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Why Island Constraint Is Weaker in Japanese than in English: A Processing Perspective

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Abstract

The constraints on discontinuous dependency in a sentence have been discussed as "island constraint". Island phenomenon can be observed in many languages; however, while the island effect is quite noticeable in English, it seems obscure in Japanese. This study thus experimentally evaluates the strength of island effect in Japanese complex sentences quantitatively and demonstrates that the island effect in Japanese is weaker than that in English. Furthermore, we attempt to attribute the difference in the strength of the island effect in these two languages to their processing characteristics; that is, the syntactic relationship between two discontinuous elements in English must be computed at the head of an island, with one of the two elements unreceived, while the syntactic computation at the head of an island in Japanese is performed with both elements received. We assume that the processing of discontinuous dependency is thus more costly in English than in Japanese, and that the strong island effect in English reflects the relative difficulty of the syntactic computation. We obtained evidence for our hypothesis from an experiment asking participants to make grammatical judgments on Japanese sentences in which we manipulated their word-order in three ways. We suggest that part of the apparent syntactic phenomenon can be attributed to processing factors.

Keywords

Discontinuous Dependency, Syntactic Island Constraint, Cross-Linguistic Phenomenon, Sentence Processing, Head Direction, Contrast between English and Japanese

1. Introduction: Constraints on Discontinuous Dependency

In a sentence of natural language, two morphemes that are discontinuous in time-series can establish a semantically closer relationship than their adjacent

morphemes. The words underlined in (1) are some examples.

1) a) <u>If</u> you don't feel well now, <u>then</u> you must tell me so.

b) I do<u>n't</u> want <u>anybody</u> to disturb me.

c) A <u>review</u> came out yesterday <u>of this article</u>.

d) <u>The woman</u> who you were talking <u>about</u> is my aunt.

Discontinuous dependency is cross-linguistic. In the Japanese examples in (2), the underlined words establish discontinuous dependency (abbreviations, -*nom*, -*top*, and -*acc* mean nominal, topic, and accusative respectively).

2) a) If, ... then.

<u>Moshi</u> guai-ga warui <u>nara</u>, kaette yasumi-nasai.

If condition-nom ill then go home to rest

"If you are ill, then you should go home to rest."

b) Negative polarity item

Sofu-wa joobu-de <u>ichido-shika</u> kaze-o hiita-koto-ga <u>nai</u>.

grandfather-top strong only once cold-acc had fact-nom not

"My grandfather is so strong that he has had a cold only once."

c) Quantifier floating

Gakuee-ga <u>san-satsu</u> hoNya-de <u>hon</u>-o katta.

student-nom three at the bookstore book-acc bought

"A student bought three books at the bookstore."

Discontinuous dependency indicates that the set of sentences of natural language exceeds the generative capacity of finite-state grammar. The phenomenon is thus important for the study of computational aspects of natural language, and it has been intensively discussed in theories of syntax and sentence processing. Discontinuous dependency can cross the clause boundaries of verbal complement clauses. In (3), for example, who can be interpreted as the object of *met*, and the number of the embeddings is assumed to be unlimited in principle.

3) a) <u>Who</u> does Bill think that [$_S$ John <u>met</u> yesterday]?

b) <u>Who</u> does George believe that [$_S$ Bill thinks that [$_S$ John <u>met</u> yesterday]]?

c) <u>Who</u> does Tom suppose that [$_S$ George believes that [$_S$ Bill thinks that [$_S$ John <u>met</u> yesterday]]]?

It is, however, well known that discontinuous dependency cannot always cross clause boundaries. In (4), for example, who cannot be interpreted as the object of met.

4) a) *<u>Who</u> does Bill know [$_{NP}$ the rumor that [$_S$ John <u>met</u> yesterday]]?

b) *<u>Who</u> does Bill know [$_{NP}$ the cafe where [$_S$ John <u>met</u> yesterday]]?

c) *<u>Who</u> was Bill sleeping [$_{PP}$ when [$_S$ John <u>met</u> yesterday]]?

