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Introduction

The present research has been an attempt to explore whether there is a significant effect of subsequent discourse context on the successful resolution of ambiguity of sentences. From the result of the study of the single sentence condition, it was suggested that putting priority on syntactic processing would have a positive effect on the comprehension of garden path sentences. This also implied that semantic processing, parallel to syntactic information, is relatively less involved the process during the analysis of garden path sentences. Though the degree of using semantic information might have depended on the complexity of the sentences, it was not clear how much semantic processing can contribute to interpretation. Rather than complementing it, discourse information can actually interfere with appropriate effective processing. In this study, by adding contextual information following garden path sentences, the process and product of analysis of garden path sentences were further explored.

1. Research questions and hypotheses

Research Question 1: Is there improvement in the comprehension of a garden path sentence, if it is presented with the discourse condition?

Hypothesis 1: More readers would be able to reach a proper interpretation in the discourse condition than in the single sentence condition.

Reason: With assumption that garden path sentences tend to confuse the reader's smooth interpretation, the added sentences, as discourse information, were expected to assist

comprehension. Also on the basis of the situation model of reading comprehension (Kintch, 1998 :292), the more the amount of text-based information is available, the more the chance that a proper mental representation can be constructed in the mind.

Research Question 2: How much of the priority is given to the discourse information when it exists, compared with syntactic and semantic information within a garden path sentence?

Hypothesis 2: The discourse information would be primarily used next to or parallel to the syntactic information.

Reason: In line with the result of the single sentence condition, the readers who can use the additional information effectively can reach a proper comprehension. Since the task was to translate the target sentence and indicate some marks showing the sentence construction, the priority must be on the syntactic information. Therefore the second most prioritized information is desirably the discourse information.

2. Research method

2.1 Subjects:

244 Japanese University students (Hosei Univ. N=185; Keio Univ. N=14; Chiba Univ. N=21; Tsurubunka Univ. N=21).

2.2 Material:

Eight garden path sentences were picked out from 12 used in experiment 1 (Table 1). In the discourse condition, contextual information was expected to help interpretation of the garden path sentences. Therefore, the sentences with high complexity such as the ones requiring theta-role reanalysis and the ones with an embedded clause were picked.

2.3 Procedure

Procedure for the single sentence condition: regarding each of the eight garden path sentences, the subjects were required to put marks and translate each sentence into

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Table 1 Garden path sentences used in the study

No.	the garden path sentences	required processing
1	Without her contributions failed to come in.	θ -role, LC
2	While the boy scratched the big and hairy dog yawned loudly.	LC
3	This was only the beginning of the bad-mouthing robots would receive for the next couple of decades.	θ -role, LC
4	The criminal confessed his sins harmed too many people.	LC
5	As the woman edited the magazine amused all the reporters.	LC
6	I told the boy the dog bit Sue would help him.	LC, [embedded]
7	The cotton clothing is made of grows in Mississippi.	LC, [embedded]
8	The pitcher tossed the ball tossed the ball.	EC

Japanese. The marking instructed to make, was for example, to put brackets like [] for the part of opening and closing of a clause, or to indicate a phrase by parentheses like (), or to put an arrow for modifying relationship. After the marking and translation, the subjects were required to reflect on cognitive processes and procedures in their own processing and write down as concrete a description as possible in Japanese. The three questionnaires about the processing strategy were done in the following three questions: (1) “What did you think about the possibility of interpretation?; (2) What did you do when you found your interpretation incorrect?; (3) Where did you start your reanalysis in the sentence? (For the choices, see appendix A). For the completion of the tasks, 60 minutes were given to the participants.

Procedure for the discourse condition: All the subjects were required to do the tasks of translating a garden path sentence in the discourse condition after an interval of approximately one month. In the discourse condition, the task sequence of translation followed by a questionnaire was the same as in the single sentence condition. However, the questions were different from that of the single condition. The subjects were asked to put a ranking on which information they used the most to the least among the three types of information: syntactical, semantic, and discourse information (Appendix B).

3. Result

3.1 Descriptive statistics: the differences between the ratio of correct interpretation

Based on the sample of 244 subjects, the ratio of correct translation in each sentence is shown in Table 2, together with Figure 1 showing the comparison between the conditions in which the sentences were presented. The correct percentage of all the sentences was 32% under the single sentence condition, and 34% under the discourse condition. A difference of 2% was statistically significant ($t=2.227$, $df=1952$, $p < .05$). The hypothesis was supported.

