides an opportunity for the verb to θ-mark the object in the TP-adjoined position.

(41)  [Mary to Pam]-ni  [otagai-no  hahaoya]-ga  t[Mary to Pam]-ni  atta.

Mary and Pam-dat  each other-gen mothers-nom  met

‘Mary and Pam, each other’s mothers met.’
In the cases of processing a scrambled \textit{wh}-question such as (40), this discrepancy between the operation of long-distance scrambling and that of clause-internal scrambling would predict that the parser fails to posit the gap for a fronted \textit{wh}-phrase in the matrix clause. Under B&T’s theory, a clause-internal scrambled phrase does not have to undergo LF-lowering to the matrix argument position. However, recall in Chapters 2 and 3 that the experimental results indicate that the parser posits the gap in the matrix argument position even when it does not know if the entire sentence is a multi-clausal structure. The proposed parsing model can predict this matrix gap creation, discussed in Chapters 4. In addition, B&T also have difficulty in explaining why the unforced reanalysis occurs in interpretation of \textit{wh}-scrambled sentences, because they fail to predict the matrix gap. On the other hand, the parsing model can properly predict the case of unforced reanalysis. Hence, B&T’s system is different from the current parsing system with respect to the postulating of the first, matrix gap in long-distance scrambling constructions.

I also point out that B&T give \(\theta\)-features a special status, in the sense that the Japanese \(\theta\)-feature must be seen as weak so that it can be licensed in LF. For them, the \(\theta\)-feature of a so-called “scrambled” phrase is not a trigger for an overt merge of the phrase into the surface position. \(\Theta\)-features can be relevant only to LF operations such as lowering from the overt “scrambled” position to the argument position. In other words, B&T have to distinguish features relevant to overt syntactic derivations from \(\theta\)-features relevant to LF operations. In contrast to B&T’s view of \(\theta\)-features, the current study’s view of \(\theta\)-features is consistent with taking those features as relevant for merger in both cases of parsing and grammar. The proposed model assumes that the parser employs
underspecified features of the new material in order to build a structure at each integration stage. The parser can posit a gap for a displaced phrase due to the need for licensing features of the displaced phrase. The features, of course, include $\theta$-features. Since I support the traditional view of scrambling as a species of overt syntactic displacement operations from a base-generated position, this view of $\theta$-features also fits with grammatical theories which assumes that merging of a phrase and a verb allows the phrase to check the $\theta$-feature of the verb (Hornstein, 1999, 2001; Chomsky, 2000). The current theory treats $\theta$-features as relevant for merger in both cases of parsing and grammar.

I conclude that B&T``s theory and the current theory do not share the same predictions and conclusions, although they are apparently alike with respect to of the manner of searching for the argument position of a displaced phrase and in the employment of $\theta$-features. B&T fail to predict the gap creation in the matrix clause of $wh$-scrambling structure, and need to treat $\theta$-features as special for LF operation. In contrast, the current theory can predict that the parser posits the matrix gap as well as the embedded gap. In addition, it views $\theta$-features as relevant for merger both in parsing and grammar.

6.5 Summary

This chapter considered the asymmetries in Subjacency effects ($wh$-island effects and CNP-island effects) among island types in Japanese $wh$-in-situ questions, and pointed
out that Subjacency holds only on the S-Structure level because all the cases of
Subjacency effects observed in \textit{wh}-movement at LF are constrained by the minimality
constraint. I also showed that the hypothesis that scrambling is an obligatory LF lowering
poses a serious problem on Subjacency effects seen in \textit{wh}-scrambling. This is so because
LF lowering fails to be constrained by island constraints which are all S-Structure level
constraints. In contrast, the traditional view of scrambling has an advantage of accounting
for Subjacency effects on Japanese \textit{wh}-scrambling. Lastly, I showed that B&T’s theory
the current theory do not share the same predictions and conclusions with respect to the
postulating of the gap and the treatment of \(\theta\)-features in the structures of interest.
CHAPTER 7

CONCLUSION

In this study, I have examined several mechanisms of \(wh\)-dependency formation. I have claimed that both the parser and grammar of \(wh\)-dependencies are driven by the satisfaction of syntactic and semantic constraints. Furthermore, I have suggested using experimental findings that structure-building is fully incremental and accurate with respect to grammatical principles. I have also claimed that on-line and off-line \(wh\)-scope interpretations are supported by the same grammatical principles underlying the local relation of a \(wh\)-element and a \(wh\)-scope marker. The parsing model developed in this study makes minimal assumptions to derive heretofore unrelated facts. The assumptions are twofold. First, grammatical constraints drive both learning and parsing theory. The same principles that govern language learning also contribute to processing sentences. Secondly, incrementality and efficiency force the parser to predict some of the grammatical status of an incoming word. Under these assumptions, the model can predict several facts which do not apparently relate each other. This thesis has shown that the current parsing model predicts the following facts; the time-course of gap creation, the possibility of reanalysis, a constraint on rapid gap-creation, and on-line versus off-line
preference of *wh*-scope interpretation in Japanese long-distance *wh*-scrambling construction.