The examples in (4) indicate that discontinuous dependency is affected by syntactic environment. A complex noun phrase (NP) in (4a, b) and an adverbial adjunct clause in (4c) interfere with the dependencies. A constituent that blocks discontinuous dependency is called *syntactic island* in the linguistic literature. A complex NP and an adverbial adjunct clause are examples of syntactic island in English. Because the word-order in Japanese is relatively free, we can discuss the Japanese discontinuous dependency corresponding to the English examples by

preposing subordinate objects. The preposed *sono hon-o* (that book-acc) in (5) can be interpreted as the object of *katta* (bought). The dependency here crosses the clause boundary of a verbal complement clause in the same manner as in (3a).

5) Japanese discontinuous dependency for verbal complement clause.

Sono hon-o Hanako-ga [$_S$Taroo-ga katta]-to omotteiru.

that book-acc name$_f$-nom name$_m$-nom bought-Comp think

"That book, Hanako thinks that Taroo bought." (Saito, 1992)

Island phenomenon is assumed to be cross-linguistic, though syntactic categories that constitute islands can vary among languages (Goodluck & Rochemont, 1992). We should note here that while the island effect in English is strong, the effect of possible islands in Japanese sentences is obscure. Kuno (1973), for example, judges (6) to be marginal, with the subordinate object preposed from the inside of a complex NP.

6) Japanese discontinuous dependency for complex NP (with nominal complement clause).

?Saburoo-o Taroo-wa[$_{NP}$[$_S$ Hanako-ga nikundeiru]-toiu uwasa]-o shinjiteita.

name$_m$-acc name$_m$-top name$_f$-nom hate-Comp rumor-acc believed

"As for Saburoo$_i$, Taro believed the rumor that Hanako hated him$_i$."

Furthermore, sentences in (7) are judged to be grammatical, with a discontinuous dependency between the inside and outside of a complex NP in (7a) and of an adverbial adjunct clause in (7b).

(7) a) Japanese discontinuous dependency for complex NP (with nominal complement clause).

√ Sono hon-o Jon-ga[$_{NP}$[$_S$ Mary-ga katta]-toiu uwasa]-o

that book-acc John-nom Mary-nom bought-Comp rumor-acc

kiita (Nakamura, 2001)

heard

"(As for) that book, John heard the rumor that Mary had bought (it)."[1]

b) Japanese discontinuous dependency for adverbial adjunct clause

√ Bungakubu-ni Taro-wa [$_{PP}$[$_S$ Jiroo-ga nyuugakushita]-node]

faculty of letters-dat name$_m$-top name$_m$-nom entered-because

odoroita (Mihara, 2000)

got surprised

"(As for) a faculty of letters, Taro got surprised because Jiroo had entered (it)."

The possible difference in the strength of island effects can be theoretically significant because island phenomenon is assumed to be cross-linguistic. However, the comparison of the effects in two languages is difficult for a single researcher. We thus experimentally described the relative strength of island effects

[1]The complementizer in (7a), *toiu*, is optional, and Japanese has no phonetically overt relative pronoun. In our experimental sentences we will discuss below, therefore, the complementizer *toiu* was not placed at the end of a subordinate clause so that a nominal complement and a relative clause may be distinguished at the head noun. Note here that complementizer *to* cannot head a nominal complement clause, as in (i).

(i) *Jon-ga [NP[S Mary-ga   Sono hon-o katta]-to   uwasa]-o   kiita.

  John-nom Mary-nom that book-acc bought-Comp rumor-acc heard.

in English and Japanese quantitatively. The research questions of this study are enumerated in (8).

(8) a) Can we observe a significan difference in the strength of island effect between English and Japanese?

b) When we observe a significant difference of the effect in the two languages, what is the reason?

As for (8a) we will demonstrate that the island effect is weaker in Japanese than in English on the basis of our experimental results. As for (8b), we will propose a hypothesis for the degree of island effect from the viewpoint of time-series of sentence processing and discuss our experiment to examine our hypothesis.

