The Processing of Wh-Phrases in Japanese

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We propose that in-situ wh-phrases in Japanese and fronted wh-phrases in languages such as English are processed in a similar manner despite their configurational differences. Three self-paced reading experiments are reported supporting the view that in-situ wh-phrases require the prediction of an upcoming question particle (QP). Because of working memory restrictions, readers expect the QP to occur at the earliest position made available by the grammar. The evidence is based on typing mismatch effects (TME), which are similar in a number of relevant respects to the filled-gap effect observed in English. A TME occurs when a potential position for a QP is filled by an affirmative complementizer and as a consequence slow reading times are observed because of the discrepancy between the interrogative typing expected and the affirmative typing imposed by the complementizer. The TME only occurs in positions in which the grammar allows a QP to license a prior wh-phrase. Furthermore, the TME is observed even when it is clear that there is another upcoming position which can hold the QP.

1. Introduction

One central issue in sentence-level processing is how readers create dependencies between words in order to understand the meaning of a sentence. For example, a noun phrase (NP) has to be associated with a verb to be interpreted as the subject of a sentence; a pronoun such as *herself* has to be associated with a previous feminine NP in order to have its referent determined. Wh-phrases (e.g. *who*, *which computer*, *how long*) raise critical issues for models of sentence processing because these phrases often require associations that cross an arbitrary number of clauses. An extensive literature on English and other similar languages has revealed that the processing of fronted wh-phrases create the expectation for a gap (an empty argument or adjunct position) at the earliest point in the sentence licensed by the grammar of the language.

The features that make fronted wh-phrases interesting are seemingly lacking in in-situ wh-phrases in East-Asian languages. In-situ wh-phrases are not fronted to the beginning of the clause, and as their name suggests,

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they are pronounced in their base position, where lexical NPs (i.e. non-wh NPs) are also pronounced. As a consequence, in-situ wh-phrases may seem not to provide further insights into language processing mechanisms because they could in principle be processed in the same manner as lexical NPs. This may in part explain the lack of interest in the processing of in-situ wh-phrases in the past.

We argue that in-situ wh-phrases raise crucial issues about the treatment dispensed to fronted wh-phrases thus far, and that the nature of wh-phrases, both in-situ and fronted, can only be understood in its entirety if scope requirements as well as thematic role requirements are taken into consideration. The present paper investigates the processing of in-situ wh-phrases in Japanese and argues that their processing presents the same basic properties found in their fronted counterparts. Despite their configurational differences, it will be argued that the processing of the two types of wh-phrases should be accounted by a single processing model based on working-memory constraints generalizing proposals for fronted wh-phrases (de Vincenzi, 1991; Frazier, & Clifton, 1989; Gibson, 1998).

The results of three self-paced reading experiments are reported supporting the claim that in-situ wh-phrases trigger the search for a question particle (QP) and, because of working memory constraints, readers expect the QP to occur as soon as possible in the sentence being processed. Two types of evidence will be provided. First, a *typing mismatch effect* (TME) is shown to occur when a potential position for a QP is filled by an affirmative complementizer. The TME can be seen as the Japanese counterpart of the *filled-gap effect* observed in the processing of fronted wh-phrases (Crain & Fodor, 1985; Stowe, 1986). Second, the TME will be used to show that readers only expect the QP to occur at points licensed by the grammar as is the case with gaps in English (Stowe, 1986).

It may seem arbitrary to propose that some types of wh-phrases trigger the search for a gap while others require the search for a QP. However, any arbitrariness to the proposal is explained away once we consider the dual nature of wh-phrases. Like other NPs, wh-phrases need a thematic role; as quantificational phrases, they have to be associated with a scope position. The position in which the wh-phrase is pronounced can satisfy one requirement (e.g. the scope requirement when the wh-phrase is fronted; the thematic role requirement when it is in-situ), and the remaining requirement leads to the search of a constituent that can be an arbitrary number of clauses away. In short, the nature of wh-phrases is constant across languages, the only difference is the position in which they are pronounced.

An underlying assumption in the present paper is that it is necessary to see past structural differences dictated by grammars in order to investigate language-independent mechanisms for sentence processing. Assuming the null hypothesis that all human languages are parsed by the same type of

processing mechanism, one has to understand how such a mechanism can handle languages with distinct configurational properties and how it may manifest itself in seemingly distinct guises. In the present case, by unifying the explanation for the two types of wh-phrases, we are more likely to discern the cognitively relevant aspects of sentence processing from idiosyncratic properties of languages.

2. Wh-Phrases in English and in Japanese

Wh-phrases in English are *fronted* in the sense that they are placed at the beginning of a clause. Compare the distinct positions of *what* in (1a) and the lexical NP (i.e. a non-wh NP) *a computer* in (1b), even though both constituents are direct objects of the verb *buy*.

(1) a. *What*$_i$ did Mary buy <gap$_i$>?
b. Did Mary buy *a computer*?

Fronted wh-phrases have to be associated with a *gap* — an empty argument or adjunct position — in order to receive their thematic role. For example, in (1a), <gap$_i$> indicates the usual position of direct objects in English immediately after the verb. The phrase *what*$_i$ has to be associated with <gap$_i$> in order to be interpreted as the entity being *bought*.

In Japanese, the neutral position of wh-phrases is *in-situ*, in the same position as lexical NPs; therefore, no gap is involved in this construction as can be seen in the examples below (but see Hagstrom, 1999, for an analysis in which question particles, QPs, such as 'no' below, are base generated next to the wh-phrase and then moved during the syntactic derivation of the sentence, thus creating an empty position next to the wh-phrase).

(2) a. Mary-ga *nani-o* katta-no?
Mary-Nom what-Acc bought-QP
'What did Mary buy?'

b. Mary-ga *pasokon-o* katta-no?
Mary-Nom computer-Acc bought-QP
'Did Mary buy a computer?'

The strikingly distinct configurations of wh-phrases in the two types of languages could lead one to postulate different mechanisms in order to handle their processing.[2] However, building on the vast literature on the processing of fronted wh-phrases in Dutch, English, and Italian, we will suggest that the same characteristics pervade the processing of in-situ wh-

[2] The contrast between English and Japanese is observed in single wh-phrases in standard interrogative environments. In multiple wh-questions (as in (a)) and echo questions (as in (b)), not dealt in the present paper, in-situ wh-phrases are also allowed in English.
a. Who bought *what*?
b. Mary bought *what*?

phrases in Japanese. Contrary to previous studies, which have concentrated on thematic role requirements, we will argue that a full understanding of wh-phrases can only be attained when their scope requirements are also taken into consideration. In particular, we will draw a parallel between search processes for gaps in fronted wh-phrase constructions and search processes for QPs in in-situ wh-phrase constructions.

3. The Processing of Fronted Wh-Phrases

The interest in fronted wh-phrases is due not only to the fact that the constituent they require — a gap — is phonologically null, but also because an arbitrary number of clauses may intervene between the wh-phrase and its gap. Those two characteristics allow a relevant gap to be postulated at virtually any point in the sentence. For example, *what* in (3a) is associated as the direct object of *hitting* in the same clause, whereas in (3b) the thematic role of *what* as the instrument used for *hitting* is only determined in the most embedded clause (from Stowe, 1986).

(3) a. What$_i$ is Mary hitting <gap$_i$>?
    b. What$_i$ did Harry say that Tom thought that Mary was hitting that woman with <gap$_i$>?

Because the position of the gap in many cases is not known for certain until the end of the sentence, researchers proposed different types of strategies that readers may use when processing such constructions. One hypothesis that was entertained was that the requirement for a gap is held in a passive storage, and the gap is postulated when no other interpretation is possible, in other words, among the alternative interpretations available during the processing of a sentence, the gap is ranked as the least preferred; in the opposite extreme of possible strategies, it was also suggested that the position for a gap is actively sought and the gap is created as soon as possible because it is ranked as the most preferred among the possible interpretations (Fodor, 1978; also, Wanner, & Maratsos, 1978, for relevant discussion on relative clauses). Eventually, experimental evidence tipped in favour of the latter type of models. As soon as readers detect a wh-phrase, the requirement for a gap is activated and a gap is inserted at the earliest point allowed by the grammar, even when alternative continuations are possible (Boland, Tanenhaus, Garnsey, & Carlson, 1995; Crain & Fodor, 1985; de Vincenzi, 1991; Frazier, & Clifton, 1989; Frazier, & Flores d'Arcais, 1989; Stowe, 1986; Tanenhaus, Boland, Garnsey, & Carlson, 1989).

An early proposal that encapsulated such findings is the *active filler hypothesis* (Frazier, & Clifton, 1989; Frazier, & Flores d'Arcais, 1989).

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

The AFH successfully summarized how the processing of fronted wh-phrases takes place within an *incremental model*, in which words are associated in a representation without delay as soon as they are read (see, for example, Marslen-Wilson & Tyler, 1980, and references therein).

3.1 Generalizing the AFH

The basic insight of the AFH has been formulated in a number of different ways and applied to various types of constructions. Below we briefly discuss two of such developments.

3.1.1 The Minimal Chain Principle

Cross-linguistic comparisons have been invaluable in order to better understand the nature of wh-phrase processing. The *minimal chain principal* (MCP) is a classical case in which cross-linguistic investigations have allowed the generalization of models that had been originally proposed for English (de Vincenzi, 1991).

(5) Minimal Chain Principle (MCP): Avoid postulating unnecessary chain members at S-structure, but do not delay required chain members. [...] The definition of chain is that it is a set of coindexed elements, bearing one and only one Theta-role (for example agent, patient, recipient, etc.; henceforth, Th-role) and one and only one case (such as nominative, accusative, etc.), where each element of the chain is in a relation configurationally defined (i.e. c-commands) with the next one. (de Vincenzi, 1991, p. 13).

By making reference to chains — the syntactic mechanism that had been proposed to account for the syntax of wh-phrases and other types of dislocated constituents in Government and Binding (Chomsky, 1981) — de Vincenzi suggested that the processing of wh-phrases was an instance of a more widespread phenomenon, namely the creation of chains as a process constrained by working memory resources. Supporting this claim, she provided experimental evidence that other types of empty positions (e.g. *pro* as a singleton chain in Italian) were also subject to the MCP. Apart from generalizing the processing of wh-phrases, de Vincenzi's work also had the merit of providing evidence for the cross-linguistic validity of the characterization given to fronted wh-phrases in English.

3.1.2 Working-Memory Based Models

The processing of wh-phrases can also be explained exclusively in terms of working-memory resources. Because long dependencies require constituents to be maintained in working memory for longer periods of time, it can be argued that the processing of wh-phrases is an instance of a

general preference to minimize the distance between related constituents in a sentence (see Gibson, 1998, for a detailed discussion of a working memory based model and its applicability to wh-phrases; also, Just, & Carpenter, 1992, for related discussion on relative clauses) . Working-memory based models rely primarily on general requirements for cognitive resources and deemphasize the exact nature of the syntactic relation being processed. Thus, it is not important if the association being created is a chain or not; as long as two positions in a sentence have to be associated, there should be some cognitive cost involved.

The active filler hypothesis (AFH), the minimal chain principle (MCP) and working memory models (WMMs) agree in their basic characterization of the phenomena covered. The parsing of fronted wh-phrases is a process in which working memory restrictions lead speakers to prefer the distance between the wh-phrase and its gap to be as short as possible. Their disagreement is related to the level at which the generalization should be made. The AFH circumscribes the phenomena being considered exclusively to wh-phrases and relative clauses, the MCP generalizes the phenomena to chains, and WMMs expands coverage to all types of dependencies in a sentence.