In Chapter 2, I argued that the cross-linguistic patterns of long-distance dependencies are driven by the same underlying mechanism of parsing. The gap-creation is driven not by the need to create gap positions as soon as possible after encountering a filler, but rather by the need to satisfy syntactic and semantic principles or constraints as soon as possible. Using three different measures of *wh*-dependency formation, three experiments confirm that the grammatical principle-based approach correctly predicts that fronted *wh*-phrases should be preferentially associated with an embedded clause in Japanese.

In Chapter 3, I have shown the implications of these results for long-standing debates over both the status of gaps in real-time sentence processing, and how much structure is built in advance of the verb. The experimental findings of pre-verbal effects of dependency formation have shown that in head-final languages like Japanese, just as in English, there is no need to assume that dependency formation is delayed until the clause-final verb is processed. This supports incremental full-attachment models over head-driven delay models. The findings further suggest that the constraints that drive dependency formation are independent of the lexical properties of individual verbal heads. In this way, the implications of these findings also support gap-based parsing models, contrary to some versions of the gap-less direct association models.

In Chapter 4, I have demonstrated how *wh*-scrambling sentences are parsed by implementing the parsing model I adopt. The model properly predicts the experimental
results, predicts that the gap is posited ‘as soon as possible’ without any additional step of the algorithm, and explains why an unforced reanalysis is permitted in the relevant \textit{wh}-scrambling structures but reanalysis is avoided in other cases.

In Chapter 5, I have confirmed that Japanese \textit{wh}-scrambling constructions do not exhibit a scope-fixing effect. There exists a divergence in preferred scope interpretations between on-line and off-line reading. However, I have claimed that a preference principle can capture both on-line and off-line preferences, and pointed out that the difference in preferences between those readings stems from structural differences derived in terms of the timing of when the head of a scope marker is confirmed.

In Chapter 6, based on the asymmetries in Subjacency effects among island types in Japanese \textit{wh}-in-situ questions, I have pointed out that Subjacency holds only on the S-Structure level because all the cases of Subjacency effects observed in \textit{wh}-movement at LF are constrained by the minimality constraint. I also discussed the hypothesis that scrambling is an obligatory LF lowering which poses a serious problem for Subjacency effects seen in \textit{wh}-scrambling. LF lowering fails to be constrained by island constraints which are all S-Structure level constraints. In contrast, the traditional view of scrambling has the advantage of accounting for Subjacency effects on Japanese \textit{wh}-scrambling.

This work has focused on the processing and syntax of Japanese \textit{wh}-dependencies. I have shown cases where the processing of a filler-gap dependency in real time follows grammatical principles which are independently needed to explain competence systems. The work thus suggests that the grammar and the parser must be related in some fairly direct way. However, it is certain that more evidence is needed to discover the precise
nature of their relationship. In particular, in order to more intensively examine the parsing theory presented here, I would like to experimentally investigate whether there are limits on the amount of incrementality which is associated with processing head-final structures, and whether the current theory explains a full range of reanalysis phenomena. Furthermore, in order to argue for a closer grammar-parser relationship, more investigation into syntactic structures such as Chapters 5 and 6’s analyses on locality effects is called for to pursue the question of how much grammatical constraints limit the parsing mechanisms.
APPENDICES

Appendix A: Experimental Materials for Experiments 1A and 1B

Each of the items in this list represents a full set of stimuli from Experiments 1A and 1B. Alternative word orders of wh-phrases (scrambled or in-situ) are given in curly brackets. The alternation of the declarative complementizer and the question particle is indicated in square brackets, separated by a slash (/). Where different items were used in Experiments 1A and 1B, both items are shown.

A full set of conditions from item number (1) can be seen below.

Scrambled, Declarative Complementizer
dō no jūgōtei ni tōren wa kōchō ga dono jūgōtei ni hon o yonda to kōchō ni shisarete ite kōchō ni itte imashita ka.

In-situ, Declarative Complementizer
dō no jūgōtei ni tōren wa kōchō ga dono jūgōtei ni hon o yonda to kōchō ni shisarete ite kōchō ni itte imashita ka.

Scrambled, Question Particle
dō no jūgōtei ni tōren wa kōchō ga dono jūgōtei ni hon o yonda to kōchō ni shisarete ite kōchō ni itte imashita ka.

In-situ, Question Particle
dō no jūgōtei ni tōren wa kōchō ga dono jūgōtei ni hon o yonda to kōchō ni shisarete ite kōchō ni itte imashita ka.