2. Experiment 1: Quantitative Evaluation of Island Effect in English and Japanese

2.1. Method

2.1.1. Participants
Forty-three undergraduate university students speaking Japanese as their native language participated in the study.

2.1.2. Materials and Procedure
Sprouse, Wagers & Phillips (2012) presented English sentences to native speakers of English and asked them to judge their acceptability by one of the seven scales. Some of their experimental sentences are shown in Table 1. In making experimental sentences, Sprouse, Wagers & Phillips (2012) managed to keep the propositional meaning of a subordinate clause to be the same and manipulated the presence or absence of a construction that could function as a syntactic

Table 1. Examples of experimental sentences in Sprouse et al. (2012). Subordinate clauses are indicated by angle brackets and the manipulations of discontinuous dependency are indicated by underlines.

Wh-dependency	Island	Experimental sentences in Sprouse et al. (2012)
Main clause	None	Who thinks that [the lawyer forgot his briefcase at the office]?
Embedded clause	None	What do you think that [the lawyer forgot at the office]?
Main clause	Adjunct clause	Who worries if [the lawyer forgets his briefcase at the office]?
Embedded clause	Adjunct clause	What do you worry if [the lawyer forgets at the office]?
Main clause	None	Who heard that [Jeff baked a pie]?
Embedded clause	None	What did the chef hear that [Jeff baked]?
Main clause	Complex NP	Who heard the statement that [Jeff baked a pie]?
Embedded clause	Complex NP	What did the chef hear the statement that [Jeff baked]?
Main clause	None	Who thinks that [Matt chased the bus]?
Embedded clause	None	What does the police officer think that [Matt chased]?
Main clause	Indirect question	Who wonders whether [Matt chased the bus]?
Embedded clause	Indirect question	What does the police officer wonder whether [Matt chased]?

island. With this manipulation, Sprouse, Wagers & Phillips (2012) succeeded in observing the effect of the discontinuous dependency and that of the syntactic island independently. Here the effect of the island effect was indicated by the interaction between the discontinuous dependency and the presence or absence of syntactic island. Furthermore, Sprouse, Wagers & Phillips (2012) calculated the Z-scores for the acceptability judgments for each native speaker to normalize his/her judgments. With this normalization, Sprouse, Wagers & Phillips (2012) successfully indicated the relative strength of the island effects between the multiple constructions. We can now evaluate the relative strength of island effect cross-linguistically by the method of Sprouse, Wagers & Phillips (2012).

In this study, we made Japanese sentences directly corresponding to the experimental sentences in Sprouse, Wagers & Phillips (2012) as in Table 2, and quantitatively described the island effects in Japanese to compare them with those in English.

We made forty-eight Japanese complex sentences including potential syntactic islands, namely, an adverbial adjunct clause, a complex NP, and an indirect question with sixteen sentences for each, in which we manipulated the presence

Table 2. Examples of experimental sentences in this study and their English glosses. Sub-ordinate clauses are indicated by angle brackets and the manipulations of discontinuous dependency are indicated by underlines.