In the following discussion, the type of model adopted will not be particularly relevant because we will restrict our attention to phenomena for which the three models above agree in their overall predictions. We will initially concentrate on the type of evidence that has been used to uncover the nature of fronted wh-phrases, then we will provide similar evidence for the Japanese construction.

3.2 The Filled Gap Effect

The main type of evidence used to investigate the processing of fronted wh-phrases comes from a phenomenon called the *filled-gap effect* (FGE; Crain & Fodor, 1985; Stowe, 1986), illustrated in the following sentence (adapted from Crain & Fodor, 1985).

(6) Filled gap effect (FGE)
Who$_i$ did the children force $\wedge$ us to sing the songs for <gap$_i$>?

Readers initially insert the gap for *who* at the position indicated by the wedge sign, '$\wedge$', and slow down when they read the next word, *us*, because it becomes apparent that the position of the gap is incorrect. The search for the gap resumes and the correct position is eventually found at the end of the sentence. The FGE suggests that a required gap is created as soon as possible without checking the following words coming up in the sentence. In the sentence above, if readers had used a one-word lookahead and checked the upcoming word *us* before inserting the gap, they would have known that the gap could not be in that position. The behavior attested by the FGE, such that parsing decisions are made without delay and

without lookahead, is consistent with incremental processing models, in which consulting upcoming words in order to make a parsing decision is not a possible strategy.

In the following, we describe two findings associated with the FGE that have revealed more detailed aspects of wh-phrase processing. The first result suggests that the FGE is more pronounced in object position than in subject position (Stowe, 1986). The second result indicates that argument structure and plausibility constraints guide the gap insertion process (Boland, et al., 1995; Tanenhaus, et al., 1989).

3.2.1 Lack of FGE in Subject Position

When processing relative clauses, English speakers have a preference for positing a gap in subject position rather than in object position (Just, & Carpenter, 1992, and references therein). Such a preference for subject gaps has also been found in the processing of wh-phrases in Dutch (Frazier, & Flores d'Arcais, 1989) and in Italian (de Vincenzi, 1991). However, researchers have failed to detect a slow-down that should be caused by a FGE in subject position in English. For example, consider the following sentence in (7a) and its control (7b) (from Stowe, 1986, Experiment 1).

(7) a. My brother wanted to know who$_i$ $\wedge$ Ruth will bring $\wedge$ us home to <gap$_i$> at Christmas.

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

The wedge signs in (7a) indicate the positions where readers may be successively positing a gap for the wh-phrase *who*. The first wedge sign turns out to be an incorrect position for the gap as signaled by the presence of the lexical NP *Ruth*. The pronoun *us* makes it equally clear that the second wedge sign position is not a possible position for the gap either. If readers are positing gaps at those two positions, there should be a FGE taking place at each one of them, and slow-downs should be observable at both points. However, Stowe (1986) only detected a statistically significant slow-down at *us* in (7a) in comparison to the same word in its control sentence, whereas the slow-down at *Ruth* was not statistically significant. There was also a significant interaction between sentence type and potential gap position.

Based on this result alone, one could speculate that the FGE does not occur if readers assume that a second candidate position for the gap is upcoming. However, the study described in the next section rules out this possibility by comparing two potential positions for a gap.

3.2.2 The FGE and Plausibility

Experiments using a stop-making-sense task, in which a self-paced reading presentation can be interrupted by readers at any point that they judge

the sentence to become incomprehensible, found a plausibility effect for verbs such as *remind* which can take more than one argument (Boland, et al., 1995; Tanenhaus, et al., 1989).

Judgement data and longer reading times starting at *to* in (8a) indicate that a FGE is taking place at that point, in other words, readers expected a gap at the position indicated by the $\wedge$ sign and were surprised when *them* was detected instead. No FGE was observed in (8b).

(8) a. [Which child]$_i$ did Mark remind $\wedge$ them to watch <gap$_i$> this evening?

b. [Which movie]$_i$ did Mark remind them to watch <gap$_i$> this evening?

The contrast between this pair of sentences suggests that readers take into consideration both grammatical constraints (such as argument structure) as well as plausibility constraints in order to decide where to expect a gap. The argument structure of *remind* makes available more than one potential host site for the gap, but readers only expect the gap to occur at the first site if plausibility allows it. Because *which movie* is not a plausible direct object in (8b), readers do not expect its gap to occur immediately after the verb. Furthermore, the FGE in (8a) suggests that, the grammar and plausibility allowing, the gap will necessarily be posited for the first candidate site and a slow-down will occur even if a second candidate position is likely to follow.[3]

4. In-Situ Wh-Phrases

The canonical position of wh-phrases in Japanese, as well as Chinese and Korean, is in-situ — in the same position as lexical NPs. Thus, it could be suggested that the processing of wh-phrases and lexical NPs in these languages is performed in the same way. There is, however, one aspect in which in-situ wh-phrases differ from lexical NPs. Several languages that allow in-situ wh-phrases require them to be accompanied by some morphological marking (Cheng, 1991).

In Japanese, in particular, wh-phrases have to be accompanied by a question particle (QP) in complementizer position in order to indicate their force as interrogative, but they can also be interpreted as universals or existentials depending on the accompanying particle (Nishigauchi, 1990). We will restrict the present discussion to interrogative environments.

Example (9a) below is ungrammatical because the wh-phrase is not

[3] There may be an alternative explanation for the slow-down in (8a). In eleven of the 18 experimental items, a third person pronoun such as *them* was used (the remaining items included first or second person pronouns; Boland, et al., 1995, Appendix 1, Experiment 2). If readers interpreted *them* as a resumptive pronoun, the slow-down may have been caused by a number mismatch with *which child*, and not because of a FGE.

followed by a QP such as 'no' (although it would be acceptable in colloquial speech with a rising intonation).

(9) a. * Dare-ga Mary-o sitteiru.
who-Nom Mary-Acc knows
* 'Who knows Mary.'

b. Dare-ga Mary-o sitteiru-no?
who-Nom Mary-Acc knows-QP
'Who knows Mary?'

There is a structural restriction on the relative position between wh-phrases and QPs (Nishigauchi, 1990). Part of the requirement can be stated as follows. The position in which the wh-phrase receives its thematic role must be dominated by a clause marked with a QP (in Government and Binding terms, Chomsky, 1981, the base position of the wh-phrase must be c-commanded by a QP).

For example, the wh-phrases in the sentences in (10) are in the matrix clause and, therefore, this clause must be marked by a QP otherwise the sentence is ungrammatical (as shown in (10a)). A QP in the embedded clause is irrelevant: Its presence does not license the matrix wh-phrase (as in (10a)) and its presence or absence does not affect grammaticality, as attested by (10bc).

(10) a. * Dare-ga John-ga Mary-ni atta-ka sitteiru.
who-Nom John-Nom Mary-Dat met-QP knows.
* 'Who knows whether John met Mary.'

b. Dare-ga John-ga Mary-ni atta-ka sitteiru-no?
who-Nom John-Nom Mary-Dat met-QP knows-QP
'Who knows whether John met Mary?'

c. Dare-ga John-ga Mary-ni atta-to itta-no?
who-Nom John-Nom Mary-Dat met-that said-QP
'Who said that John met Mary?'

The requirement above for Japanese has a parallel in the English constraint that a wh-phrase must be within an interrogative clause. Thus, (11a) is ungrammatical because *who* is within an affirmative sentence. Moreover, (11c) is ungrammatical even though the embedded clause headed by *whether* has interrogative typing. In (11d), the affirmative typing of the embedded clause does not interfere with the licensing of a wh-phrase in the matrix clause.

(11) a. * Who knows Mary.

b. Who knows Mary?

c. * Who knows whether John met Mary.

d. Who knows that John met Mary?

Another property of interest for the present discussion is that QPs can occur an arbitrary number of clauses away from the in-situ wh-phrase, in the same way that gaps can occur several clauses away from a fronted wh-phrase in English. In the examples below, the thematic role of *what* is determined locally, but the QP can occur in the same clause (as in (12a)) or a few clauses away (as in (12b); translated from English examples in Stowe, 1986).

(12) a. Mary-ga nani-o tataiteiru-*no*?
Mary-Nom what-Acc hitting-is-QP
'What is Mary hitting?'

b. Mary-ga nani-o tukatte ano onna-o tataiteita-to
Mary-Nom what-Acc using that woman-Acc hitting-was-that
Tom-ga omotta-to Harry-ga itta-*no*?
Tom-Nom thought-that Harry-Nom said-QP
'What did Harry say that Tom thought that Mary was hitting that woman with?'

5. General Requirements of Wh-Phrases

The following provides a general characterization of wh-phrases, both in-situ and fronted, by discussing the constraints they have to satisfy in order to receive an interpretation.

Wh-phrases have two basic requirements. Like NPs in general, they need a thematic role; moreover, as quantificational phrases, they also need to determine at which clausal level they are to take scope. English and Japanese meet those two requirements in different manners. English satisfies the scope requirement by placing the wh-phrase at the beginning of the clause in which scope is to be taken. Consider the following examples.

(13) a. I know $\underline{\text{what}_i}$ John found out Mary had bought $<\text{gap}_i>$.

b. I know John found out $\underline{\text{what}_i}$ Mary had bought $<\text{gap}_i>$.

The only difference between the two sentences is in the position of *what*, which determines the distinct scope positions in each case and consequently the distinct interpretations for the two sentences. In (13a), the speaker knows what is it that *John found out Mary had bought*; in (13b), however, the speaker has knowledge of the fact that *John found out that Mary had bought something*, but the speaker does not necessarily know the exact identity of the object in question.

Because the wh-phrase is dislocated to the front of the clause, satisfying the thematic role requirement in English entails searching for a gap position, in other words, searching for a predicate that has an available thematic role to assign. In Japanese, in contrast, the thematic requirement of in-situ wh-phrases is satisfied by a local verb. Scope, on the other hand, is

determined by the position of the QP (Nishigauchi, 1990). Thus, *what* is placed in the same position in the sentences below, and it is the position of the italicized QPs that determines scope.[4]

(14) a. Mary-ga nani-o katta-to John-ga itta-*ka*
Mary-Nom what-Acc bought-that John-Nom said-QP
watasi-wa kikimasita.
I-Top asked
'I asked what John said Mary had bought.'

b. Mary-ga nani-o katta-*ka* John-ga kiita-to
Mary-Nom what-Acc bought-QP John-Nom asked-that
watasi-wa iimasita.
I-Top said
'I said John asked what Mary had bought.'

In general, the position in which a constituent is pronounced can indicate many of its functions in the sentence. In the case of wh-phrases, there is a tension between thematic role assignment and scope taking because both constraints cannot be satisfied simultaneously by the position where the wh-phrase is pronounced. Languages have found different ways to resolve this dilemma. Some languages choose to pronounce the wh-phrase in its scope position, other languages choose to pronounce the wh-phrase in its thematic role position. Whichever the choice made, the other requirement has to be satisfied by a dependency that can cross an arbitrary number of clauses. Regardless of where the wh-phrase is pronounced, speakers have to be able to associate the thematic role position and the scope position in order to interpret the wh-phrase.

