Processing of Empty Subjects in Control Structures of Chinese

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1. Introduction

One of the central objectives of psycholinguistic research is to clarify the mechanism of language processing of sentences with “gaps” and “fillers” (cf. Demestre et al. 1999). There is a type of gap that appears in the subject position of infinitive constructions. Chomsky posits in this position the empty category PRO, an abstract syntactic element with no phonetic content. PRO must establish a relationship with an antecedent in order to acquire its meaning. This coreference is determined by a relationship called “control” (Chomsky 1981). When PRO appears in an infinitival complement clause, one of the arguments in the matrix clause will be understood as its antecedent (its controller). Whether the controller is the subject or the object of the matrix clause depends on the intrinsic lexical properties of that verb. In (1) and (2) (adapted from Chomsky 1981) below, the reflexive in the embedded clause takes the controlling NP as its antecedent. The ungrammatical versions show clearly that promise is a subject control verb and persuade is an object control verb.

(1) a. John promised Bill to feed **himself**.
   b. *Mary promised Bill to feed **himself**.

(2) a. John persuaded Bill to feed **himself**.
   b. *John persuaded Mary to feed **himself**.

The study of PRO is interesting for various reasons. First, it lacks phonological realization. Second, it does not involve a moved element (NP-trace or wh-trace), so readers have no warning about the empty element downstream in the sentence. Finally, PRO as an anaphoric element needs to be linked to an antecedent. These special features of PRO provide an attractive structure to test predictions from different models of syntactic processing. Nonetheless, the empirical evidence on how readers resolve PRO on-line is far from conclusive (Betancort et al. 2005). Currently, experiments have only been performed on a limited number of languages, such as English, Japanese, and the experimental method and data are also inadequate. There is therefore room for more in-depth research.

2. Processing of empty subject in English

Frazier, Clifton, and Randall (1983) tested English control structures to determine the strategy used by the parser to identify the antecedent of the subordinate empty subject by using a speeded comprehension task. They presented sentences such as (3) to (6).

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(3) **Recent Filler (Subject control), unambiguous**
Everyone liked the woman who the little child started [PRO to sing those stupid French songs for trace last Christmas].

(4) **Distant Filler (Object control), unambiguous**
Everyone liked the woman who the little child forced trace [PRO to sing those stupid French songs last Christmas].

(5) **Recent Filler (Subject control), ambiguous**
Everyone liked the woman who the little child begged [PRO to sing those stupid French songs for trace last Christmas].

(6) **Distant Filler (Object control), ambiguous**
Everyone liked the woman who the little child begged trace [PRO to sing those stupid French songs last Christmas].

It was found that reaction times (RTs) were faster for (3) and (5) than for (4) and (6). Frazier et al. explain these findings with the application of the Most Recent Filler Strategy (MRFS), which is stated as follows (p. 196):

(7) **Most Recent Filler Strategy:** During language comprehension a detected gap is initially and quickly taken to be co-indexed with the most recent potential filler.

The argument by Frazier et al. (1983) consists of three assumptions: (i) verb control information is delayed, (ii) during this delay the MRF strategy applies, and (iii) an empty category (trace) is not recognized as a possible filler in applying the MRF strategy (i.e., LFO hypothesis). The schematic representation would be as in (8) below.

(8) **Frazier et al. (1983): English**

\[
\text{Movement} \\
[filler_2] - [filler_1] - [verb] - [trace] - [PRO]
\]

MRF + LFO

3. **Processing of empty subject in Japanese**

Sakamoto (1995, 1996, 2002), Oda et al. (1997), and Ninose et al. (1998) conducted a series of experiments on empty subjects in Japanese. Sakamoto (1995) tested both subject control (9a) and object control (9b) sentences in order to clarify which of them are preferred. The experimental sentences were ‘read-out sentences’ that had normal sentential contours. Participants were given a ‘retrieval task’ in which they were instructed to listen to each sentence and respond by naming the person who is going to be in Tokyo.
a. Subject control

<table>
<thead>
<tr>
<th>Tosio1-ga</th>
<th>kino</th>
<th>Junko2-ni</th>
<th>[PRO1 Tookyoo iki]-o</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tosio-NOM</td>
<td>yesterday</td>
<td>Junko-DAT</td>
<td>Tokyo</td>
</tr>
<tr>
<td>tegami-de</td>
<td>hakuzyoosita.</td>
<td>letter-by</td>
<td>confessed</td>
</tr>
</tbody>
</table>

‘Yesterday, Tosio confessed to Junko by a letter that he would go to Tokyo.’

b. Object control

<table>
<thead>
<tr>
<th>Tosio1-ga</th>
<th>kino</th>
<th>Junko2-ni</th>
<th>[PRO2 Tookyoo iki]-o</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tosio-NOM</td>
<td>yesterday</td>
<td>Junko-DAT</td>
<td>Tokyo</td>
</tr>
<tr>
<td>tegami-de</td>
<td>meireisita.</td>
<td>letter-by</td>
<td>ordered</td>
</tr>
</tbody>
</table>

‘Yesterday, Tosio ordered Junko by a letter that she would go to Tokyo.’