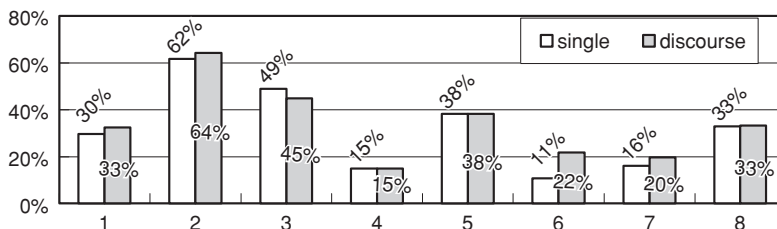
Table 2 Comparison of percentage of correct translation in two conditions and t-test results

No.	Conditions		differences	t-value (df=244)
	Single	Discourse		
1	30%	33%	3%	1.22 n.s.
2	62%	64%	2%	.654 n.s.
3	49%	45%	-4%	-1.447 n.s.
4	15%	15%	0%	0 n.s.
5	38%	38%	0%	0 n.s.
6	11%	22%	11%	4.158 **
7	16%	20%	4%	1.622 n.s.
8	33%	33%	0%	0 n.s.
Total	32%	34%	2%	2.290*(df=1952)

* $p < .05$

** $p < .01$

Figure 1 Comparison of percentage of correct translation in the two conditions (n=244)



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Each sentence being focused, Number 6 had a significant difference between the two conditions ($t=4.158$, $df=243$, $p < .01$). The other sentences indicated statistically no significant difference.

3.2 Priority order of use of information during the process

Based on the answers to the questionnaire immediately after the translation task, the average points indicating priority of information used are shown in Table 3. The numbers indicate the higher the priority is, the larger the numerical value (between 1-3 points) is. Regarding hypothesis 2, by looking at the total average of the whole sample, the average value of the syntactic information was the highest ($M=2.08$), followed by the semantic information ($M=1.83$) and the discourse information ($M=1.82$). According to one-way ANOVA analysis, these three averages had a statistically significant difference ($F(2,1952)= 43.555$, $p < .01$). The following paired comparisons showed that the difference between syntactical information and semantic information, as well as that between syntactical and discourse information, is verified statistically significant ($p < .01$) with the LSD (the Least Significant Difference) method. It can be said that hypothesis 2 was

Figure 2 Priority levels of information in each sentence (out of 3 points)

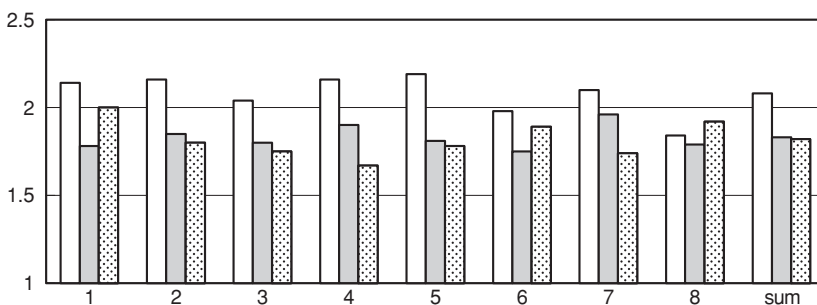


Table 3

	1	2	3	4	5	6	7	8	sum
□ syntactic	2.14	2.16	2.04	2.16	2.19	1.98	2.1	1.84	2.08
■ semantic	1.78	1.85	1.8	1.9	1.81	1.75	1.96	1.79	1.83
▨ discouse	2	1.8	1.75	1.67	1.78	1.89	1.74	1.92	1.82

partly supported because the priority is given to the syntactic information while the discourse information was used at the same time to some degree. This can be explained by the viewpoint of parallel processing of information; it is assumed that the reader performed reanalysis, relying on contextual information subsequent to syntactic information. The distinctive feature of this result is that the discourse information was adopted at the almost same degree with the semantic information. It can be said that the reader tried to understand utilizing both discourse information and the semantic information within a target sentence further in parallel.

4. Analysis of each sentence

Sentence 1. Without her contributions failed to come in. She had been a good supporter of the group from the early days of its history. So the group is short of money now.

As for the percentage of correct answers, 3% was the observed difference between the single sentence condition (33%) and the discourse condition (30%), which was not statistically significant. The second sentence shows that the woman who might have been active in a fund raising campaign was not participating there. By the second sentence, it was expected to construct mental representation by offering a concrete image of the relationship between ‘the group’ and ‘her’. The third sentence displays the outcome of her absence, i.e. ‘failure to collect enough contributions’. This explains the syllogistic relationship of the three sentences. Aggravation of a financial situation is brought about by what the first sentence means.