The main clause verbs, which all require a dative-marked argument, were all ‘report’ verbs; tutaeta ‘told’, itta ‘said’, siraseta ‘informed’, osieta ‘taught’, setumeisita ‘explained’, and hookokusita ‘reported’.


1. {dō no jūgōtei ni} tōren wa kōchō ga {dō no jūgōtei ni} hon o yonda [to/ka] kōchō ni shisarete ite kōchō ni itte imashita [ka./].
1B. {dō no jūgōtei ni} tōren wa kōchō ga {dō no jūgōtei ni} engō no hon o yonda [to/ka] kōchō ni shisarete ite kōchō ni itte imashita [ka./].
2. {dō no jūgōtei ni} tōren wa kōchō ga {dō no jūgōtei ni} engō no hon o yonda [to/ka] kōchō ni shisarete ite kōchō ni itte imashita [ka./].
3. {dō no jūgōtei ni} tōren wa kōchō ga {dō no jūgōtei ni} engō no hon o yonda [to/ka] kōchō ni shisarete ite kōchō ni itte imashita [ka./].
4. {dō no jūgōtei ni} tōren wa kōchō ga {dō no jūgōtei ni} engō no hon o yonda [to/ka] kōchō ni shisarete ite kōchō ni itte imashita [ka./].
5. {どの女性に} 部長は 社長が {どの女性に} 新車を 買った[と/ か] 食堂で 専務に 教えました[か。/。]
6. {どの助手に} 研究員は 教授が {どの助手に} コンピュータを 選んだ[と/ か] 実験室で 所長に 説明しました[か。/。]
6B. {どの教え子に} 研究助手は 教授が {どの教え子に} 研究テーマを 選んだ[と/ か] 実験室で 学長に 説明しました[か。/。]
7. {どのファンに} 監督は 選手が {どのファンに} 似顔絵を 描いた[と/ か] ロッカールームで マネージャーに 言いました[か。/。]
8. {どの家族に} 夫は 妻が {どの家族に} サンドイッチを 作った[と/ か] 公園で 友人に 伝えました[か。/。]
9. {どの老人に} 看護婦は お坊さんが {どの老人に} お経を 唱えた[と/ か] 病室で 医者に 報告しました[か。/。]
10. {どの先生に} 校長は 生徒が {どの先生に} 詩を 詠んだ[と/ か] 職員室で 教頭に 報告しました[か。/。]
11. {どの孫に} 祖母は 祖父が {どの孫に} 家を 購入した[と/ か] 居間で 父親に 教えました[か。/。]
12. {どの学生に} 教授は 父親が {どの学生に} 就職先を 見つけた[と/ か] 研究室で 学部長に 説明しました[か。/。]
13. {どのビアニストに} 指揮者は 音楽家が {どのビアニストに} オペラを 作曲した[と/ か] 練習室で 声楽家に 言いました[か。/。]
14. {どの甥に} 祖父は 叔父が {どの甥に} 魚を 釣った[と/ か] 庭で 叔母に 知らせました[か。/。]
14B. {どの孫に} 祖母は おじさんが {どの孫に} 大きなフナを 釣った[と/ か] 庭で 祖母に 知らせました[か。/。]
15. {どの男の子に} 班長は 指導員が {どの男の子に} かぶと虫を とった[と/ か] キャンプ場で 団長に 知らせました[か。/。]
15B. {どの男の子に} 班長は ガイドが {どの男の子に} 大きなカブト虫を 取った[と/ か] キャンプ場で 団長に 知らせました[か。/。]
16. {どの園児に} 先生は 留学生が {どの園児に} 折り紙を 折った[と/ か] 教室で 父兄に 敎えました[か。/。]
17. {どの女優に} マネージャーは 歌手が {どの女優に} 花を 摘んだ[と/ か] テレビで 記者に 伝えました[か。/。]
18. {どの乗客に} スチュワーデスは 機長が {どの乗客に} ドアを 開けた[と/ か] 機内で 副操縦士に 報告しました[か。/。]
18B. {どの乗客に} スチュワーデスは 警備員が {どの乗客に} ドアを 開けた[と/ か] 操縦室で 機長に 報告しました[か。/。]
19. {どの女の人を}ディレクターは タレントが {どの女の人を} ギターを 弾いた[と/ か] 楽屋で 記者に 説明しました[か。/。]
20. {どの作家に} 編集長は 担当者が {どの作家に} アシスタントを 雇った[と/ か] 廊下で 秘書に 教えました[か。/。]
20B. {どの作家に} 担当者は 編集長が {どの作家に} アシスタントを 雇った[と/ か] 会議で 出版者に 教えました[か。/。]

Appendix B: Experimental Materials for Experiment 2

Each of the items in this list represents a full set of stimuli from Experiment 2. The two conditions (Scrambled and Control) differ in the case markers in the first two noun phrases. The alternation of the case markers is indicated in square brackets, separated by a slash (/).