The results show that Object control sentences are easier to process than Subject control sentences. The object NPs in this experiment are also the most recent fillers. Thus, the results of this experiment are compatible with the hypothesis that the MRF strategy applies to Japanese control structures. However, the results of Experiment 2, with “Object-Subject” order, reveal that not the most recent lexical filler but the object NP is preferred as a controller, even when it is more distant than another lexical filler. This is not compatible with the MRF strategy for Japanese unless the parser recognizes empty categories as possible fillers (i.e., Empty Filler Also (EFA) hypothesis). The schematic representation would be as in (10) below.


Movement

\[ \text{[filler}_2\text{]} \rightarrow \text{[filler}_1\text{]} \rightarrow \text{[trace]} \rightarrow \text{[PRO]} \rightarrow \text{[verb]} \]

\[ \text{MRF + EFA} \]

However, the results of Oda et al. (1997), in which experimental sentences have “Subject-Object” order, show that Subject control sentences are easier to process than Object control sentences. Furthermore, the results of Ninose et al. (1998), with “Object-Subject” order, also show that the subject NP is preferred as a controller. This is not compatible with the MRF strategy for Japanese.

4. Experiment

The result of the empty subject sentence processing in English and Japanese is different, and a unanimous opinion has not been reached regarding the processing of the empty subject
sentence as stated above now. Therefore, this study aims to clarify the following two points by using empty subject sentences in Chinese such as (11).

(i) Is the control information on the verb used immediately or delayed?
(ii) Is the MRF strategy applicable to the control structures in Chinese?

a. If the MRF strategy is not applicable to Chinese, is it accomplished by "Subject preference" or accomplished by "Object preference" or both neither?
b. If the MRF strategy is applied to Chinese, is it accomplished by LFO (Lexical Filler Only) or EFA (Empty Filler Also)?

(11) Chinese

\[
\begin{align*}
\text{Movement} & \\
[filler_2] & \rightarrow [filler_1] & \rightarrow [trace] & \rightarrow [verb] & \rightarrow [\text{PRO}] \\
\uparrow & & \uparrow & & \uparrow \\
\text{MRF + EFA} & & & & \text{MRF + LFO}
\end{align*}
\]

There are two advantages of using Chinese over English and Japanese. Firstly, in (8) and (11), Chinese is similar to English in that the [verb] is located before [PRO]. It is therefore possible to verify whether the verb control information is delayed or not in this case. Delay in the control information of a verb cannot be tested using Japanese, since Japanese is a verb-final language. Secondly, (10) and (11) indicate that Chinese is similar to Japanese in that they both allow scrambling of arguments. As such, the MRF strategy can be tested to determine whether it applies to Chinese or not.

Moreover, the reading time of each word was not measured in the previous studies of English and Japanese. It is therefore not clear how the parser processes each word, especially to verify whether control information on the verb is to be used immediately. The experiment in this paper observes the reading time of each word.

4.1 Materials

Consider the following examples from the list of sentences tested in this experiment.

(12) a. S-control (SO order)

\[
\begin{align*}
\text{Shangzhou} & \rightarrow \text{Xiaodong}_1 & \rightarrow \text{zai xinzhong} & \rightarrow \text{dui Xiaohong}_2 & \rightarrow \text{zhencheng tanbai shuo} \\
\text{last week} & \rightarrow \text{Xiaodong} & \rightarrow \text{in letter} & \rightarrow \text{to Xiaohong} & \rightarrow \text{seriously confess that} \\
\text{[biye hou} & \rightarrow \text{cong Changchun} & \rightarrow \text{zhijie} & \rightarrow \text{[\text{PRO}_1]} & \rightarrow \text{qu Beijing}^3 .]
\end{align*}
\]

\[^3\text{It was pointed out that there is a possibility that the parser uses some special strategies for processing if all the experimental sentences end with "qu Beijing" (Edson Miyamoto, personal comunication). However,}\]
after graduate from Changchun immediately go Beijing
"Last week Xiaodong confessed to Xiaohong seriously in a letter that he would go
to Beijing from Changchun immediately after graduate."

b. O-control (SO order)
Shangzhou Xiaodong1 zaixinzhong duiXiaohong2 zhencheng quangao shuo
last week Xiaodong in letter to Xiaohong seriously counsel that
[biehe hou cong Changchun zhijie 〈PRO2〉 qu Beijing.]
after graduate from Changchun immediately go Beijing
"Last week Xiaodong counseled Xiaohong to go to Beijing from Changchun
immediately after graduate seriously in the letter."

c. S-control (OS order)
DuiXiaohong2 shangzhou Xiaodong1 zaixinzhong trace2 zhencheng
to Xiaohong last week Xiaodong in letter seriously
tanbai shuo [biehe hou cong Changchun zhijie 〈PRO1〉 qu Beijing.]
confess that after graduate from Changchun immediately go Beijing
d. O-conrole (OS order)
Dui Xiaodong2 shangzhou Xiaodong1 zaixinzhong trace2 zhencheng
to Xiaohong last week Xiaodong in letter seriously
quangao shuo [biehe hou cong Changchun zhijie 〈PRO2〉 qu Beijing.]
counsel that after graduate from Changchun immediately go Beijing

4.2 Method and Results

Participants

Twenty-four participants (8 men and 16 females) participated in this experiment. All
participants are native speakers of Chinese, who are students at the Kyushu University in
Japan. The average age is 28 years old. Vision is normal. They were paid 500 yen for forty
minutes.