The contrast between English and Japanese illustrates the two possibilities outlined above. English satisfies the scope requirement as a local relation in the sense that the position in which the wh-phrase is pronounced indicates where scope is to be taken. As a consequence, wh-phrases in English are fronted and require determining the position of a gap in order to receive a thematic role. In Japanese, wh-phrases are pronounced in-situ, where they can receive a thematic role locally, and, as a consequence, they require the search for a QP in order to determine their scope position. In short, the two languages satisfy one requirement as a local dependency (scope in English; thematic role in Japanese) and consequently the other requirement (thematic role in English; scope in Japanese) involves search-

[4] Many verbs in English are ambiguous and can subcategorize for an affirmative complement (e.g. 'John reported that Mary...') or an interrogative complement (e.g. 'John reported whether Mary...'). In this respect, subcategorization seems to be stricter in Japanese, and most speakers only allow one alternative for a given verb. Therefore, in (14), we swapped not only the position of the QPs but also the subcategorizing verbs.

ing for a constituent which may be several clauses away.[5]

The processing literature on fronted wh-phrases has concentrated on gap searching, in other words, on the thematic requirement, because the scope requirement in languages such as Dutch, English and Italian, is unproblematic, being satisfied immediately at the position where the wh-phrase is pronounced. For in-situ wh-phrases, in contrast, the thematic role requirement is satisfied by a predicate in the same clause; the problem then is how speakers associate the in-situ wh-phrase with the required QP in order to satisfy the scope requirement. In the following section, we will argue that the search for a gap in English-like languages and the search for a QP in Japanese proceed in the same manner.

It may be suggested that there is a significant way in which gaps differ from QPs, namely, the former do not have phonological content and, therefore, determining their position could involve more ambiguity. However, QPs with phonological content seem to be a characteristic particular to Japanese. Other languages with wh-phrases in-situ have been argued to have phonologically null QPs (Cheng, 1991). Moreover, it will become apparent in the following that the (lack of) phonological content of the QP or the gap is irrelevant for the present discussion.

6. A Unified Approach to the Processing of Wh-Phrases

We propose the following model for the processing of wh-phrases in general.

i. a wh-phrase triggers the search for a constituent (a gap for fronted wh-phrases; a QP for in-situ wh-phrases) that can be several clauses away;
ii. the required constituent is posited at the earliest possible position because of working memory restrictions;
iii. if a possible position for the constituent turns out to be occupied by a different constituent, there is a slow-down;
iv. only positions licensed by parsing constraints (e.g. plausibility factors; grammatical constraints such as argument structure) are considered as possible hosts for the constituent.

The characterization above is not new and each of its features can be found in previous literature dealing with the processing of fronted wh-phrases and their gaps (Boland, et al., 1995; de Vincenzi, 1991; Frazier, & Clifton, 1989; Gibson, 1998; Stowe, 1986; Tanenhaus, et al., 1989).

[5] The use of scope requirements is a simplification for expository purposes. Syntacticians provide a number of alternative factors to explain the obligatory fronting of wh-phrases in English. For example, it has been proposed that fronting is required in order to type the clause as interrogative (in the same way that a clause headed by *whether* is typed as interrogative; Cheng, 1991). The exact factor that leads to the fronting of wh-phrases in English will not be relevant to the present discussion.

However, by abstracting away from language-specific characteristics, we are able to isolate the processing properties that are constant across languages. There is nothing special about gaps that causes the processing of fronted wh-phrases to proceed as described; even when a distinct element such as a QP is sought for, the process remains the same.

The exact nature of the constituent sought is not central to the process described, but it is clearly important. The positions in which a reader may posit a gap are different from the positions at which a QP may be expected to be. As a consequence factors that have been shown to modulate gap insertion are not always important for QP insertion. For example, plausibility plays a role in gap insertion but is not easily manipulated in order to vary readers expectations of where a QP should be expected.

The present paper provides two types of evidence to support the parallel between the processing of the two types of wh-phrases. First, a phenomenon parallel to the FGE will be argued to take place in Japanese, providing support to the applicability of points (i), (ii), (iii) above to this language. Second, only grammatically relevant positions are considered when positing the QP as suggested by (iv).

6.1 Typing Mismatch Effects

If in-situ wh-phrases in Japanese create the expectation for a QP and, furthermore, working memory restrictions require the QP to occur as soon as grammatically possible, there should be a *typing mismatch effect* (TME) taking place in the sentence below.

(15) Typing mismatch effect (object wh)
Senmu-ga donna-pasokon-o tukatteiru ∧ to
director-Nom what-kind-computer-Acc using-is that
kakarichoo-ga itta-no?
supervisor-Nom said-QP
'What kind of computer did the supervisor say the director is using?'

The wh-phrase *what-kind-of-computer* in (15) requires a QP, and the complementizer position immediately after the verb *using-is* is a potential site for such a QP as indicated by the wedge sign, '∧'. If speakers of Japanese are expecting a QP at this position, a TME should occur because the affirmative typing indicated by the complementizer 'to' (*that*) is incompatible with the interrogative typing required by the QP.

The parallel with the FGE discussed in relation to sentence (6) should be clear. In both cases, the wh-phrase triggers the expectation for a constituent (a gap in English; a QP in Japanese) which is predicted to come at the earliest point made available by the grammar. When this expectation is violated, a slow-down takes place (the FGE in English; the TME in Japanese). Experiment I below provides evidence that there is indeed a slow-down at the affirmative complementizer position in (15).

6.2 Subject Wh-Phrases

As discussed above, subject positions in English do not seem to give rise to a FGE, or at least they seem to be considerably weaker when compared to FGEs in object position. In other words, given a fronted wh-phrase, there does not seem to be a (statistically significant) slow-down if a subject position, which is a possible host for a wh gap, turns out to be filled by a lexical NP.

It is possible that such an asymmetry between subject and object positions is also observed in Japanese so that a wh-phrase in subject position causes a weaker TME than an object wh-phrase. In the following sentence, the subject wh-phrase *which-director* requires a QP, and the embedded complementizer position, immediately after the verb *using-is*, is a potential site for the QP. Because of the affirmative complementizer, there should be a TME at this point. If there is no TME or if it is weaker than for wh-phrases in object position, the parallel with English may help determine the factors behind the asymmetry.

(16) Typing mismatch effect (subject wh)
Dono-senmu-ga atarasii-pasokon-o tukatteiru ∧ to
which-director-Nom new-computer-Acc using-is that
kakarichoo-ga itta-no?
supervisor-Nom said-QP
'Which director did the supervisor say is using the new computer?'

Note that the word order in (16) is not canonical given that the subject *supervisor*, rather than the sentential complement, occurs immediately before the matrix verb *said*. In transformational grammars, it is assumed that the subject NP *supervisor* is in its canonical position and that the sentential complement has been preposed (Saito, 1985). Hence, (17a) is the canonical word order, whereas in (17b) (corresponding to (16) above), the sentential complement has been scrambled to the beginning of the sentence leaving the matrix subject next to the matrix verb.

(17) a. Canonical word order (Preposed matrix subject)
matrix-subject sentential-complement matrix-verb

b. Scrambled word order (Postposed matrix subject)
sentential-complement$_i$ matrix-subject t_i matrix-verb

The trace for the scrambled sentential complement will not be relevant for present purposes and we will refer to these conditions according to the position of the matrix subject, namely, preposed (at the beginning of the sentence as in the canonical word order) or postposed (after the sentential complement, as in the scrambled word order).

Although non-canonical, the word order in (17b) is easier to process than the canonical word order because the latter order involves center-

embedding as shown below in the canonical version of (16).

(18) Kakarichoo-ga [$_{CP}$ dono-senmu-ga atarasii-pasokon-o
supervisor-Nom which-director-Nom new-computer-Acc
tukatteiru-to] itta-no?
using-is-that said-QP
'Which director did the supervisor say is using the new computer?'

A further processing difference between the scrambled sentence in (16) and the canonical sentence in (18) allows us to investigate another aspect of the TME. No single verb in Japanese can take two nominative NPs and one accusative NP as arguments; thus, before any predicate is processed, it is clear that (18) must contain two clauses in order to accommodate *supervisor*, *which-director* and *new-computer* (Miyamoto, 2002). Thus, from early on in the sentence, readers know that two predicates (one for each clause) have to follow and, with each predicate, a complementizer position should be available. When the embedded complementizer position of *using-is* is processed, it is possible that no TME will be observed because readers are aware that another complementizer position (for the matrix clause) will be available eventually. In contrast, in (16), the presence of another clause may become apparent too late to prevent a TME to occur.

The English examples in (8) repeated below are relevant for the present discussion in terms of when an upcoming position can override the preference to posit a constituent immediately.

(19) a. Which child did Mark remind ∧ them to watch this evening?
b. Which movie did Mark remind them to watch this evening?

As observed earlier, there is a FGE taking place at *them* in (19a) even though a second candidate position for the gap is made available by the argument structure of *remind*. The fact that readers are aware of this later position for the gap is apparent in (19b), in which a FGE does not take place at *them* when plausibility prevents the gap to be posited in the direct object position. If the parallel that we are advocating between the FGE and the TME holds, we should expect Japanese speakers to prefer a required QP to occur at the first possible position even if they are aware that an alternative position for the QP is to come. Thus, we should expect a TME to occur at the embedded complementizer position of (18). Experiment II investigates this prediction by comparing sentences (16) and (18).

The plausibility effect in (19b) is particularly interesting because it suggests that English speakers expect a required gap to occur at the first candidate position which is made available by the grammar and which is also sanctioned by other constraints (such as plausibility). Strictly speaking, the direct object position in (19b) is not a candidate position because of plausibility restrictions, even though it would be grammatically permissible for

a gap to be created there.

Such plausibility effects are unlikely to be observed in Japanese because QPs are not sensitive to plausibility information. Neither is argument structure easily manipulated for present purposes because the relevant argument structure belongs to the matrix verb which in general occurs after the embedded complementizer position.

Although plausibility and argument structure do not seem to allow more detailed investigations of the TME, there are nevertheless some structural constraints which the wh-phrase and its QP must obey. In the following section, we manipulate one such structural constraint in order to vary the possible positions in which a QP is to be expected.

6.3 Grammatically Relevant Positions

It is not clear at this point how to manipulate plausibility or argument structure in order to vary the candidate positions for a QP. There is, however, a structural constraint discussed above in relation to (10) repeated below as (20).

(20) a. * Dare-ga John-ga Mary-ni atta-ka sitteiru.
who-Nom John-Nom Mary-Dat met-QP knows.
* 'Who knows whether John met Mary.'

b. Dare-ga John-ga Mary-ni atta-to sitteiru-no?
who-Nom John-Nom Mary-Dat met-that knows-QP
'Who knows that John met Mary?'

From the sentences in (20), it is clear that the typing of an embedded clause is irrelevant for the licensing of a matrix wh-phrase. A matrix wh-phrase has to be licensed by a QP in the matrix complementizer position (such as 'no' in (20b)). Consequently, a wh-phrase in matrix clause should not trigger the prediction for a QP in the embedded complementizer position, because a QP in such a position would not license the wh-phrase. Hence, there should not be a slow-down at the embedded complementizer position of the following sentence.

(21) Dono-kakarichoo-ga senmu-ga atarasii-pasokon-o
which-supervisor-Nom director-Nom new-computer-Acc
tukatteiru-to itta-no?
using-is-that said-QP
'Which supervisor said that the director is using the new computer?'

Because the complementizer position of the embedded clause is irrelevant for the licensing of the matrix subject wh, there is no expectation for a QP to occur immediately after *using-is* in the sentence above. Thus, there should not be a slow-down due to a TME at this point when the affirmative complementizer is read.

Note that it is grammatically acceptable to have a QP in the embedded complementizer position of (21), but such a QP would not satisfy the scope requirement of the matrix wh-phrase. To be more exact, the grammar is relevant in two respects: First, the grammar of Japanese determines that QPs can only occur in complementizer positions; second, the grammar imposes structural restrictions for the positions in which a wh-phrase and its QP can occur (e.g., a QP in embedded complementizer position cannot license a wh-phrase in the matrix clause). We are assuming that readers do not posit a QP in ungrammatical positions; the question investigated here is whether readers posit a QP in a grammatical position (namely, at the embedded complementizer) even though such a position does not satisfy a prior wh-phrase requirement.