Wh-dependency	Island	Experimental sentences in this study
Main clause	None	誰が，[弁護士が事務所にカバンを忘れた] と思っているんですか？ Who-nom, [lawer-nom office-at briefcase-acc forgot]-Comp thinks?
Embedded clause	None	何を，君は，[弁護士が事務所に忘れた] と思っているんですか？ What-acc, you-top, [lawer-nom office-at forgot]-Comp thinks?
Main clause	Adjunct clause	誰が，[弁護士が事務所にカバンを忘れた]ら，困るんですか？ Who-nom, [lawyer-nom office-at briefcase-acc forget]-if, worries?
Embedded clause	Adjunct clause	何を，君は，[弁護士が事務所に忘れた]ら，困るんですか？ What-acc you-nom [lawyer-nom office-at forget]-if, worries?
Main clause	None	誰が，[奥田さんがパイを焼いた] と聞いたんですか？ Who-nom, [Mr./Ms. Okuda-nom pie-acc baked]-Comp heard?
Embedded clause	None	何を，料理長は，[奥田さんが焼いた] と聞いたんですか？ What-acc, chef-top, [Mr./Ms. Okuda-nom baked]-Comp heard?
Main clause	Complex NP	誰が，[奥田さんがパイを焼いた] 話を聞いたんですか？ Who-nom [Mr./Ms. Okuda-nom pie baked] statement-acc heard?
Embedded clause	Complex NP	何を，料理長は，[奥田さんが焼いた] 話を聞いたんですか？ What-acc, chef-top, [Mr./Ms. Okuda-nom baked] statement-acc heard?
Main clause	None	誰が，[今井さんがバスを追いかけた] と思っているんですか？ Who-nom [Mr./Ms. Imai-nom bus-acc chased]-Comp thinks?
Embedded clause	None	何を，警官は，[今井さんが追いかけた] と思っているんですか？ What-acc, police officer-top, [Mr./Ms. Imai-nom chased]-Comp thinks?
Main clause	Indirect question	誰が，[今井さんがバスを追いかけた] かどうか気にしているんですか？ Who-nom [Mr./Ms. Imai-nom bus-acc chased]-whether wonders?
Embedded clause	Indirect question	何を，警官は，[今井さんが追いかけた] かどうか気にしているんですか？ What-acc, police officer-top, [Mr./Ms. Imai-nom chased]-whether wonders?

or absence of a (possible) syntactic island and the discontinuous dependency in the same manner with Sprouse, Wagers & Phillips (2012). Here a discontinuous dependency was present when the sentence-initial object of the subordinate verb was in an embedded clause. The forty-eight experimental sentences and twenty-four fillers were counterbalanced to make the questionnaire asking the acceptability judgments by choosing one of seven point scale ("very good" to "very bad").

2.2. Results: Comparison of Island Effects in English and Japanese

The Z-scores for three kinds of Japanese complex sentence and those for corresponding English sentences by Sprouse, Wagers & Phillips (2012) are presented in Figures 1-3 respectively.
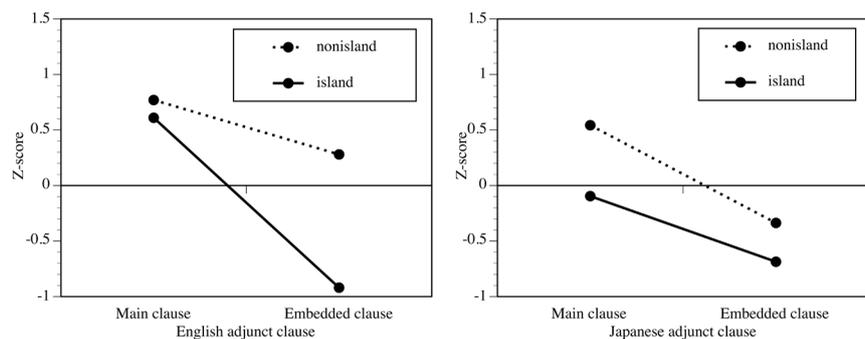
Figure 1. Z-scores for adjunct clauses in English and Japanese.
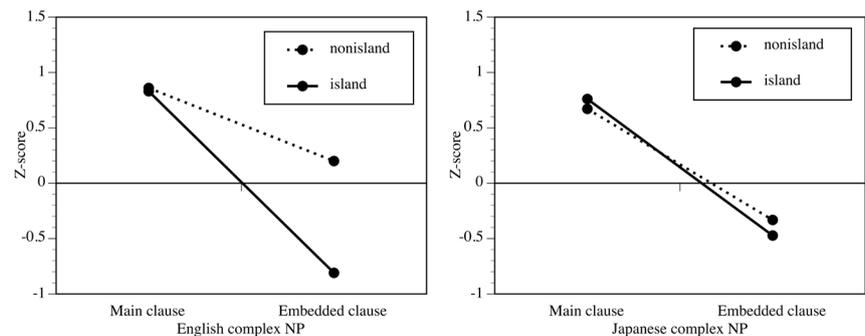
Figure 2. Z-scores for complex NPs in English and Japanese.
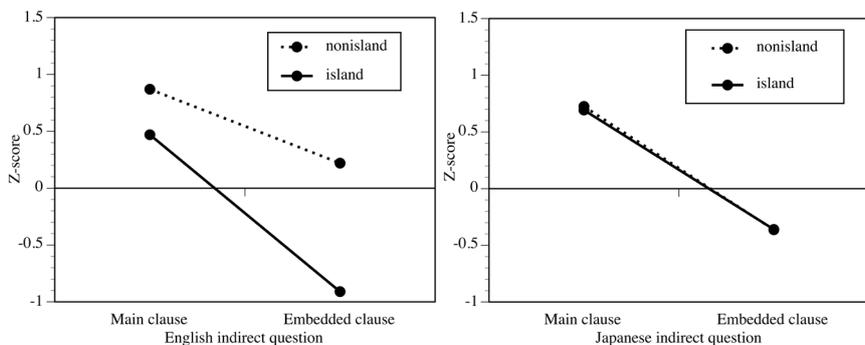
Figure 3. Z-scores for indirect questions in English and Japanese.