As for the reason why comprehension did not improve much in the discourse condition, it is assumed that the information to determine the point to parse between ‘her’ and ‘contributions’ was not enough; that is to say, many subjects failed to understand ‘Without her / contributions failed to come in.’ Regarding the result of the information priority (see Table 3), the degree of the discourse information was rather higher than the other sentences, or than the semantic information in the target sentence. This implies that many of the subjects could not solve the syntactic problem only by tracing the contextual

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information. Translating with the parsing like ‘Without her contributions / failed to come in’, many of the subjects might have inappropriately transferred the Pro-drop rule of their L1 (Japanese).

Sentence 2. While the boy scratched the big and hairy dog yawned loudly. He hadn’t taken a shower for three days.

The percentages of correct answers in both conditions were high, 62% in the single sentence condition, and 64% in the discourse condition. Therefore the successful rate was fairly satisfactory in both conditions, with a little rise in the discourse condition. The second sentence was added with the intention of making it easier to parse between ‘scratched’ and ‘the big and hairy dog’. Although at the beginning of the second sentence whether the referent ‘he’ denotes ‘the boy’ or ‘the dog’ is not clear, it is explained in the second sentence that ‘he’ is ‘the boy’, because the sentence implies it is only a human that takes a shower daily. A possibility of interpreting ‘the boy scratches the dog’ is canceled. Therefore it is himself that ‘the boy scratched’.

The reason why comprehension of the target sentence improved only a little (2%) in the discourse condition could be a rather fundamental problem, some of the readers could not think of ‘scratch’ as an intransitive verb, only thinking ‘the big and hairy dog’ as a predicative phrase even after they have read the second sentence. Therefore it was guessed that the second sentence played only a role as a reconfirmation tool for the subjects who could interpret the target sentence successfully. Regarding the result of the information priority in Table 3, the use of the discourse information was fairly low. Thus, this success of interpretation was mainly based on the syntactic information in the single sentence condition. Further contextual information could have made the difference between the distinctive conditions.

Sentence 3. This was only the beginning of the bad-mouthing robots would receive for the next couple of decades. Many people feared that machines would resent their role as slaves or use their steely strength to overthrow humanity.

The correct percentage was 49% in the single sentence condition and 45% in the discourse condition. The level of correct percentage was not as low as other sentences; the tendency of information used was biased to syntactic information like other sentences (see Table 3). It was noticeable that the percentage in the discourse condition was lower than the one in the single sentence condition. This implied the discourse information interfered with the proper interpretation.

The second sentence was added with the intention that it can cancel the connection of ‘the bad-mouthing’ and ‘robots’ as a modified noun phrase with the alternative concrete clause of ‘the bad-mouthing’ that robots would receive. It seemed, however, that the mental connection was not easily made between ‘machines’, which is a higher level concept of ‘robot’ unimaginably with it having thoughts and feelings, and ‘fear’ of humans to the way the ‘machines’ think. Furthermore, with double complement clauses, the second sentence might have been too long to help comprehension, which might have caused a ‘short circuit’ (Clark, 1977) in their working memory resources.

Sentence 4. The criminal confessed his sins harmed too many people. His confession was so late that an innocent person had been punished.

The percentages of correct answers in both conditions were the same: 15%, which is fairly low compared to other sentences. The second sentence was supposed to help the reader comprehend the target sentence starting with the subjects phrase: ‘His confession’. With the emphasis of what ‘the criminal’ did, the reader was expected to be able to see the subject-verb relationship in the first sentence clearly. There was also a possibility that since the second sentence gives only the consequence of the ‘confession’, not any detail of what the confession is, the reader still could not figure out the subject-verb relationship in the complement: ‘his sins harmed too many people.’

Referring to the result of the information priority level (see Table 3), the statistically significant difference among the three kinds of information was observed ($F(2,729)=18.001$, $p<.01$). All the comparisons between the three kinds of information with the LSD method indicated significant differences: between syntactic and semantic information ($p<.01$),

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between semantic and discourse ($p < .05$), and between syntactic and discourse ($p < .01$). Special mention should be given to the lowest use of discourse information among the eight garden path sentences. This meant the additional sentence did not promote comprehension; instead the readers' focuses were kept only on analyzing the target sentence alone, only to interpret it falsely in most of the cases. Among the translation errors collected, some interpreted 'confessed his sins' as the postpositional modification of 'criminal' as its antecedent. This ungrammatical interpretation could come from overgeneralization of the subjects' interlanguage grammar in which incomplete rules exit. Concretely, abbreviation of the relative pronoun in an objective case might have been overgeneralized like 'his sin (which) harmed too many people'.

Sentence 5. As the woman edited the magazine amused all the reporters. She is very good at editing, so the reporters are always satisfied with her work.