A set of conditions from item number (1) can be seen below.

Scrambled
どの新入生に 担任は 司書が 図書室で 校長先生に 漫画本を すすめたと 言いましたか。

Control
どの新入生が 担任に 司書が 図書室で 校長先生に 漫画本を すすめたと 言いましたか。

1. この新入生[に/が] 担任[は/に] 司書が 図書室で 校長先生に 漫画本を すすめたと 言いましたか。
2. この警備員[に/が] 会長[は/に] ミュージシャンが スタジオで 観客に マイクを 投げたと 知らせましたか。
3. この子供[に/が] 母親[は/に] お手伝いさんが 台所で 父親に お弁当を 渡したと 言いましたか。
4. この女性社員[に/が] 専務[は/に] 社長が 会議で 部長に 昇給を 約束したと 教えましたか。
5. この教授[に/が] 学部長[は/に] 助手が 実験室で 大学院生に 実験を 見せたと 説明しましたか。
7. この看護婦[に/が] 院長[は/に] 担当医が 診察室で 患者に 風邪薬を 処方したと 言いましたか。
8. この友人[に/が] 妻[は/に] 夫が 電話で 獣医に 子犬を 預けたと 報告しましたか。
10. この警官[に/が] 刑事[は/に] 容疑者が 現場で 被害者に 身の上話を 語ったと 教えましたか。
11. このピアニスト[に/が] 指揮者[は/に] 声楽家が 楽屋で バイオリン奏者に 花束を 贈ったと 言いましたか。
12. どの園児に先生は留学生が教室で園長に民族衣装を着せたと知らせましたか。
13. どのスチュワーデスに副操縦士は機長が機内で乗客に出身地を尋ねたと知らせましたか。
14. どの記者に付き人はやくざが事務所で女優に手切れ金を請求したと伝えましたか。
15. どの編集長にアシスタントは編集長が作家に原稿を手渡したと伝えましたか。
16. どの国会議員に秘書は知事が建設会社に工事を許可したと説明しましたか。
17. どのウェイトレスに料理長は見習いが調理場で常連客にやきそばを食べさせたと教えましたか。
18. どの店員に母親は店長が店先で子供にゲームを紹介したと言いましたか。
19. どの運転手に刑事は警官が車内で犯人に警察官バッジを提示したと伝えましたか。
20. どの老婦人に支配人は販売員が展示会で若い女性に靴を売ったと説明しましたか。

Appendix C: Experimental Materials for Experiment 3

Each of the items in this list represents one full set of stimuli from Experiment 3. Alternative word orders of *wh*-phrases (scrambled or in-situ) are given in curly brackets. The alternation of the topic marker and nominative case marker is indicated by square brackets, separated by a slash (/).

A full set of conditions from item number (1) can be seen below.

Scrambled, Topic-Nominative
どの新入生に担任は司書が図書室で...

Scrambled, Nominative-Nominative
どの新入生に担任が司書が図書室で...

In-situ, Topic-Nominative
担任は司書が図書室でどの新入生に...

In-situ, Nominative-Nominative
担任が司書が図書室でどの新入生に...

1. {どの新入生に}担任[は/が]司書が図書室で{どの新入生に}...
2. {どの警備員に}司会者[は/が]ミュージシャンがスタジオで{どの警備員に}...
3. {どの子供に}母親[は/が]お手伝いさんが台所で{どの子供に}...
4. {どの女性社員に}専務[は/が]社長が会議で{どの女性社員に}...
5. {どの教授に}学部長[は/が]助手が実験室で{どの教授に}...
6. {どのマネージャーに} 監督[は/が] 選手が ロッカールームで {どのマネージャーに} …
7. {どの看護婦に} 院長[は/が] 担当医 診察室で {どの看護婦に} …
8. {どの友人に} 妻[は/が] 夫が 電話で {どの友人に} …
9. {どの孫に} 祖母[は/が] 祖父が すし屋で {どの孫に} …
10. {どの警官に} 刑事[は/が] 容疑者 に 現場で {どの警官に} …
11. {どのピアニストに} 指揮者[は/が] 声楽家 楽屋で {どのピアニストに} …
12. {どの園児に} 先生[は/が] 留学生が 教室で {どの園児に} …

Appendix D: Experimental Materials for Experiment 4 (Self-paced reading task)

Each of the items in this list represents a full set of stimuli from the self-paced reading task in Experiment 4. Alternative word orders of wh-phrases (scrambled or unscrambled) are given in curly brackets, separated by a slash (/). The alternation of the gender is indicated by brackets, separated by a slash (/).