Experiment III investigates the effects of such a structural constraint on QP insertion.

To summarize, we have suggested that the gap search process triggered by fronted wh-phrases in English is equivalent to the QP search for in-situ wh-phrases in Japanese. In the following, we report three self-paced reading experiments supporting this proposal.

7. Experiment I

The purpose of this first experiment is to show that a wh-phrase in object position creates the expectation for a QP and that a slow-down occurs if the QP does not occur at the first complementizer position made available by the grammar.

7.1 Method

7.1.1 Participants

Twenty-five native speakers of Japanese, residents in the Kanto area of Japan, participated in the experiment. They were students at Kanda University of International Studies or at University of Tokyo.

7.1.2 Materials

Twenty-four sets of sentences with four conditions each were constructed.

We compared the Aff/Wh condition in (22a) with the Aff/NP condition in (22b). In the latter sentence, the wh-phrase was replaced with *new computer*, therefore there is no expectation for a QP to follow. We predict that a TME, and consequently longer reading times, should be observable at the embedded affirmative complementizer position in the Aff/Wh condition because the prediction for a QP is not satisfied at this point.

It is conceivable that clauses with wh-phrases always require longer reading times to process because of extra computations necessary for wh arguments. Therefore, we included the two conditions shown in (22cd), which are the counterparts of the first two conditions with the QP 'ka' in the embedded complementizer position. In the QP/Wh condition in (22c),

the requirement for a QP is satisfied at the earliest possible point; whereas in the QP/NP condition in (22d), the QP is unexpected because there is no earlier indication that the clause is going to be interrogative.

(22) a. Embedded affirmative complementizer / wh object (Aff/Wh)
Senmu-ga donna-pasokon-o tukatteiru-to
director-Nom what-kind-computer-Acc using-is-that
kakarichoo-ga itta-no?
supervisor-Nom said-QP
'What kind of computer did the supervisor say the director is using?'

b. Embedded affirmative complementizer / NP object (Aff/NP)
Senmu-ga atarasii-pasokon-o tukatteiru-to kakarichoo-ga itta.
director-Nom new-computer-Acc using-is-that supervisor-Nom said
'The supervisor said that the director is using the new computer.'

c. Embedded QP / wh object (QP/Wh)
Senmu-ga donna-pasokon-o tukatteiru-ka
director-Nom what-kind-computer-Acc using-is-QP
kakarichoo-ga kiita-no?
supervisor-Nom asked-QP
'Did the supervisor ask what kind of computer the director is using?'

d. Embedded QP / NP object (QP/NP)
Senmu-ga atarasii-pasokon-o tukatteiru-ka kakarichoo-ga
director-Nom new-computer-Acc using-is-QP supervisor-Nom
kiita.
asked
'The supervisor asked whether the director is using the new computer.'

If wh-phrases predict a QP, we should expect a slow-down in the third region (the embedded verb and the complementizer) of the Aff/Wh condition in comparison to the corresponding region in the Aff/NP condition. In contrast, there should be no such a difference between the QP conditions in (22cd) because the requirement for a QP is satisfied immediately in the QP/Wh condition. Because the complementizer alone does not constitute a word (a 'bunsetsu' in Japanese terminology) and is more naturally taken to be a suffix of the previous verb, we conducted the comparisons by including the verb and the complementizer in one region (see the procedure section for further details on the segmentation used for the self-paced reading presentation).

The matrix verb for each condition was chosen depending on whether the sentential complement is affirmative or interrogative. This is because few verbs in Japanese can take both types of complements.

Four lists were created by distributing the twenty-four stimuli in a Latin Square design. Each participant saw exactly one of the lists intermixed with 40 unrelated foil items in pseudo-random order. Items were counterbalanced so that 32 items in each list had affirmative main clauses and the remaining 32 items had interrogative main clauses.

7.1.3 Procedure

The experiment was conducted on Power Macintoshes running PsyScope (Cohen, MacWhinney, Flatt & Provost, 1993) with a button-box. Participants were timed in a self-paced phrase-by-phrase non-cumulative moving-window reading task (Just, Carpenter & Woolley, 1982). All sentences were presented on a single line. The segmentation indicated with spaces in (22) was the actual segmentation used in the self-paced reading presentation. The embedded complementizer was shown together with the embedded verb because presenting it separately is intuitively odd in the same way that is peculiar to show a case marker separated from its preceding head noun.

Sentences were shown using Japanese characters with the uniform-width font Osaka Toohaba 14. Stimuli segments initially appeared masked with dots, and participants pressed the leftmost button of the button-box to reveal each subsequent region of the sentence and cause all other regions to revert to dots.

After each sentence, in order to verify comprehension, a verb followed by two nominative marked NPs was presented on a new screen and participants had to decide which NP was the subject of the verb in the sentence just read by pressing one of the two rightmost buttons of the button-box (the task was adapted from Nagata, 1993). Audio feedback indicated if the answer given was correct or not. Corresponding data points were eliminated from further analyses if the participant did not answer the comprehension task correctly.

The experimental trials were preceded by one screen of instructions and eight practice trials. The experiment took participants approximately 15 minutes.

7.1.4 Data Analysis

Analyses were conducted on comprehension task response accuracy and reading times. Reading times were trimmed so that data points beyond 2.5 standard deviations from the relevant condition $\times$ region cell mean were discarded, corresponding to less than 3.7% of the test data. The means and analyses presented below are based on the trimmed reading times. Analyses conducted on the untrimmed reading times yielded the same pattern of results.

7.2 Results

7.2.1 Comprehension Task Accuracy

In the comprehension task, the average correct response percentages for the four conditions did not differ significantly (Aff/Wh, 97.3%; Aff/NP, 98.0%; QP/Wh, 97.3%; QP/NP, 95.3%; $F_1(3,72) < 1$; $F_2(3,69) < 1$).

7.2.2 Reading Times

The reading time analyses yielded the following results (see Figures 1 and 2).

In region 1 (the embedded subject position), the four conditions did not differ significantly (Fs < 1).

In region 2 (the embedded object position), there was a main effect of object type. Wh-phrases (*what type of computer* in (22ac)) were read significantly faster than lexical NPs (*new computer* in (22bd)) ($F_1(1,24) = 5.03$, $P < 0.05$; $F_2(1,23) = 5.76$, $P < 0.05$).

In region 3 (the embedded verb and complementizer), there was a significant interaction effect between type of embedded object (NP or wh) and type of embedded complementizer (QP or affirmative) ($F_1(1,24) = 6.05$, $P < 0.05$; $F_2(1,23) = 5.41$, $P < 0.05$). Pairwise comparisons yielded the following results. The Aff/Wh condition was numerically slower than the Aff/NP condition ($F_1(1,24) = 3.58$, $P = 0.070$; $F_2(1,23) = 3.29$, $P = 0.083$). The QP/Wh condition was significantly faster than the QP/NP condition but only in the analysis by subjects ($F_1(1,24) = 4.33$, $P < 0.05$; $F_2(1,23) = 2.24$, $P = 0.15$).

In region 4 (the matrix subject), the results were as follows. The interaction effect found in region 3 was also statistically significant in this region ($F_1(1,24) = 10.29$, $P < 0.01$; $F_2(1,23) = 18.01$, $P < 0.01$). Pairwise comparisons were statistically significant in the present region: The Aff/Wh condition was slower than the Aff/NP condition ($F_1(1,24) = 6.16$, $P < 0.05$; $F_2(1,23) = 9.25$, $P < 0.01$), and the QP/Wh condition was faster than the QP/NP condition ($F_1(1,24) = 6.09$, $P < 0.05$; $F_2(1,23) = 5.11$, $P < 0.05$).

In region 5 (the matrix predicate), similar to regions 3 and 4, there was a significant interaction effect ($F_1(1,24) = 17.67$, $P < 0.01$; $F_2(1,23) = 12.98$, $P < 0.01$). Moreover, the Wh conditions (22ac) were read significantly more slowly than the lexical NP conditions (22bd) ($F_1(1,24) = 12.71$, $P < 0.01$; $F_2(1,23) = 7.30$, $P < 0.05$). Pairwise comparison results were as follows. The Aff/Wh condition was significantly slower than the Aff/NP condition ($F_1(1,24) = 27.68$, $P < 0.01$; $F_2(1,23) = 16.21$, $P < 0.01$). The QP/Wh condition was only numerically faster than the QP/NP condition (Fs < 1.05).

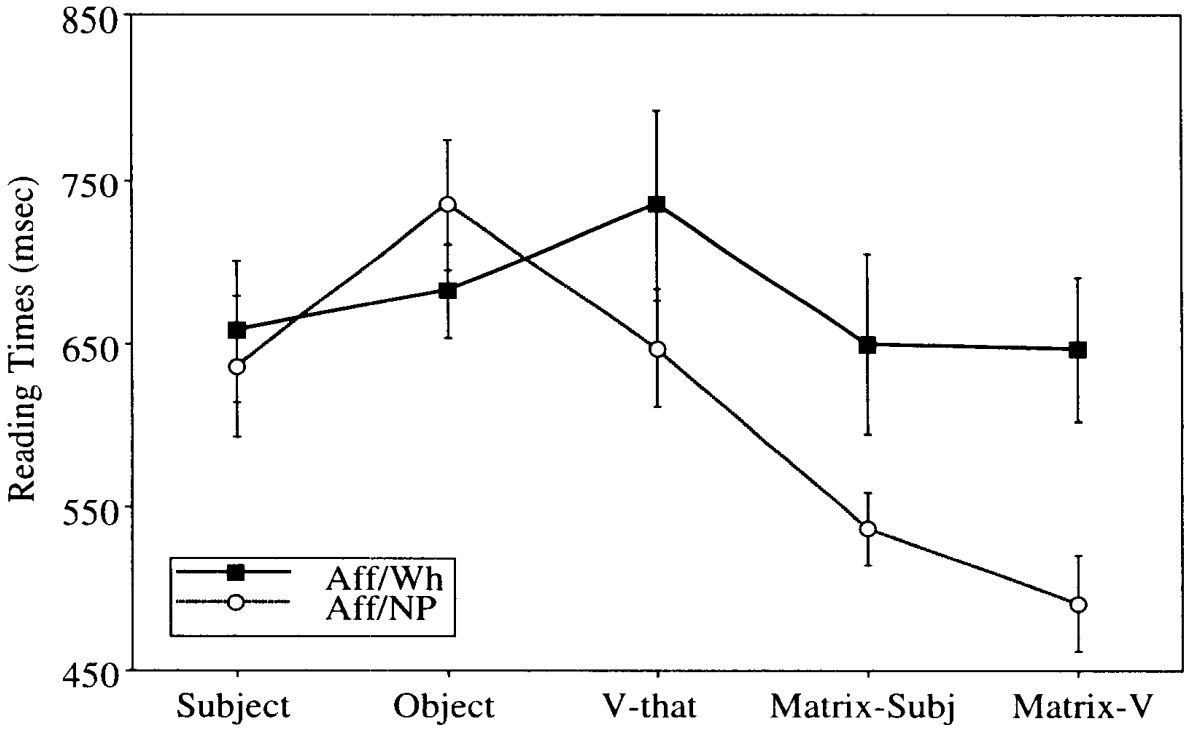

FIGURE 1 Reading times and standard errors per region for the affirmative complementizer conditions of Experiment I.

