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Research Report

On the processing of Japanese wh-questions: An ERP study

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ABSTRACT

The processing of Japanese wh-questions was investigated using event-related brain potentials (ERPs). Unlike in English or German, a wh-element in Japanese need not be displaced from its canonical position, but instead needs a corresponding Q(uestion)-particle to indicate its interrogative scope. We tested to see if there were any processing correlates specific to these features of Japanese wh-questions. Both mono-clausal and bi-clausal Japanese wh-questions elicited right-lateralized anterior negativity (RAN) between wh-words and corresponding Q-particles, relative to structurally-equivalent yes/no-question control conditions. These results suggest a reliable neural processing correlate of the dependency between wh-elements and Q-particles in Japanese, similar to effects of (left) anterior negativity between wh-fillers and gaps in English and German, but with a right- rather than left-lateralized distribution. It is suggested that wh-in-situ questions in Japanese are processed by the incremental formation of a long-distance dependency between wh-elements and their Q-particles, resulting in a working memory load for keeping track of scopeless wh-elements.

1. Introduction

1.1. *Wh-movement languages and filler-gap dependencies*

Wh-questions – i.e., questions that contain wh-elements such as 'what' and 'who' – have long been a focus of linguistic research not only in the field of theoretical syntax (Chomsky, 1981, 1986, 1995, among many others) but also in the field of language processing (e.g., Fodor, 1978, 1989; Crain and Fodor, 1985; Stowe, 1986; Frazier and Clifton, 1989; de Vincenzi, 1991, among others). In terms of electrophysiological processes, there have been a number of studies that have investigated the processing of wh-questions using ERPs (Kluender and Kutas, 1993a,b; McKinnon and Osterhout, 1996; Müller et al., 1997; Kluender and Münte, 1998; Kaan et al., 2000; Fiebach et al., 2001, 2002; Felser et al., 2003; Phillips et al., 2005; Gouvea et al., in press). These studies have been done in English and German, both of which are so-called "wh-movement" languages that require wh-elements to be displaced to the beginning of a clause.

Consider (1a): the wh-object *what* in English must be displaced to the beginning of its clause (except in the case of an "echo question" like *Calvin brought WHAT?*), rather than appear in canonical post-verbal position, as does the non-wh object *pizza* in (1b).

(1) a. Wh-question
What did Calvin bring __?
FILLER GAP
b. Yes/no-question
Did Calvin bring pizza?

In the psycholinguistic literature, the displaced wh-element is called a "filler" while its canonical position is called a "gap", and these are said to be dependent on each other for successful sentence interpretation. This is said to be because a filler is generally ambiguous in terms of its grammatical function (such as "subject" or "object") and semantic role (such as "agent" or "patient") until the parser hits the gap position and is able to

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unambiguously identify this missing information (cf. Fodor, 1989). The processing of such a "filler-gap dependency" has been associated with an ERP component known as left anterior negativity (LAN). The LAN is a negative voltage deflection that is larger over the front of the head than over the back and is often left-lateralized. It has been observed in a transient/phasic form, with a duration of a few hundred milliseconds, and in a sustained slow wave/potential form, with a duration of several seconds. Besides phrase structure and morphosyntactic violations (e.g., Neville et al., 1991; Coulson et al., 1998; Martín-Loeches et al., 2005; see Vos et al., 2001 for a review), LAN has been linked with increased working memory load in associating a displaced wh-filler with its gap (e.g., Kluender and Kutas, 1993a,b; King and Kutas, 1995a; Müller et al., 1997; Kluender and Münte, 1998). For instance, Kluender and Kutas (1993a,b) reported phasic LAN effects at the positions immediately following the filler and the gap of various English object wh-questions, and concluded that both the storage of a filler in working memory and its retrieval[1] for filler-gap assignment are indexed by LAN effects. Likewise, King and Kutas (1995a) reported a relatively frontal, negative slow wave between the filler and the gap, as well as a phasic LAN effect immediately following the gap, in response to English object relative clause sentences.