A full set of conditions from item number (1) can be seen below.

Scrambled, Mismatch
台所で 彼の どの子供に 朝食後 叔母が 急いで お弁当を 渡したか 父親は 覚えていた。

Scrambled, Match
台所で 彼の どの子供に 朝食後 叔父が 急いで お弁当を 渡したか 叔母は 覚えていた。

Unscrambled, Mismatch
台所で 彼の どの子供が 朝食後 叔母に 急いで お弁当を 渡したか 父親は 覚えていた。

Unscrambled, Match
台所で 彼の どの子供が 朝食後 叔父に 急いで お弁当を 渡したか 父親は 覚えていた。

1. 台所で 彼の どの子供に / が 朝食後 [叔母 / 叔父] [が / に] 急いで お弁当を 渡したか [父親は / 叔母]は 覚えていた。
2. 病室で 彼の どの患者に / が 診察中 [看護婦 / 院長] [が / に] 無礼に 言ったか [担当医 / 看護婦]は 知っている。
3. 教室で 彼の どの同級生に / が 放課後 [女の子 / 男の子] [が / に] こっそり 宿題の答えを 教えたか その [少年 / 女の子]は 気になった。
4. 楽屋で 彼の どのファンに / が 撮影後 [女優 / 男優] [が / に] いきなり 驚恐を あびせたか その [俳優 / 女優]は 知っていた。
5. 舞踏会で 彼の どのパートナーに / が ワルツの後 [貴婦人 / 男爵] [が / に] めずらしく ほめ言葉を くれたか その [紳士 / 貴婦人]は 知りたがった。
7. リングで 彼の どの練習生 [に / が] トレーニング中 [女子プロレスラー / プロレスラー] [が / に] しつこく 関節技を 仕掛けて たか [トレーナー / 女子プロレスラー]は 気にした。
9. グランドで 彼の どの友人{に / が} 試合後 [女子マネージャー / サッカー選手]{が / に}むりやり 応援グッズを 配ったか [コーチ / 女子マネージャー] は 覚えていた。
10. 葬式で 彼の どの親族{に / が} 突然 [末亡人 / 義父]{が / に} みさかいもなく 財産相続を 切り出したか [祖父 / 末亡人] は 知っている。
11. スポーツジムで 彼の どの会員{に / が} レッション後 [主婦 / トレーナー]{が / に} 熱心に 栄養剤を すすめたか [コーチ / 女子マネージャー] は 覚えていた。
12. レストランで 彼の どの客{に / が} 立食会の後 [ウェイトレス / 粟長]{が / に} 好事を 出したか [店長 / ウェイトレス] は 忘れていた。
13. 勉強部屋で 彼女の どの幼なじみ{に / が} 誕生会で [兄 / 妹]{が / に} 気取って バラの花束を 贈ったか [姉 / 兄] は知っていた。
14. 選挙事務所で 彼女の どの後援者{に / が} 演説後 [総理大臣 / 女代議士]{が / に} こっそり お金を 手渡したか [女性候補者 / 総理大臣] は 覚えている。
15. コンテスト会場で 彼女の どの知り合い {に / が} 事前に [警備員 / ミス東京]{が / に} 急いで 落とし物を 届けたか [ミス大阪 / 警備員] は 知っていた。
16. 母体forgeで 彼女の どの仕事仲間{に / が} 心地よい [花婿 / 花嫁]{が / に} 自慢げに 写真を見せたか [妹 / 花嫁] は 思いだした。
17. 田舎で 彼女の どの知人{に / が} 法事のあと [次男 / 母親]{が / に} 無理に 焼き物を売りつけたか [長女 / 次男] は知っている。
18. 玄関ホールで 彼女の どの訪問客{に / が} 会議前に [会長 / 女社長]{が / に} 誤って 資料を あずけたか [受付嬢 / 会長] は 気になった。
19. 観光バスで 彼女の どの乗客{に / が} カラオケで [運転手 / バスガイド]{が / に} おもしろがって 民謡を 歌わせたか [見習いバスガイド / 運転手] は 覚えていた。
20. 大広間で 彼女の どの家来{に / が} 舞踏会中 [国王 / 女王]{が / に} こっそり 王室の秘密を 伝えたか [王女 / 国王] は 知りたがった。
21. パーティーで 彼女の どの招待客{に / が} 人前で [社長令息 / 社長令嬢]{が / に} 恥じもなく 身の上話を 語ったか [社長夫人 / 社長令] 息は 気にした。
22. 保育園で 彼女の どの園児{に / が} お昼休みに [保父 / 保母]{が / に} 気取って 飲食の話を 伝ええたか [保育婦 / 保父] は 忘れてしまった。
23. オフィスで 彼女の どの取引先{に / が} 残業中 [ビジネスマン / キャリアウーマン]{が / に} 無断で 内部資料を 転送したか [その秘書 / ビジネスマン] は 知っている。
24. 空港で 彼女の どの同僚{に / が} 離陸前 [機長 / スチュワーデス]{が / に} 誤って 睡眠薬を 飲ませたか [ペテレンスチュワーデス / 機長] は 気になった。