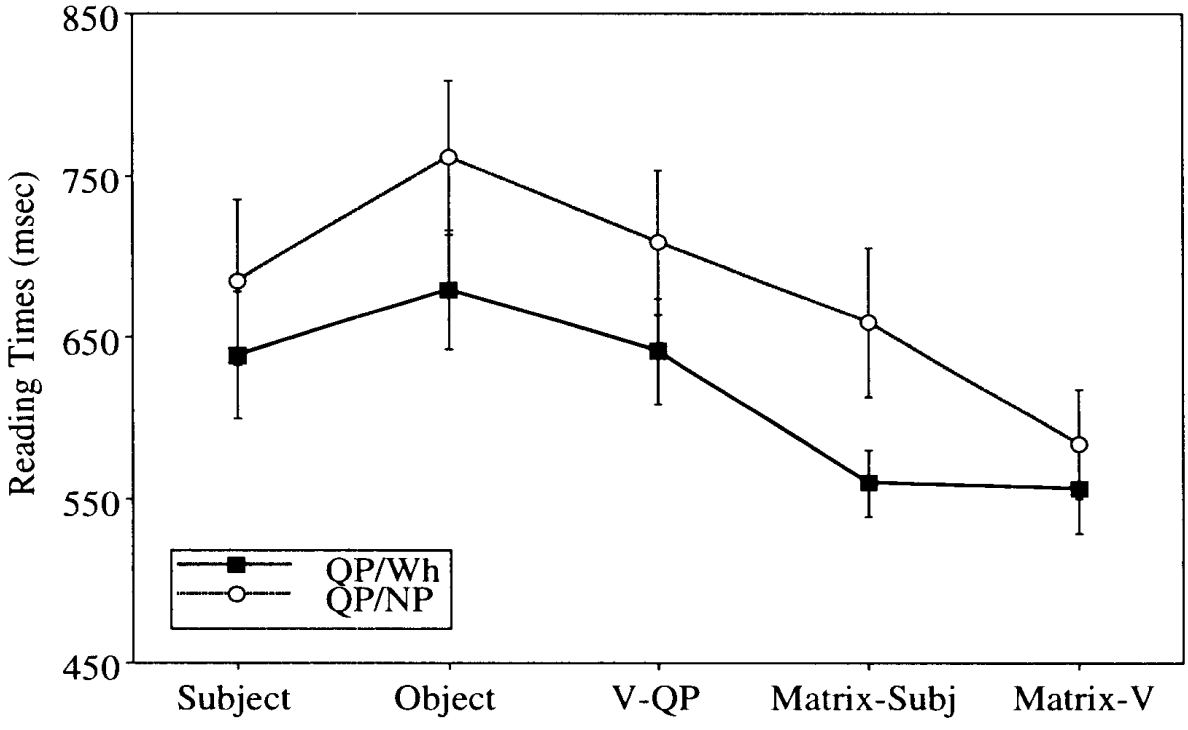

FIGURE 2 Reading times and standard errors per region for the QP conditions of Experiment I.

7.3 Discussion

The pattern of reading times observed in regions 3, 4 and 5 supports the observation that there is a TME taking place at the complementizer position (region 3) of the Aff/Wh condition shown in (22a). The parallel with the FGE in (6) suggests that a similar process is taking place in both cases: A wh-phrase is read and requires a certain type of constituent, and a slow-down is observed when the required constituent does not occur at the earliest possible position.

The relative slow-down in the QP/NP condition in regions 3 and 4 can be explained if we assume that lexical NPs do not require a QP, and furthermore, that clauses have the affirmative typing as their default. In this case, the slow-down in the QP/NP condition occurs because the clause had been initially typed as affirmative and then some extra processing was necessary in order to change the typing to interrogative when the QP was processed.

8. Experiment II

In this experiment, we provide evidence that wh subjects also lead to a TME if the earliest candidate position for a QP is occupied by an affirmative complementizer.

8.1 Method

8.1.1 Participants

Forty-one native speakers of Japanese participated in the experiment. They were undergraduate students at Kanda University of International Studies and had not participated in Experiment I. Three participants' data were eliminated from the analyses because less than 70% of their responses to the comprehension task for the test items were correct (for the remaining 38 participants, $M = 89.5$, $SD = 8.3$).

8.1.2 Materials

The experimental design had four conditions. Twenty-four items were created based on the items used in Experiment I.

The experiment had two main goals. First, we created two conditions in which the matrix subject occurs after the sentential complement (the postposed subject conditions, or Post for short). We would like to show that there is a slow-down at the embedded complementizer position in the Post/Aff condition shown in (23a) because the subject wh-phrase creates the expectation for a QP at this point. The control in this case is the Post/QP condition in which the embedded affirmative complementizer was replaced by a QP.

We would also like to investigate whether the position of the matrix subject can modulate the occurrence of a TME. For this purpose, we included the two conditions with the matrix subject in canonical position, be-

fore the sentential complement (the preposed subject conditions, or Prep). Such a configuration indicates that the sentence includes more than one clause, thus, before readers reach the embedded complementizer position they know that a second complementizer position may be available later on.

(23) a. Postposed matrix subject / embedded affirmative complementizer (Post/Aff)
Dono-senmu-ga atarasii-pasokon-o tukatteiru-to
which-director-Nom new-computer-Acc using-is-that
kakarichoo-ga itta-no?
supervisor-Nom said-QP
'Which director did the supervisor say is using the new computer?'

b. Postposed matrix subject / embedded QP (Post/QP)
Dono-senmu-ga atarasii-pasokon-o tukatteiru-ka
which-director-Nom new-computer-Acc using-is-QP
kakarichoo-ga kiita-no?
supervisor-Nom asked-QP
'Did the supervisor ask which director is using the new computer?'

c. Preposed matrix subject / embedded affirmative complementizer (Prep/Aff)
Kakarichoo-ga dono-senmu-ga atarasii-pasokon-o
supervisor-Nom which-director-Nom new-computer-Acc
tukatteiru-to itta-no?
using-is-that said-QP
'Which director did the supervisor say is using the new computer?'

d. Preposed matrix subject / embedded QP (Prep/QP)
Kakarichoo-ga dono-senmu-ga atarasii-pasokon-o
supervisor-Nom which-director-Nom new-computer-Acc
tukatteiru-ka kiita-no?
using-is-QP asked-QP
'Did the supervisor ask which director is using the new computer?'

If the pattern of results here is to mirror the results obtained for the FGE in English (see discussion on examples (8) and (19) above; Boland, et al., 1995; Tanenhaus, et al., 1989), we should expect a TME to occur at the embedded affirmative complementizer of the Prep/Aff condition in (23c), even though readers are aware of an upcoming complementizer position. One possible outcome, still compatible with the English results, is that

the availability of a second position will make the slow-down smaller in the Prep/Aff condition compared to the Post/Aff condition. In the Prep/QP control, the embedded affirmative complementizer was replaced with a QP.

Four lists were created by distributing the twenty-four stimuli in a Latin Square design. Each participant saw exactly one of the lists intermixed with 40 unrelated foil items in pseudo-random order. For each list, half of the items had main clauses with affirmative typing and the other half had main clauses with interrogative typing.

8.1.3 Procedure and Data Analyses

The procedure and analyses were the same as the ones used for Experiment I. Trimming procedures for the reading times removed data points beyond 2.5 standard deviations from the relevant conditions × region cell mean, corresponding to less than 2.8% of the test data.

In order to facilitate the reading time analyses, the regions were numbered according to Table 1, so that the embedded clause regions were aligned in all four conditions (the original design comparing preposed subject sentences to postposed subject sentences in such a manner is due to Inoue (1990a,b), who was investigated the processing of relative clauses in Japanese). An advantage in this kind of comparison is that the same lexical items are compared across conditions. One disadvantage in the procedure is that the actual linear position in the presentation differed between the preposed conditions and the postposed conditions. For example, the embedded object (region 3 in Table 1) was the third region read in the preposed conditions, but it was the second region that readers saw in the postposed conditions. In order to avoid linear position effects, we do not compare a preposed condition to a postposed condition directly.

Regions	1	2	3	4	5	6
Postposed subject conditions (23ab):		wh-Nom	NP-Acc	V-Comp	NP-Nom	V
Preposed subject conditions (23cd):	NP-Nom	wh-Nom	NP-Acc	V-Comp		V

TABLE 1 Regions used in the reading time analysis.

8.2 Results

8.2.1 Comprehension Task Accuracy

The percentages of correct responses on the comprehension task were significantly different for the four conditions (Post/Aff, 93.9%; Post/QP, 92.1%; Prep/Aff, 85.5%; Prep/QP, 86.4%; $F_1(3,111) = 5.23$, $P < 0.01$; $F_2(3,69) = 3.91$, $P < 0.05$).

There was no statistically significant interaction between complemen-

tizer type (affirmative or QP) and position of the subject (preposed or postposed) ($F_1(1,37) < 1$; $F_2(1,23) < 1$). There was a main effect due to subject position with performance in the postposed subject conditions being significantly better than in the preposed subject conditions ($F_1(1,37) = 12.61$, $P < 0.01$; $F_2(1,23) = 9.53$, $P < 0.01$). There was no main effect due to complementizer type (Fs < 1).

8.2.2 Reading Times

The regions were numbered as in Table 1 for analysis purposes. See Figures 3 and 4 for the reading times per region.

In region 1 (the matrix subject of the preposed subject conditions), the two preposed subject conditions did not differ significantly ($F_1(1,37) = 2.39$, $P = 0.13$; $F_2(1,23) < 1$).

In region 2 (the wh subject in the embedded clause), the four conditions did not differ significantly ($F_1(3,111) = 1.35$, $P = 0.26$; $F_2(3,69) < 1$).

In region 3 (the direct object in the embedded clause), there was a main effect related to the position of the matrix subject: The postposed subject conditions were significantly slower than the preposed subject conditions in the analysis by subjects ($F_1(1,37) = 4.55$, $P < 0.05$), but the difference was not significant in the analysis by items ($F_2(1,23) = 3.56$, $P = 0.072$).

In region 4 (the embedded verb and complementizer), there was no interaction between subject position and complementizer type ($F_1(1,37) < 1$; $F_2(1,23) < 1$). There was a main effect related to complementizer type with the QP conditions being significantly faster than the Aff conditions in the analysis by subjects $F_1(1,37) = 6.14$, $P < 0.05$) and marginally in the analysis by items ($F_2(1,23) = 3.68$, $P = 0.067$). There was also a main effect of subject position with the postposed subject conditions being significantly slower than the preposed subject conditions ($F_1(1,37) = 30.68$, $P < 0.01$; $F_2(1,23) = 21.10$, $P < 0.01$). Pairwise comparisons yielded the following results. The Post/Aff condition was only numerically slower than the Post/QP condition ($F_1(1,37) = 2.56$, $P = 0.12$; $F_2(1,23) = 1.03$, $P = 0.32$). The Prep/Aff condition was significantly slower than the Prep/QP condition ($F_1(1,37) = 7.35$, $P < 0.05$; $F_2(1,23) = 7.53$, $P < 0.05$).

In region 5 (the matrix subject for the postposed subject conditions), the Post/Aff condition was numerically slower than the Post/QP condition ($F_1(1,37) = 1.39$, $P = 0.25$; $F_2(1,23) = 1.18$, $P = 0.29$).