The percentages of correct answers in both conditions were the same: 38%. This meant the additional sentence did not promote further comprehension. In order to cancel the transitive use of 'edit' by interpreting 'edit the magazine,' the first clause of the second sentence mentioned the ability of 'the woman' to edit. The last clause specifies the consequence of what the former clause tells with the conjunction 'so', i.e. 'the magazine' was the inanimate subject that can amuse the reporter.

Regarding the result of the information priority (see Table 3), syntactic information was used mostly. Therefore, it can be said that the subjects focused only on the syntactic analysis of the target sentence. Since the additional discourse information seemed to have given enough information, the subjects might have relied more on syntactic information, presumably following the principle of 'lexical preference' (Ford, Brown & Kaplan, 1982).

Sentence 6. I told the boy the dog bit Sue would help him. I had the boy find her by himself since his injury did not seem very serious. Then he rushed to find her, crying loudly.

The target sentence includes a central embedded clause. The percentage of correct answers in the single sentence condition was as low as 11%. However; the one in the discourse condition was twice as much, 22%. This difference was proven to be statistically significant ($t = 4.158, p < .01$).

Regarding the result of the information priority (see Table 3), dependence on syntactic information was the lowest, whereas dependence on the discourse information was the highest. As a result, it can be said that the discourse information promoted comprehension. The additional sentences succeeded to enhance comprehension probably because in the second sentence the relationship among ‘I’, ‘boy’ and ‘her’ was clarified with the causative verb ‘have’. Thanks to the second sentence, the possibility to interpret ‘the dog bit Sue’ as a chunk was canceled, and with the phrase ‘his injury’, it was clarified that ‘the boy was bitten by the dog’. Additionally in the third sentence the phrase ‘finds her’ and ‘crying loudly’ made the situational picture clearer with a fair amount of redundancy.

The result of interpretation of this garden path sentence indicated that proper repetition and redundancy helped the readers reach a proper comprehension.

Sentence 7. The cotton clothing is made of grows in Mississippi. The climate there is suitable for growing it. Many buyers of clothing companies visit the plantations there to see how cotton grows in the year.

The target sentence included a central embedded clause. Starting with the subject of ‘climate’ followed by a locative adverb ‘there’, the second sentence aimed at turning the subject’s viewpoint to the weather of ‘Mississippi’ in the first sentence. Also in the last phrase of the second sentence ‘for growing it’, the predicate verb of the first sentence was reused and the pronoun ‘it’ gives the opportunity to think of ‘cotton’ as a referent. The third sentence tries to give the reader a more concrete situational image.

The percentage of correct answers in the single sentence condition was 16%; the one in the discourse condition was slightly higher, 20%. This difference was not statistically significant, though it was close to a 10% level of significance ($t = 1.622, p = .106$).

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Regarding the result of the information priority level in Table 3, there was a significant difference among the three kinds of information ($F(2,729)=9.889, p<.01$). The comparison between the paired information with the LSD test showed less than a 5% level of significance in the relationship between syntactic and discourse, and the one between semantic and discourse. This meant that though the additional sentences were not used much, it helped some readers read a proper interpretation to some extent.

Sentence 8. The pitcher tossed the ball tossed the ball. He said to the catcher, “I don’t like this one. You can see some scratches on it, can’t you?”

The percentages of correct answers in both conditions were the same, 33%. The second sentence indicates the cause of the action presented in the target sentence with direct speech style. Particularly with the anaphoric phrase ‘this one’, focus of the reader was invited to motion of the ball from the pitcher to the catcher’. The third sentence strengthens what the pitcher told the catcher. With the pronoun ‘it’, focus on the ball was repetitively invited. Since the percentage did not rise at all with this discourse information, it can be said that (no effect of additional sentences was made.)

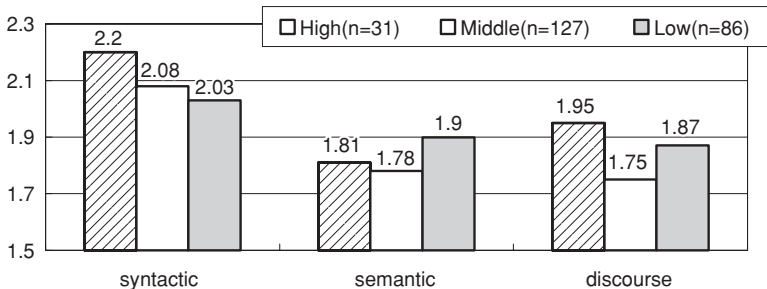
With regard to the result of the information priority in Table 3, the amount of dependence on the discourse information outnumbered the rest; the use of syntactic information was the lowest among the eight garden path sentences. This implied that the target sentence itself was so confusing that many of the readers could not help counting on the contextual clues. However, since the percentage in the discourse condition did not rise, the difficulty of interpreting the target sentence was not alleviated. This case exemplified the limitation of discourse information as a help to solve the garden path sentences. There would be a boundary of how much contextual information may help solve garden path sentences when the sentence itself is syntactically too complicated.