Appendix E: Experimental Materials for Experiment 4
(Off-line anaphoric relation judgment task)

Each of the items in this list represents a full set of stimuli from the anaphoric relation judgment task in Experiment 4. Alternative types of wh-phrases (non-wh-phrase, wh-phrase) are indicated Alternative word orders (scrambled, unscrambled) are given in square brackets, separated by a slash (/). Noun phrases of the co-reference in question are underlined.
A full set of conditions from item number (1) can be seen below.

**Non-wh-phrase, Unscrambled**
彼の学生が食堂で先生に会った。

**Non-wh-phrase, Scrambled**
彼の学生に食堂で先生が会った。

**Wh-phrase, Unscrambled**
彼のどの学生が食堂で先生に会ったの?

**Wh-phrase, Scrambled**
彼のどの学生に食堂で先生が会ったの?

1. 彼のどの学生が / に食堂で先生と会った。 / の?
2. 彼のどの同僚が / に試合後野球選手が / に激励の言葉を送った。 / の?
3. 彼のどの友人が / に腹いせに暴力団組長が / に脅迫状を送りつけた。 / の?
4. 彼のどの取引先が / に国際電話で仲買人が / に株券を売った。 / の?
5. 彼のどの知人が / に気軽よく即席工員が / にお金を貸した。 / の?
6. 彼のどの友人が / に街角で会社員が / が道順をきいた。 / の?
7. 彼のどの知り合いが / に包丁でその男性が / 袭いかかった。 / の?
8. 彼のどの幼稚が / に社長が / に外車を売った。 / の?
9. 彼女のどの友人が / に駐車場で主婦が / が話しかけた。 / の?
10. 彼女のどの同級生が / に誕生日に女子生徒が / が詩集をあげた。 / の?
11. 彼女のどの友人が / にやっとその女の子が / 挨拶状を出した。 / の?
12. 彼女のどの上司が / にめずらしく女子社員が / が挨拶した。 / の?
13. 彼女のどのいとこが / に夜遅く長女のファックスを送った。 / の?
14. 彼女のどの客が / にレストランでウェイターが / が電話番号を尋ねた。 / の?
15. 彼女のどの子供が / に庭で叔母が / がボールを投げた。 / の?
16. 彼女のどの先生が / に女子大生が / が新しい論文を紹介した。 / の?
17. 彼のどの患者が / に病院で院長が / が文句を言った。 / の?
18. 彼のどの同僚が / にめずらしい夜遅く刑事が / が寿司をつかった。 / の?
19. 彼のどの愛人が / に不当にもやくそが / が賠償金を請求した。 / の?
20. 彼のどのパートナーが / に舞踏会で男爵が / がめげた。 / の?
21. 彼のどの会員が / にレッスン後トレーナーが / が栄養剤をすすめた。 / の?
22. 彼のどの友人が / に試合後サッカー選手が / が応援グッズを配った。 / の?
23. 彼のどの同級生が / に教室で男の子が / 宿題の答えを教えた。 / の?
24. 彼のどの客が / に立食会の後料理長が / がお礼状を出した。 / の?
25. 彼女のどの知り合いが / にコンテスト会場でミス東京が / に落し物を届けた。 / の?
26. 彼女のどの幼なじみが / に誕生会で姫が / がバラの花束を贈った。 / の?
27. 彼女のどの後援者が / にこっそり女大生が / がお金を手渡した。 / の?
28. 彼女のどの取引先が / に残業中キャリアウーマンが / が内部資料を転送した。 / の?
29. 彼女のどの園児が / にお昼休みに保母が / が遠足の話を伝えた。 / の?
30. 彼女のどの訪問客が / に玄関ホールで女社長が / が資料をあずけた。 / の?
Appendix F: Experimental Materials for Experiment 5

Each of the items in this list represents a full set of stimuli from Experiment 5. Alternative word orders of *wh*-phrases (scrambled or in-situ) are given in curly brackets. The alternation of the non-island and island condition is indicated in square brackets, separated by a slash (/). Alternative answer types (matrix or embedded) are separated by a vertical line (|).

A full set of conditions from item number (1) can be seen below.