In region 6 (the matrix predicate), there was no interaction between subject position and complementizer type (Fs < 1). There was a main effect of subject position such that the postposed subject conditions were significantly slower than the preposed subject conditions in the analysis by subjects and marginally so in the item analysis ($F_1(1,37) = 4.56$, $P < 0.05$; $F_2(1,23) = 4.15$, $P = 0.053$). Moreover, the Aff conditions were significantly slower than the QP conditions ($F_1(1,37) = 4.36$, $P < 0.05$;

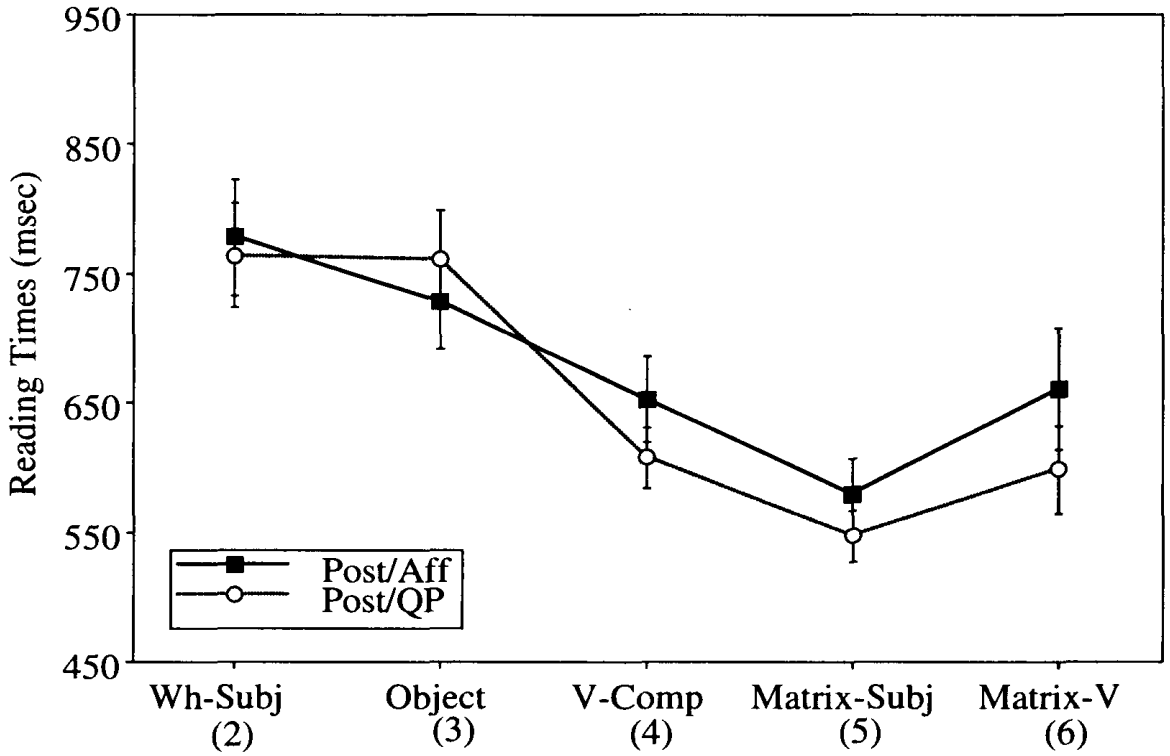

FIGURE 3 Reading times and standard errors per region for the postposed matrix subject conditions of Experiment II (numbers in parentheses indicate the region numbers used in the analyses; see Table 1).

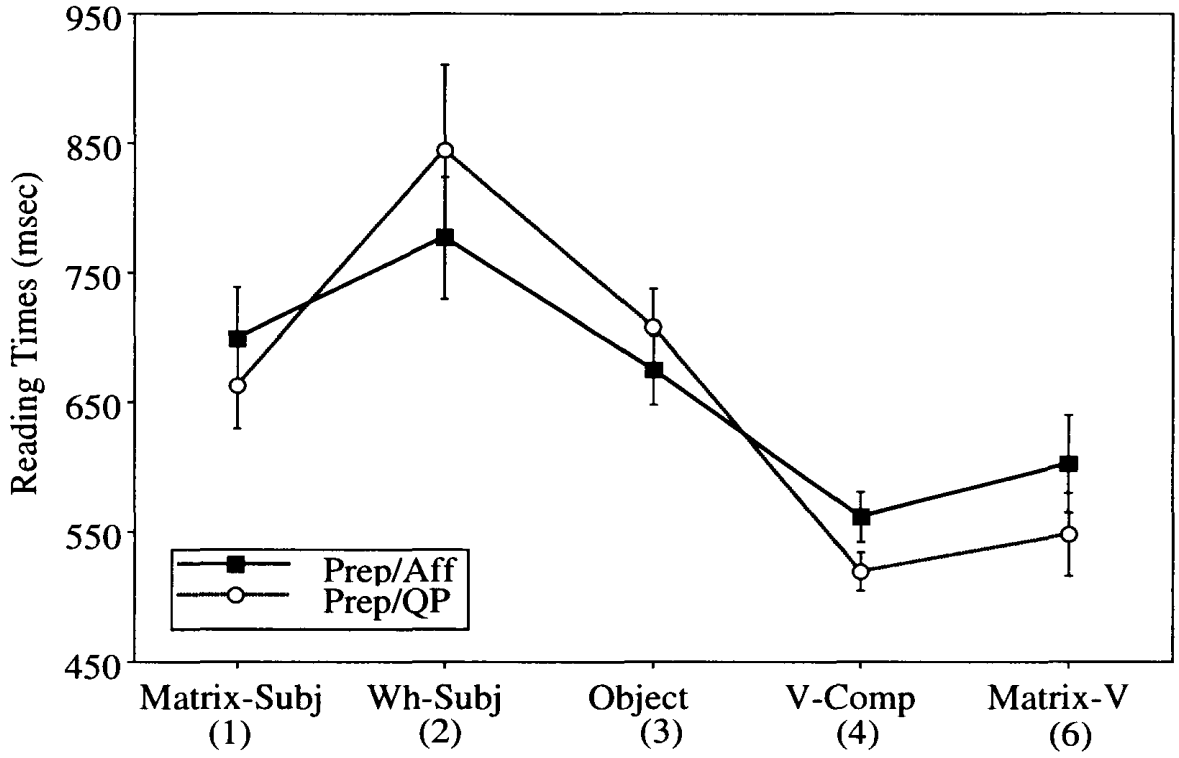

FIGURE 4 Reading times and standard errors per region for the preposed matrix subject conditions of Experiment II (numbers in parentheses indicate the region numbers used in the analyses; see Table 1).

$F_2(1,23) = 5.82$, $P < 0.05$).

Because the reading times in regions 5 and 6 are likely to reflect spillover effects from region 4, a further analysis was conducted including those three regions with the following results (for the Prep conditions, only regions 4 and 6 were included). There was no interaction (Fs < 1). The Aff conditions were significantly slower than the QP conditions in both analyses ($F_1(1,37) = 7.08$, $P < 0.05$; $F_2(1,23) = 6.47$, $P < 0.05$). The postposed subject conditions were significantly slower than the preposed subject conditions in both analyses ($F_1(1,37) = 15.85$, $P < 0.01$; $F_2(1,23) = 8.16$, $P < 0.01$). Pairwise comparisons revealed the following patterns. The Post/Aff condition was significantly slower than the Post/QP in the analysis by subjects ($F_1(1,37) = 4.31$, $P < 0.05$; $F_2(1,23) = 2.00$, $P = 0.17$). The Prep/Aff condition was significantly slower than the Prep/QP condition in both analyses ($F_1(1,37) = 5.15$, $P < 0.05$; $F_2(1,23) = 6.42$, $P < 0.05$).

8.3 Discussion

The results of the experiment indicate that a subject wh-phrase creates the expectation for a QP and that a TME occurs when the affirmative complementizer is detected. There was a main effect such that the Aff conditions were significantly slower than the QP conditions; however, the Post/Aff condition was only numerically slower than the Post/QP condition.

Effects of the matrix subject position are observed in the comprehension performance and in the reading times. In the comprehension task, the Post conditions were answered more accurately than the Prep conditions. The difference is unsurprising given that the task involved identifying the subject of a predicate, thus having one of the possible subjects at a late position in the sentence may have facilitated its identification. The faster reading times in regions 3 and 4 in the Prep conditions may be attributed to a linear position effect because those conditions had an extra region (the matrix subject in region 1) compared to the Post conditions. In region 6 (the matrix verb), the Post conditions may have been slower because of effects from scrambling the embedded clause.

Although there is no statistically significant interaction, numerically the difference between the Prep/Aff and the Prep/QP conditions is more robust than between the two Post conditions. This is the opposite pattern that we entertained in the earlier discussion. Because the Prep conditions make it clear from early on in the sentence that a second complementizer position may follow, it was suggested that the slow-down caused by the TME in the Prep/Aff condition would be weaker than in the Post/Aff condition. Nevertheless, the present result in the Prep/Aff condition is consistent with previous results in English according to which the FGE occurs even when a second candidate position for the gap is made available by

the argument structure of the verb (Boland, et al., 1995; Tanenhaus, et al., 1989).

8.3.1 Memory Load

A possible explanation for the weaker TME generated in the Post/Aff condition is that readers' expectation for a QP depends on the memory load incurred as the sentence is processed. Because the Prep/Aff condition has an extra NP (the matrix subject) in the initial segment of the sentence, its memory load is greater and, consequently, the preference for the QP to occur as soon as possible may be stronger than in the Post/Aff condition. This explanation is compatible with our present proposal as long as memory load increases the preference for the QP to occur as soon as possible, but only at grammatically relevant positions.

One extreme version of this proposal could be used to argue that the TME is governed exclusively by memory load, regardless of grammatical requirements, so that, the less memory available, the stronger the preference for the QP to occur soon — even in positions that are not grammatically relevant. It is important to consider this agrammatical model because it could potentially explain the results reported so far, thus undermining the parallel we are attempting to draw between the FGE and the TME. Given that the FGE and, consequently, gap insertion processes have been shown to obey grammatical constraints (Experiment 2 in Stowe, 1986; also Boland, et al., 1995; Tanenhaus, et al., 1989), it is paramount for present purposes that we show that the TME and QP insertion are constrained by the grammar in a similar fashion.

Although both types of models are based on working memory factors, we will refer to the present hypothesis as the agrammatical memory load hypothesis in order to differentiate it from WMMs discussed earlier on. Experiment III investigates whether the grammar constrains the TME.

9. Experiment III

In this experiment, we demonstrate that TMEs only occur at grammatically relevant positions, in other words, only in positions in which the grammar allows a QP to license a prior wh-phrase.

9.1 Method

9.1.1 Participants

Thirty-three native speakers of Japanese participated in the experiment. They were undergraduates at Kanda University of International Studies and had not participated in the previous two experiments. Two participants' data were eliminated from the analyses because their percentage of correct responses to the comprehension task was lower than 70% for all the items in the session (for the remaining 31 participants, $M = 88.9\%$, $SD = 7.96$).

9.1.2 Materials

As suggested by the results in Experiment II, a wh-phrase in subject position induces a TME at a following embedded affirmative complementizer.

(24) a. Postposed matrix subject / embedded wh subject (Post/Wh)
Dono-senmu-ga atarasii-pasokon-o tukatteiru-to
which-director-Nom new-computer-Acc using-is-that
kakarichoo-ga itta-no?
supervisor-Nom said-QP
'Which director did the supervisor say is using the new computer?'

b. Postposed matrix subject / embedded NP subject (Post/NP)
Senmu-ga atarasii-pasokon-o tukatteiru-to
director-Nom new-computer-Acc using-is-that
kakarichoo-ga itta-no?
supervisor-Nom said-QP
'Did the supervisor say that the director is using the new computer?'

c. Preposed matrix subject / matrix wh subject (Prep/Wh)
Dono-kakarichoo-ga senmu-ga atarasii-pasokon-o
which-supervisor-Nom director-Nom new-computer-Acc
tukatteiru-to itta-no?
using-is-that said-QP
'Which supervisor said that the director is using the new computer?'

d. Preposed matrix subject / matrix NP subject (Prep/NP)
Kakarichoo-wa senmu-ga atarasii-pasokon-o
supervisor-Top director-Nom new-computer-Acc
tukatteiru-to itta-no?
using-is-that said-QP
'As for the supervisor, did he say that the director is using the new computer?'