More recent studies have reported P600 effects instead of LAN effects at the gap location. The P600 is a positivity that typically peaks 500–800 ms after stimulus onset and is broadly distributed over the head, typically with a bilateral centro-posterior maximum. For instance, Kaan et al. (2000) found P600 effects at the pre-gap position of wh-questions (*bring* in 1a) in comparison to yes/no-questions. Based on this, they argued that the P600 indexes the difficulty of syntactically integrating wh-fillers in the ongoing parse (see also Gouvea et al., in press). Other recent studies have reported the combination of both slow/phasic LAN and P600 effects in wh-questions in English (Phillips et al., 2005) and German (Fiebach et al., 2001, 2002; Felser et al., 2003), as well as in "scrambled" (see Section 1.2 below) wh-questions in Japanese (Ueno and Kluender, 2003).

1.2. *Japanese: a wh-in-situ language*

Unlike English and German, Japanese is a "wh-in-situ" language, in which wh-words stay in the same canonical SOV (subject-object-verb) position as their non-wh counterparts. As shown in (2), 'pizza' and 'what' typically occupy the same position. Although it is also possible in Japanese to displace objects to the beginning of the clause, this involves another process called "scrambling" (see Saito 1985, 1992 for syntactic considerations and Yamashita 1997, 2002, Ueno and Kluender, 2003, and Hagiwara et al., 2007 for processing considerations).

While displacement/scrambling is optional, Japanese wh-words always require a question (Q) particle *ka* or *no* (meaning 'whether') at the end of the clause, as in (3a). The only exception is when a question is spoken with a rising intonation, which can be interpreted as a prosodic version of a Q-particle. Wh-questions without a Q-particle are ungrammatical in Japanese, as shown in (3b). (Here a non-question particle *–yo* 'you.know' is inserted after the verb to block possible rising intonation imposed implicitly by the reader.)

(3)

a. カルビンが	何を	持ってきたんですか。
Calvin-ga	**nani-o**	mottekita-ndesu-**ka**.
Calvin-NOM	**what-ACC**	brought-POLITE-**Q**
'What did Calvin bring?'		
b. カルビンが	何を	持ってきたんですよ。
*Calvin-ga	**nani-o**	mottekita-ndesu-**yo**.
Calvin-NOM	**what-ACC**	brought-POLITE-**you.know**
*'Calvin brought what.'		

In addition, the Q-particle *ka* determines the interrogative scope of a wh-element. Interrogative scope can be defined as the domain of the sentence that is being questioned. In wh-movement languages, such as English and German, the position of a wh-element at the beginning of a clause transparently indicates its interrogative scope within the sentence. For instance, both (4a) and (4b) consist of two clauses, main and embedded. The wh-element *what* can be placed either at the beginning of the embedded clause as in (4a), yielding an embedded clause wh-question (traditionally termed an "indirect question")[2], or at the beginning of the main clause as in (4b), yielding a main clause wh-question (also termed a "direct question"). Although in daily conversation one might actually provide the referent of the wh-word (*pizza*) in answer to either type of question for pragmatic reasons, the logical response to the two is different. The logical answer to an embedded clause wh-question like (4a) would be *yes* or *no*, since no element in the main clause is questioned by a wh-word, while the logical answer

(2)

a. カルビンが	ピザを	持ってきたんですか。
Calvin-ga	pizza-o	mottekita-ndesu-ka.
Calvin-NOM(INATIVE)	pizza-ACC(USATIVE)	brought-POLITE-Q(UESTION)
'Did Calvin bring pizza?'		
b. カルビンが	何を	持ってきたんですか。
Calvin-ga	**nani-o**	mottekita-ndesu-ka.
Calvin-NOM	**what-ACC**	brought-POLITE-Q
'What did Calvin bring?'		

[1] This process has recently been argued to be the parser's backward search through memory for an appropriate entity to establish a dependency (Kwon, 2008 based on data from Korean relative clauses; see Ueno and Garnsey, 2008 for a similar LAN effect for Japanese relative clauses).

[2] More strictly speaking, (4a) is both an embedded clause wh-question and a (main clause) yes/no-question. The embedded clause wh-question only would be *Hobbes asked what Calvin brought*. However, the form shown in (4a) is used because it is more parallel to the ERP stimuli discussed later.