**Non-island, Scrambled, Matrix**

A (場面)
太郎は花子が宴会でだれに会ったか知っている。
智子も花子が宴会でだれに会ったか知っている。
B（質問文）
でも、だれに次郎は花子が宴会で会ったか知っているの？
C（答え）
三郎にだよ。

**Non-island, Scrambled, Embedded**

A (場面)
太郎は花子が宴会でだれに会ったか知っている。
智子も花子が宴会でだれに会ったか知っている。
B（質問文）
でも、だれに次郎は花子が宴会で会ったか知っているの？
C（答え）
うん、次郎も知っているよ。

**Non-island, In-situ, Matrix**

A (場面)
太郎は花子が宴会でだれに会ったか知っている。
智子も花子が宴会でだれに会ったか知っている。
B（質問文）
でも、次郎は花子が宴会でだれに会ったか知っているの？
C（答え）
三郎にだよ。

**Non-island, In-situ, Embedded**

A (場面)
太郎は花子が宴会でだれに会ったか知っている。
智子も花子が宴会でだれに会ったか知っている。
B（質問文）
でも、次郎は花子が宴会でだれに会ったか知っているの？
C（答え）
うん、次郎も知っているよ。

Island, Scrambled, Matrix
A（場面）
太郎は花子が宴会でだれに会ったか知ってている友人のことを話した。
智子も花子が宴会でだれに会ったか知ってている友人のことを話した。
B（質問文）
でも、だれに次郎は花子が宴会で会ったか知っている友人のことを話したの？
C（答え）
三郎にだよ。

Island, Scrambled, Embedded
A（場面）
太郎は花子が宴会でだれに会ったか知ってている友人のことを話した。
智子も花子が宴会でだれに会ったか知ってている友人のことを話した。
B（質問文）
でも、だれに次郎は花子が宴会で会ったか知っている友人のことを話したの？
C（答え）
うん、次郎も話したよ。

Island, In-situ, Matrix
A（場面）
太郎は花子が宴会でだれに会ったか知ってている友人のことを話した。
智子も花子が宴会でだれに会ったか知ってている友人のことを話した。
B（質問文）
でも、次郎は花子が宴会でだれに会ったか知ってている友人のことを話したの？
C（答え）
三郎にだよ。

Island, In-situ, Embedded
A（場面）
太郎は花子が宴会でだれに会ったか知ってている友人のことを話した。
智子も花子が宴会でだれに会ったか知ってている友人のことを話した。
B（質問文）
でも、次郎は花子が宴会でだれに会ったか知ってている友人のことを話したの？
C（答え）
うん、次郎も話したよ。

1.
A（場面）
太郎は花子が宴会でだれに会ったか知ってている[友人のことを話した]。
智子も花子が宴会でだれに会ったか知ってている[友人のことを話した]。
B（質問文）
でん、{だれに}次郎は花子が宴会で{だれに}会ったか知っているの？ /友人のことを話したの？
でも、だれに次郎は花子が宴会で会ったか知っている友人のことを話したの？
C（答え）
三郎にだよ。 | うん、次郎も[知っているよ / 話したよ。]

2.
A（場面）
松島君は田村さんが突然だれに抱きついたか[知りたかった / 知りたがっていた人のことをしゃべった]。
馬場さんも田村さんが突然だれに抱きついたか[知りたかった / 知りたがっていた人のことをしゃべった]。
B（質問文）
でも、{だれに}新島君は田村さんが突然{だれに}抱きついたか[知りたかったの？ /知りたがっていた人のことをしゃべったの？]
C（答え）
富田君にだよ。 | うん、新島君も[知りたかったよ / しゃべったよ。]

3.
A（場面）
健二は美奈子がだれにその本を借りたか[知りたがっている /友人のことを話した]。
和子も美奈子がだれにその本を借りたか[知りたがっている /友人のことを話した]。
B（質問文）
でも、{だれに}俊彦は美奈子が{だれに}その本を借りたか知りたがっているの？ /友人のことを話したの？
C（答え）
愛子にだよ。 | うん、俊彦も[知りたがっている /話した]よ。

4.
A（場面）
恵子は利夫がパーティでだれに花を贈ったか覚えている[友人のことをしゃべった]。
三郎も利夫がパーティでだれに花を贈ったか覚えている[友人のことをしゃべった]。
B（質問文）
でも、{だれに}君子は利夫がパーティで{だれに}花を贈ったか覚えているの？ /友人のことをしゃべったの？
C（答え）
美恵子にだよ。 | うん、君子も[覚えているよ / しゃべったよ]。
村山君にだよ。| うん。大島さんも[覚えているよ /話したよ]。

6.
A（場面）
規子は信太郎が会議でだれに同意したか[知りたかった /知りたいている人のことを話した]。
良太も信太郎が会議でだれに同意したか[知りたかった /知りたいている人のことを話した]。
B（質問文）
でも、[だれに]桃子は信太郎が会議で[だれに]同意したか[知りたかったの？ /知りたいている人のことを話したの？]
C（答え）
健太郎にだよ。| うん、桃子も[知りたかったよ /話したよ]。