There are three goals in the present experiment. First, we would like to investigate the Aff/Post condition in Experiment II (repeated as (24a) and relabelled as Post/Wh) in relation to a new control, namely, the Post/NP condition in (24b).

Second, because the embedded complementizer position is irrelevant for the licensing of a matrix wh-phrase (as argued in the discussion of example (21) above), readers should not expect a QP at the embedded complementizer position in the Prep/Wh condition in (24c), and, as a consequence, no TME should occur when the embedded affirmative complementizer is read in this sentence. Sentence (24d) was used as a control.

Third, if the agrammatical memory load hypothesis discussed in the previous section is correct, so that the TME is determined exclusively by memory load factors and not at all by grammatical requirements, there should be a greater slow-down at the embedded complementizer of the Prep/Wh condition than the same word in the Post/Wh condition in relation to their respective controls because the memory load in the former sentence is greater due to the preposed subject.

The choice of a control sentence for the Prep/Wh condition is somewhat problematic. A first alternative would be the sentence in (25). However, there is some uncertainty as to how this sentence may be processed.

(25) Dono-kakarichoo-ga senmu-ga atarasii-pasokon-o
which-supervisor-Nom director-Nom new-computer-Acc
tukatteiru-ka kiita-no?
using-is-QP asked-QP
'Which supervisor asked whether the director is using the new computer?'

As the result of Experiment I suggests, there is likely to be a slow-down at the embedded QP in this sentence because this is the first point that indicates that the embedded clause has interrogative typing. Alternatively, because the matrix subject *which-supervisor* signals that the whole sentence is going to be interrogative, it may not require extra processing to type the embedded sentence as interrogative. Intuitive judgements suggest that there may in fact be some unexpectedness at the embedded QP.

The alternative adopted is the sentence in (24d) in which there is no wh-phrase and consequently no requirement for a QP in the embedded complementizer position. Note that for the matrix subject of (24d) we used the topic marker 'wa' rather than the nominative marker 'ga'. This is because two consecutive lexical NPs marked with the nominative 'ga' are particularly confusing in Japanese, and topicalization facilitates processing in this case (Miyamoto, 2002; Uehara, 1997).

In the Prep/Wh condition, the wh-phrase is marked with the nominative marker *ga* because wh-phrases cannot be marked with *wa* (Kuno, 1973, p. 37). For reasons not entirely clear at this point, the difficulty with two consecutive nominative NPs is considerably lessened if one of the NPs is a wh-phrase (but see Lewis, 1996; Lewis & Nakayama, 2001, for a possible explanation in terms of less interference when constituents are more dissimilar); therefore, the two nominative NPs in the Prep/Wh condition should not be particularly difficult to process. Because we are investigating whether the Prep/Wh condition is easy to process at the embedded complementizer position, it should not constitute a problem that we are facilitating the processing of its control sentence by using topicalization.

Four lists were created by distributing the twenty-four stimuli in a Latin Square design. Each participant saw exactly one of the lists intermixed with 40 unrelated foil items in pseudo-random order. For each list, half of the items had main clauses with affirmative typing and the other half had main clauses with interrogative typing.

9.1.3 Procedure and Data Analyses

The procedure and analyses were the same as the ones used for Experiment I. Trimming procedures for the reading times removed data points beyond 2.5 standard deviations from the relevant conditions × region cell mean, corresponding to less than 3.4% of the test data.

As in Experiment II, the regions were numbered so that the embedded clauses are aligned across the four conditions for analysis purposes (see Table 2).

Regions:	1	2	3	4	5	6
Postposed subject conditions (24ab):		embedded subject	NP-Acc	V-that	matrix subject	V
Preposed subject conditions (24cd):	matrix subject	embedded subject	NP-Acc	V-that		V

TABLE 2 Regions used in the reading time analysis.

9.2 Results

9.2.1 Comprehension Task Accuracy

Performance in the comprehension task differed significantly for the four conditions (Post/Wh, 91.4%; Post/NP, 94.6%; Prep/Wh, 86.0%; Prep/NP, 83.8%; $F_1(3,90) = 4.07$, $P < 0.01$; $F_2(3,69) = 4.93$, $P < 0.01$).

There was no main effect related to subject type, nor interaction (all Fs < 1). However, there was a main effect due to position of the matrix subject with performance for the postposed subject conditions being significantly better than in the preposed subject conditions ($F_1(1,30) = 12.09$, $P < 0.01$; $F_2(1,23) = 11.94$, $P < 0.01$).

9.2.2 Reading Times

The regions were numbered as in Table 2 for analysis purposes. (See Figures 5 and 6 for the reading times per region.)

In region 1 (the matrix subject in the preposed subject conditions), the wh subject in the Prep/Wh condition was read significantly more slowly than the lexical subject in the Prep/NP condition in the analysis by subjects ($F_1(1,30) = 5.87$, $P < 0.05$; $F_2(1,23) = 3.53$, $P = 0.073$).

In region 2 (the embedded subject), the wh subject in the Post/Wh condition was read significantly more slowly than the lexical subject in the Post/NP condition ($F_1(1,30) = 10.4$, $P < 0.01$; $F_2(1,23) = 6.08$,

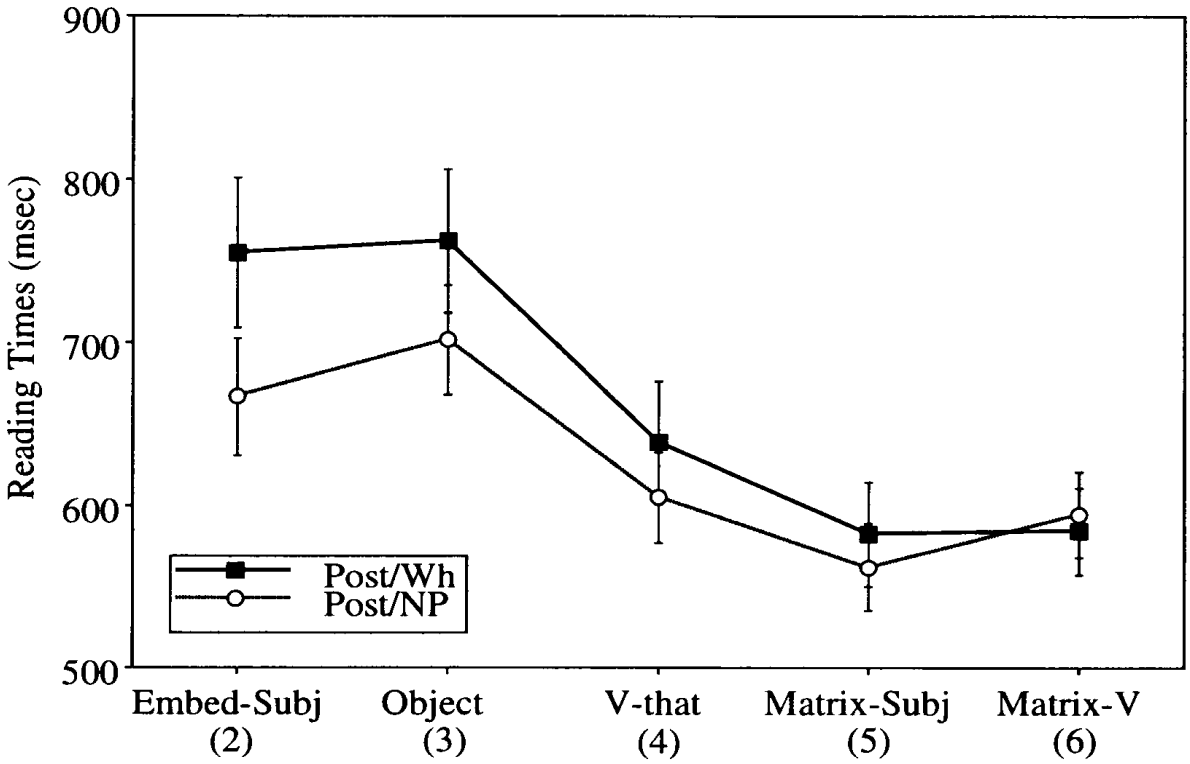

FIGURE 5 Reading times and standard errors per region for the postposed matrix subject conditions of Experiment III (numbers in parentheses indicate the region numbers used in the analyses; see Table 2).

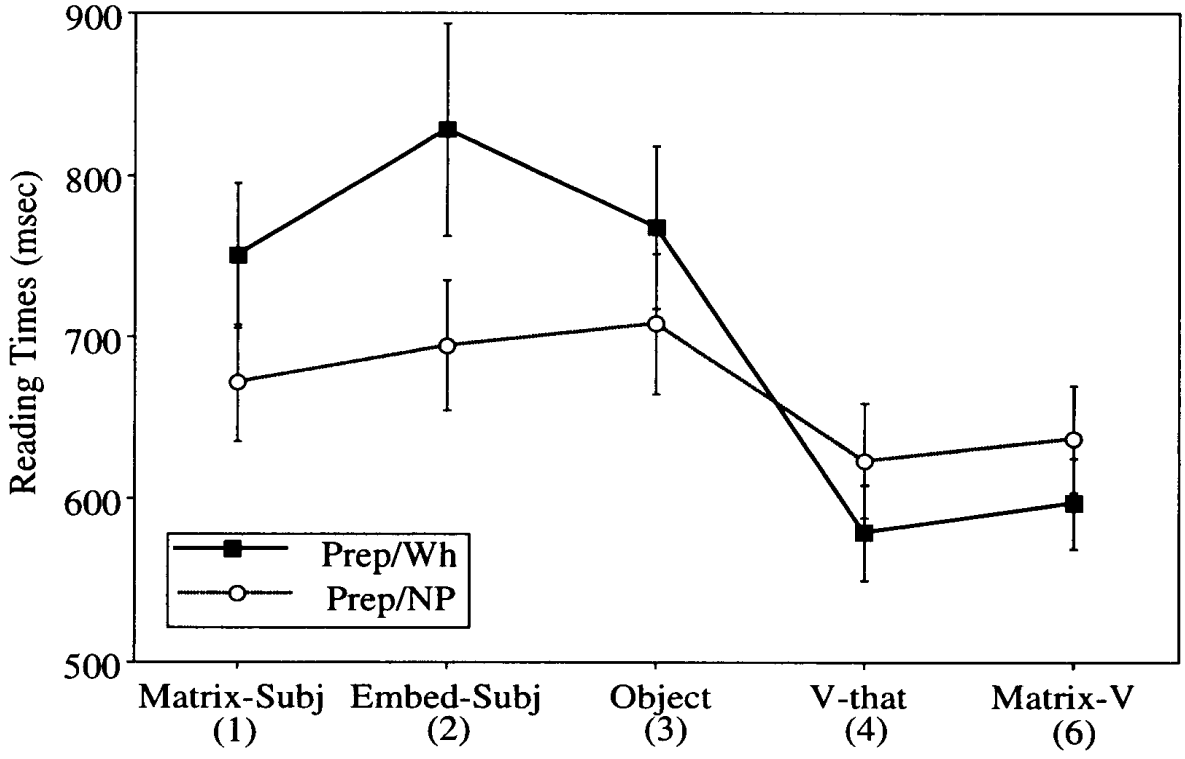

FIGURE 6 Reading times and standard errors per region for the preposed matrix subject conditions of Experiment III (numbers in parentheses indicate the region numbers used in the analyses; see Table 2).