Linear-mixed modelings were performed for the Z-scores with the kind of *wh*-dependency and the presence or absence of a potential island as fixed factors and with the participants and the experimental sentences as random factors. The statistics by the modelings are presented in Table 3. The absolute *t*-values for Dependency exceeded 2 for all the kinds of embedded clause, but as for Presence or Absence of Island, the *t*-value was over 2 only for Adjunct clause. Furthermore, no absolute *t*-value for the interaction of Dependency × Presence or Absence of Island exceeded 2. Sprouse, Wagers & Phillips (2012), on the other hand, reported the significant main effects for Dependency and Presence or Absence of Island and the significant interaction of Dependency × Presence or Absence of Island with the significant level lower than 0.01%. These results indicated that Japanese sentences with the discontinuous dependency crossing clause boundaries were judged less acceptable than the sentences without the dependency crossing clause boundaries, as is the case in English, and that the three kinds of structure, namely, adverbial adjunct clauses, complex NPs, and indirect questions did not function as syntactic islands with the island effects much weaker than those in English.

Language has been attracting researchers from many academic fields because language is specific to human beings. This is one of the main reasons why many theoretical linguists have focused on the cross-linguistic and universal aspects of language. However, our experimental results suggest that a cross-linguistic phenomenon can vary among languages. In the next section, I will propose a hypothesis for the difference of the strength of the island effects between English and Japanese from the view point of sentence processing and discuss the experiment to examine the hypothesis.

Table 3. Statistics by linear-mixed modeling for Z-scores in Japanese sentences (SE for standard errors).

		β	SE	*t*-value
Adjunct clause	Intercept	−0.096	0.087	−1.101
	Dependency	−0.593	0.130	−4.567
	Presence or Absence of Island	0.634	0.124	5.128
	Dependency × Presence or Absence of Island	−0.281	0.179	−1.570
Complex NP	Intercept	0.767	0.053	14.404
	Dependency	−1.233	0.114	−10.842
	Presence or Absence of Island	−0.094	0.146	−0.640
	Dependency × Presence or Absence of Island	0.229	0.196	1.169
Indirect question	Intercept	0.687	0.081	8.431
	Dependency	−1.047	0.108	−9.652
	Presence or Absence of Island	0.033	0.126	0.262
	Dependency × Presence or Absence of Island	−0.039	0.223	−0.173

3. Experiment 2: Head Position and Processing Time-Series

In Japanese sentence processing, the syntactic relationship of two discontinuous elements is computed after the correspondence between the two is established. In (9), which has a complex noun phase, for example, after the dependency between the preposed *Sono hon-o* (that book-acc) and its gap is established (Aoshima et al., 2004), the gap is recognized to be in a complex NP at the head, *uwasa* (rumor).