7.
A（場面）
五島さんは東田課長がだれに出張を許可したか[気にした /気にしてている人のことをしゃべった]
江口さんも東田課長がだれに出張を許可したか[気にした /気にしてている人のことをしゃべった]
B（質問文）
でも、[だれに]加藤さんは東田課長が[だれに]出張を許可したか[気にしたの？ /気にしている人のことをしゃべったの？]
C（答え）
内田さんにだよ。| うん、加藤さんも[気にしたよ /しゃべったよ]。

8.
A（場面）
美枝子は雄三がだれにその写真を見せたか[知りたかった /知りたいっていた友人のことを話しした]
五郎も雄三がだれにその写真を見せたか[知りたかった /知りたいっていた友人のことを話しした]
B（質問文）
でも、[だれに]光子は雄三が[だれに]その写真を見せたか[知りたかったの？ /知りたいっていた友人のことを話したの？]
C（答え）
ゆかりにだよ。| うん、光子も[知りたかったよ /話したよ]。

9.
A（場面）
かおるは光夫がどの仲間に協力したか[覚えている /人のことをしゃべった]
正人も光夫がどの仲間に協力したか[覚えている /人のことをしゃべった]
B（質問文）
でも、[どの仲間に]彩子も光夫が[どの仲間に]協力したか覚えている[の？ /人のことをしゃべったの？]
C（答え）
達男にだよ。| うん、彩子も[覚えているよ /しゃべったよ]。
10.
A（場面）
藤本さんは田中君が水泳でどの競争相手に勝ったか気にしていた[仲間のことを話した]。
木内さんも田中君が水泳でどの競争相手に勝ったか気にしていた[仲間のことを話した]。
B（質問文）
でも、{どの競争相手に}村越さんは水泳で{どの競争相手に}勝ったか気にしていた[の？ /仲間のことを話したの？]
C（答え）
下田君にだよ。 うん、村越さんも[気にしていたよ /話したよ]。

11.
A（場面）
加奈子は信子がどの友達にお金を貸したか知っている[友人のことを話した]。
明子も信子がどの友達にお金を貸したか知っている[友人のことを話した]。
B（質問文）
でも、{どの友達に}桃子は信子が{どの友達に}お金を貸したか知っている[の？ /友人のことを話したの？]
C（答え）
忠明にだよ。 うん、桃子も[知っているよ /話したよ]。

12.
A（場面）
民夫は真知子がどの客に閉店の理由を説明したか覚えている[知人のことをしゃべった]。
八千代も真知子がどの客に閉店の理由を説明したか覚えている[知人のことをしゃべった]。
B（質問文）
でも、{どの客に}和彦は真知子が{どの客に}閉店の理由を説明したか覚えている[の？ / [知人のことをしゃべったの？]
C（答え）
菊池さんにだよ。 うん、和彦も[覚えているよ /しゃべったよ]。

13.
A（場面）
忠夫はゆかりがどの先輩に逆らったか[知っていた /知っている人のことを話した]。
明美もゆかりがどの先輩に逆らったか[知っていた /知っている人のことを話した]。
B（質問文）
でも、{どの先輩に}智彦はゆかりが{どの先輩に}逆らったか[知っていたの？ /知っている人のことを話したの？]
C（答え）
福田先輩にだよ。 うん、智彦も[知っていたよ /話したよ]。

14.
A（場面）
戸塚さんは田端先生が腕相撲でどの生徒に負けたか[知りたがった / 知りたがっていた人のことをしゃべった]。
宮崎君も田端先生が腕相撲でどの生徒に負けたか[知りたがった / 知りたがっていた人のことをしゃべった]。
15.
A (場面)
悦子は裕司がどの同級生にゲームソフトを売ったか気にしていた [友達のことを話した]。
道彦も裕司がどの同級生にゲームソフトを売ったか気にしていた [友達のことを話した]。
B (質問文)
でも、どの同級生に明恵も裕司がどの同級生にゲームソフトを売ったか気にしていた [の？]
/友達のことを話したの？
C (答え)
聡志にだよ。 うん、明恵も [気にしていたよ /話したり]

16.
A (場面)
三枝さんは坂木さんがどの客に招待券をあげたか覚えていた [覚えている同僚のことを話した]。
戸田さんも坂木さんがどの客に招待券をあげたか覚えていた [覚えている同僚のことを話した]。
B (質問文)
でも、どの客に村上さんは坂木さんがどの客に招待券をあげたか覚えていたの？ /覚えて
いる同僚のことを話したの？
C (答え)
取引先の山下社長にだよ。 うん、村上さんも [覚えていたよ /話したよ]。
REFERENCES


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