5. Analyses based on the three subjects groups depending on the total score

In order to explore processing patterns of the subjects in terms of their rate succeeded

in interpretation, a sample of 244 was divided into three groups based on the total score out of eight. Since, as a whole, the percentage of the correct answers was rather low; the sample was divided by the following scales: the upper group (6 to 8 points, $N=33$), the middle group (3 to 5 points, $N=122$), and the low group (1 to 2 points, $N=89$). Based on the result of the information priority level shown in Table 3, one way ANOVA was carried out among the three groups for each kind of information. The result indicated no significant differences: the syntactic information ($F(2,241)=.902$, n.s.), the semantic information ($F(2,241)=.962$, n.s.), and the discourse information ($F(2,241)=1.354$, n.s.), respectively. From these results, it was found that the subjects, regardless of their scores, primarily relied mostly on syntactical information. Therefore, it is suggested that the successful interpretation may be caused by the capability of syntactic processing. In short, their local grammatical analysis during reading played the key role. This conclusion requires further investigation, however, since individual difference of the readers and individual uniqueness of garden path sentences have to be considered.

Figure 3 Degree of information used by score groups



Though no significant difference was found, the high score group tended to use the syntactic information and the discourse information more in parallel than other groups. Also the low score group used three kinds of information with not many differences. This implies that the unsuccessful readers did not, or could not, consistently use the discourse information; rather they used the semantic information more than the discourse information.

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6. Conclusion

The following points were clarified through this study.

- (1) In the process of garden path sentences, the discourse information did not help a lot to solve the problem of syntactic parsing. However, like Sentence 6, when it is redundant enough to help comprehension of the target sentence, the discourse information functions effectively. Therefore, how much discourse information helps a reader understand a garden path sentence depends on the type of garden path sentence and, if present, the quality, quantity and relevance of the discourse information.
- (2) The priority of information used is in general given to syntactic information followed by discourse and semantic information. The discourse and semantic information are used at the same level. Successful readers, however, can take advantage of the discourse information accordingly. Adversely, unsuccessful readers tend to fail to put priority, particularly between the single sentence semantic information and the existing discourse information.

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[Appendix A]

1. ① Without her contributions failed to come in. ② She had been a good supporter of the group from the early days of its history. ③ So the group is short of money now.
2. ① While the boy scratched the big and hairy dog yawned loudly. ② He hadn't taken a shower for three days.
3. ① This was only the beginning of the bad-mouthing robots would receive for the next

- couple of decades. ② Many people feared that machines would resent their role as slaves or use their steely strength to overthrow humanity.
4. ① The criminal confessed his sins harmed too many people. ② His confession was so late that an innocent person had been punished.
5. As the woman edited the magazine amused all the reporters. ② She is very good at editing, so the reporters are always satisfied with her work.
6. ① I told the boy the dog bit Sue would help him. ② I had the boy find her by himself since his injury did not seem very serious. ③ Then he rushed to find her, crying loudly.
7. ① The cotton clothing is made of grows in Mississippi. ② The climate there is suitable for growing it. ③ Many buyers of clothing companies visit the plantations there to see how cotton grows in the year.
8. ① The pitcher tossed the ball tossed the ball. ② He said to the catcher, “I don’t like this one. ③ You can see some scratches on it, can’t you?”

[Appendix B]

The sample of Task Sheet for the discourse condition including questionnaire

読解における談話処理タスク

次の 1 から 8 の英文を読み、問 1 から問 3 に各々答えなさい。

1. ① Without her contributions failed to come in. ② She had been a good supporter of the group from the early days of its history. ③ So the group is short of money now.

問 1 ①の英文を文の構造や構文が分かるように和訳してください。

(①の英文の構造や構文が分かるように括弧や矢印を活用してください。)

和訳

問 2 下線部の文の意味がわかりにくかったときに、主に何をてがかりとして考えましたか。下記から選びなさい。(優先順位をつけてください)

- A) ①の文の構文・文法 B) ①の文の意味 C) ②や③の文の意味
(→ →)

問 3 また、どのようなプロセスで、下線部の意味を考えましたか？ 具体的に記載してください。

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