Procedure

Each sentence is presented on a word-by-word basis in Chinese script. Each word is
displayed by a moving window. Presentation of a sentence is initiated when the participant
first presses the ‘Q’ key on a standard computer keyboard labeled ‘read’. A ‘★’ first appears
in the script. It is a symbol that tells the participant that the experimental sentence will begin
in this position. Pressing the key following the final display (period) displays the question:
“Will this person go to Beijing?”. Participants are instructed to respond using either the YES
or NO key. The time between the onset of presentation of any word and the key operation for
initiating the next word is recorded by the computer’s internal clock and deemed as the
reading time.

Results

Variance analysis is performed on the data of the RTs in each clause to determine their

the significant difference between each condition in the RT of “qu Beijing (p10)” was not observed.
Therefore, I claim that the empty subject has already been filled when the main clause verb is input. In
other words, the result remains the same even if I change “qu Beijing” to another expression.
statistical significance. Here, I will introduce the results of the main clause verb p6 and the complement sentence verb p10. The RTs of p6 (verb + shuo ‘that’) for S-control sentences is shorter than that for the O-control sentences, and the difference is significant in both the participant analysis and item analysis \(F(1, 23) = 5.43, p < .05, F(1,35) = 13.87, p < .001\). The difference between SO-order sentences and OS-order sentences is not significant in both the participant analysis and item analysis \(F_1 < 1, F_2 < 1\). There was no interaction \(F(1,23) = 1.17, p = .29, F_2 < 1\). In p10 "quBeijing", neither the main effect of the word order \(F_1 < 1, F_2 < 1\), the main effect of the sentence type \(F_1 < 1, F_2 < 1\) nor the interaction \(F_1 < 1, F_2 < 1\) are admitted.

![Figure 1 reading times of each clause](image)

### 4.3 Discussion

The RTs of p6 (verb + shuo ‘that’) in the S-control sentences are faster than the O-control sentences, and the difference is also significant in both the participant analysis and item analysis. I suggest that the parser assumes the subject of the main clause to be the same as the empty subject of the complement clause when processing the sentence. This therefore leads to the assumption that empty subject sentence processing in Chinese is accomplished by "Subject preference" in the recognition task.

Chinese is different from Japanese in that the verb is input before the empty subject. In Japanese, the main clause subject is preferred when the complement clause verb is input. However, in the processing of control structures in Chinese, the parser expects that the following sentence is about the subject before the main clause verb is input. This forecast is correct when the S-control verbs is input, but not in the case of O-control verbs. It was pointed out that it is different kind of “Subject preference” in Japanese and Chinese. However, note that the complementizer “shuo” is behind the verb in Chinese, and the parser will expect
the subject of complement clause to be the same as the main clause subject. The RTs of p7 for S-control sentences is shorter than that of the O-control sentences. I think that this is a kind of “Subject preference”, and name it as “Default Subject preference”.

Moreover, no significant difference in the RTs of “qu Beijing (p10)” was observed between each condition. Therefore, I claim that the empty subject has been filled during input of the main clause verb. That is, the control information of verb is used immediately when it is input. In addition, this result disagrees with the MRF strategy. Therefore, it is not reasonable to claim that the MRF strategy does apply to Chinese.

5. General discussion

Since the MRF strategy is not applicable to the control structures in Japanese and Chinese, it is possible that the MRF strategy is a special strategy that is applied only in English. However, note that for English, application of the MRF strategy is dependent on the condition that delays the accessibility of verb control information. But the sentence processing is developed along the time axis. That is, the information on the word input is processed at a high speed without any delay. Delay in the verb control information violates the general processing system. If this condition does not exist, the basis of the MRF strategy is lost. In addition, I have also verified through our experiments that the control information of a verb is used immediately, hence indicating that there is a language processing system that is independent of the MRF strategy.

From the above discussion, I therefore claim that (i) the control information of a verb is used immediately, and (ii) there is a language processing system that is independent of the MRF strategy.

6. Issues for future research

In the experiment on self-paced reading, participants are instructed to push the key to read the experimental sentences. This is suitable for examining the reaction time for transition from one word to another. However, the Consistency Score and the YES/NO reaction time measurement may not be accurate, as the YES/NO judgment times varies among participants. Therefore, an experiment on experimenter-paced (i.e., automatic presentation) reading needs to be conducted in future.

In addition, in the recognition task, the participants tend to prefer the main clause subject as a possible antecedent for the empty subject in Japanese and Chinese. If in the retrieval task, the participants tend to prefer the main clause object as a possible antecedent for the empty subject in Chinese, this will constitute an evidence of multi-level processing. As such, there is also a need to conduct an experiment on the retrieval task.

References