$P < 0.05$). The lexical subject in the Prep/Wh conditions was read significantly more slowly than the lexical subject in the Prep/NP condition ($F_1(1,30) = 6.85$, $P < 0.05$; $F_2(1,23) = 6.20$, $P < 0.05$).

In region 3 (the direct object *new computer*), there was no significant interaction between subject type and matrix subject position (Fs < 1). There was no significant main effect related to the matrix subject position (Fs < 1). The Wh conditions (24ac) were significantly more slower than the NP conditions (24bd) in the analysis by subjects ($F_1(1,30) = 6.86$, $P < 0.05$) and marginally slower in the analysis by items ($F_2(1,23) = 3.82$, $P = 0.063$).

In region 4 (the embedded verb and the affirmative complementizer), there was a significant interaction between subject type (NP or Wh) and position of the matrix subject (preposed or postposed) ($F_1(1,30) = 4.62$, $P < 0.05$; $F_2(1,23) = 4.28$, $P = 0.05$). There was no significant difference related to subject type ($F_1(1,30) = 2.43$, $P = 0.13$; $F_2(1,23) < 1$) or to the matrix subject position ($F_1(1,30) < 1$; $F_2(1,23) < 1$). Pairwise comparisons did not reveal any statistically significant differences. The Post/Wh condition was only numerically slower than the Post/NP condition ($F_1(1,30) = 1.99$, $P = 0.17$; $F_2(1,23) < 1$). The Prep/Wh condition was only numerically faster than the Prep/NP condition ($F_1(1,30) = 2.07$, $P = 0.16$; $F_2(1,23) = 4.11$, $P = 0.054$).

In region 5 (the matrix subject in the Post conditions), the Post/Wh condition was numerically slower than the Post/NP condition ($F_1(1,30) < 1$; $F_2(1,23) = 1.28$, $P = 0.27$).

In region 6 (the matrix predicate), there was no significant interaction (Fs < 1). There was a main effect related to the position of the matrix subject as the preposed subject conditions were slower than the postposed subject conditions, but the difference was significant only in the item analysis ($F_1(1,30) = 3.38$, $P = 0.076$; $F_2(1,23) = 8.56$, $P < 0.01$). The wh conditions were only numerically faster than the lexical subject conditions ($F_1(1,30) = 2.41$, $P = 0.13$; $F_2(1,23) = 2.08$, $P = 0.16$).

9.3 Discussion

The main result in this experiment is that a QP is only predicted at grammatically relevant positions given that the TME did not occur in a position in which the grammar does not allow a QP to license a wh-phrase.

According to the agrammatical memory load hypothesis, the slow-down caused by the TME would be determined exclusively by memory load. The model does not take grammatical requirements into consideration and predicts that a slow-down should occur at the first affirmative complementizer, regardless of whether a QP in this position could grammatically license a prior wh-phrase. The predictions of this model are not supported by the present results.

The significant interaction in region 4 suggests that even though its memory load is greater, the Prep/Wh condition does not present a slow-down as the Post/Wh does at the affirmative complementizer. In fact, the Prep/Wh is numerically faster than its Prep/NP control (when regions 4 and 6 are considered together, the difference is significant in the item analysis: $F_1(1,30) = 3.11$, $P = 0.88$; $F_2(1,23) = 4.77$, $P < 0.05$).

Although the present results are not compatible with the agrammatical version of the memory load hypothesis, it is conceivable that a slow-down due to the TME will be more pronounced if there is less memory available because there is going to be more pressure to posit the QP in the first position made available by the grammar. This weaker version of the memory load hypothesis is compatible with our claims as it is restricted to positions in which a QP can license a prior wh-phrase.

The better comprehension performance in the postposed subject conditions may have been caused by the nature of the task utilized as suggested in the discussion of Experiment II.

10. General Discussion

We provided evidence for a typing mismatch effect (TME) with characteristics that mirror those observed in the filled-gap effect (FGE). Such a parallel indicate that the processing of in-situ wh and fronted wh constructions proceed in a similar fashion contrary to what their superficial differences may suggest. Such a conclusion is unsurprising if our starting point is the assumption that all languages are parsed by the same type of processing mechanism, and especially given recent proposals that all dependencies in a sentence are constrained by the limited cognitive resources available for language processing (Gibson, 1998). However, it is not always trivial how to unify processing phenomena that may seem distinct at first sight. The present paper is an attempt to provide such a framework for wh-phrases.

Once we characterize wh-phrases as constituents that have to be associated with a thematic role position and a scope position in order to be interpreted, the only arbitrary factor is the position in which each language chooses to pronounce the wh-phrase (in its scope position in Dutch, English, Romance languages; and in its thematic role position in Chinese, Japanese, Korean). The position in which the wh-phrase is pronounced satisfies one of the associations required, leaving the second association to be satisfied by a (potentially) long-distance dependency. The bulk of the processing cost for wh-phrases involves creating this dependency. The exact nature of the constituent sought is not relevant; both for gaps as well as QPs, readers attempt to insert the relevant element as soon as allowed by parsing constraints.

Below we discuss some of the topics that require further investigation.

10.1 AFH, MCP, WMMs, and the TME

As observed earlier, the active filler hypothesis (AFH), the minimal chain principle (MCP) and working memory models (WMMs), provide similar characterizations for the processing of fronted wh-phrases as they all assume that working memory restrictions lead speakers to prefer the distance between the wh-phrase and its gap to be as short as grammatically possible. At least in their basic intuition, these proposals are compatible with the processing nature of wh-phrases in Japanese: An interpretation that can rapidly satisfy the requirement triggered by in-situ wh-phrases is ranked above all other alternative interpretations that the reader could entertain for an input sentence.

Because WMMs are not limited to specific types of syntactic relations, their applicability to the Japanese construction is straightforward. However, the AFH and the MCP have to be re-stated in order to explain the Japanese facts. How to extend the MCP is a particularly interesting question because its exact definition is intimately related with the syntactic model adopted, and, as a consequence, is the most likely model to provide evidence that can distinguish between different syntactic proposals.

10.2 Extending the MCP

The MCP was originally defined in order to cover those constituent movements that syntacticians in the transformational grammar tradition (e.g. Chomsky, 1981) call overt, as opposed to covert movement which occurs in the Logical Form component (or LF; see Pesetsky, 2000, for a recent overview of the two types of movements). Wh-phrases in Japanese are subject to covert movement (see Nishigauchi, 1999, for a recent overview; also Watanabe, 1992, for an analysis which involves overt movement, but without phonological consequences). Thus, the MCP would be able to explain the TME in Japanese as long as we allow its coverage to include chains created by covert movement (see Miyamoto, & Takahashi, 2001, for a discussion on how the TME may be explained in this way). However, evidence bearing on the on-line processing cost of covert chains is scarce, making the extension of the MCP uncertain at this point (see Tunstall, 1998, Experiment 1, in which the only statistically significant reading time differences were found in a following disambiguating sentence, but no significant differences were detected in the initial sentence even though some of its quantifiers may have involved longer covert chains).

10.3 WMMs and the Grammar

As observed above, WMMs are able to account for the TME without further modifications because they are not restricted by the type of syntactic dependency created. As long as there is some type of relation between two positions in a sentence, there should be a memory cost involved in the maintenance or retrieval of the relevant elements from working memory

(see Gibson, 1998; Just, & Carpenter, 1992, for discussion).

Thus, for WMMs, it is irrelevant whether the constituent predicted is a gap or a QP, the important feature is that cognitive resources associated with working memory favour such a constituent to be available as early as possible in the sentence. An advantage of such a proposal is that it has wide coverage but, by deemphasizing the importance of the grammar, WMMs run the risk of shedding little light on grammatical relations. This should be particularly clear in the case of wh-phrases, we could have proposed that in-situ wh-phrases in Japanese require a QP, whereas fronted wh-phrases in English require a gap, and that both requirements are subject to working memory constraints. If we stopped our analysis there, we would already be making the important point that both types of dependencies are influenced by constraints related to cognitive resources. But we would miss another relevant observation: Those are not arbitrary, unrelated features of languages, but rather, the gap requirement and the QP requirement are different guises of the same problem faced by all languages, namely, how to associate a wh-phrase to two distinct positions in a sentence. By relating the two requirements at the grammatical level, we raise the prospect for more systematic comparisons in the future.

10.4 Beyond In-Situ Wh-Phrases

We limited the scope of the paper to in-situ wh-phrases in interrogative environments. But this is in fact an initial step in a larger research project required to understand wh-phrases in Japanese. The following discusses two natural extensions that may be pursued considering the findings reported above.

10.4.1 Other Typing Mismatch Effects

The TME investigated in this paper considered only situations in which a predicted constituent with interrogative typing (a QP) clashes with an upcoming constituent with affirmative typing. However, TMEs may also occur in other environments in which the expected typing does not match the actual typing of the constituent detected (for a discussion of other environments in which wh-phrases may occur as existentials, or as universals, see Nishigauchi, 1990). More generally, whenever a constituent does not match some feature that was predicted for it, there should be a mismatch effect.

For example, negative polarity items (NPIs) have to be in the scope of a negative constituent in order to be licensed. The preference for NPIs and the negative constituent to be in the same clause is sometimes stated as an obligatory constraint, the *clausemate condition*. However, there are counter-examples to the clausemate condition, which suggest that this is not a syntactic constraint (Tanaka, 1997). One possibility is that the clausemate condition is caused by a processing preference for the negative con-

stituent to occur at the earliest possible position after being predicted by the NPI.

10.4.2 Scrambled Wh-Phrases

The present paper discussed the processing of in-situ wh-phrases; however, it is often the case that wh-phrases in Japanese are not pronounced in-situ because word order is relatively free in this language. The nature of the dislocation in Japanese, also called scrambling, is arguably different from that of fronting wh-phrases in English (see Nishigauchi, 1990, for discussion; but see D. Takahashi, 1993, for a potentially fronted wh-phrase case in Japanese). For example, in Japanese, but not in English: The movement is optional; the landing site (i.e. the position in which the wh-phrase is pronounced) does not have to be at the front of a clause; the landing site does not indicate the scope of the wh-phrase; lexical NPs can be dislocated in similar fashion.

An underlying assumption in the present work is that the processing of wh-phrases in Japanese, whether in-situ or scrambled, necessarily involves the search for a QP. This assumption should be uncontroversial given that the scope of wh-phrases in Japanese is never determined by the position of the wh-phrase alone, and it always involves the position of a QP (or some specific prosodic contour). Apart from a QP, scrambled wh-phrases also require a gap, in other words, the position associated with its thematic role.[6] The gap requirement in this case is unrelated to the wh nature of the constituent: All scrambled constituents, whether wh-phrases or not, require the search for a gap (Miyamoto, & Takahashi, 2002). The two requirements generated by scrambled wh-phrases (namely, a QP and a gap) are independent and their cost should additively affect readers' behavior. By providing the basic evidence for the QP requirement in the present paper, we allow future research to investigate whether the additive nature of the gap requirement for scrambled wh-phrases is empirically supported (see Ueno, & Kluender, 2001, for ERP evidence indicating that scrambled wh-phrases may incur extra right-lateralized negativity when compared to scrambled demonstratives).

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[6] Finding the gap position does not entail determining the thematic role of the wh-phrase because the exact role will only be known when the predicate is found. The gap position can only restrict the kinds of roles that can be assigned by the upcoming predicate. Nevertheless, finding the position of the gap is a necessary precondition in the process because, in the very least, it indicates which is going to be the predicate assigning the thematic role.

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