 9) <u>Sono hon-o</u> [_S John-ga [_{NP}[_S Mary-ga <u>katta</u>] <u>uwasa</u>]-o kiita].

<div align="center">⇓</div>

<div align="center">syntactic computation</div>

In (10), corresponding directly to (9), on the other hand, when the syntactic relationship between the discontinuous elements is computed at the head noun, the gap is not yet recognized.

 10) a) (As for) that book, John heard the rumor that Mary had bought (it).

 b) <u>That book</u>, John heard [_{NP} the rumor that [_S ...(?)...

<div align="center">⇓</div>

<div align="center">syntactic computation</div>

A head functions here as an operator, syntactically relating two discontinuous elements to each other. We hypothesize (11) as the processing effect on the grammatical judgment of discontinuous dependency.

 11) Processing effect on grammatical judgment of discontinuous dependency

 The syntactic computation of a discontinuous dependency with one of the two elements unreceived is more costly than that with both of the two received. Sentences with costly processing are likely to be judged as ungrammatical.

 We will describe the method of our experiment in detail in the next section.

3.1. Method

3.1.1. Participants

Thirty-eight native speakers of Japanese participated in the study. They were paid.

3.1.2. Materials

Four types of complex sentences with six phrases were examined as experimental sentences, namely, sentences with their subordinate clauses as verbal complement (Comp), nominal complement (Ncomp), adverbial adjunct (Adjunct), and relative (Relative) clauses.

 Word-order was manipulated in three ways, namely, canonical, scrambled and relativized orders. In (12) of Comp, for example, the sentence in scrambled order was constructed from (12a) in canonical order by proposing the subordinate object *shakkin-o* (debt-acc), as in (12b). The sentence in relativized order was constructed from (12a) by postponing the object as the head of the relative clause, as in (12c). In (12b), after the filler-gap correspondence is established, the syntactic relationship between them is computed at the complementizer *to* (indicated in bold face). In (12c), on the other hand, the syntactic relationship be-

tween the gap and the filler must be computed at *to*, with the filler unreceived. The computation in (12c), with one of the two discontinuous elements unreceived, is comparable to that in the English examples, as in (3a).

(12) a) Sentence with verbal complement clause (Comp) in canonical order

Tanaka-ga [s Akechi-ga shakkin-o hensaishita]-to bengoshi-ni shoogenshita.

name-nom name-nom debt-acc paid back-Comp lawyer-dat testified

"Tanaka told the lawyer as the testimony that Akechi had paid back the debt."

b) Comp in scrambled order

Shakkin-o [s Tanaka-ga [s Akechi-ga hensaishita]-to bengoshi-ni shoogenshita].

"The debt, Tanaka told the lawyer as the testimony that Akechi had paid back."

c) Comp in relativized order

[s Tanaka-ga [s Akechi-ga hensaishita]-to bengoshi-ni shoogenshita] shakkin.

"The debt that Tanaka told the lawyer as the testimony that Akechi had paid back."

The clause structures and the sequence of case particles in canonical order are presented in Table 4, and examples of four types of subordinate clauses in three word-orders are shown in Table 5. The phrase frequency was controlled by *Asahi News Paper Digital Archives* for the four types of subordinate clauses × the six phrase positions. The sequence of accents at the beginning of a sentence may affect the recognition of a clause boundary (Hirose, 2003). In our experimental sentences, therefore, all the human names in P1 and P2 were unaccented. Furthermore, half of the subordinate objects were accented and the other half were unaccented for each type of subordinate clause. Pragmatic plausibility was controlled for the four types of sentences in canonical order so that the availability of context would not affect grammatical judgments. Eighteen sentences were constructed for each type of subordinate clause. Thirty control sentences and twelve experimental sentences with a different purpose from this study were included in the main session. The controls were simple sentences including only one verb, and half of them were ungrammatical, in violation of argument realization. The main session thus included one hundred and fourteen sentences. Three experimental scripts were written in counter-balanced design for the four types of subordinate clauses and the three word-orders. All stimulus sentences were synthesized by computer into vocal sound.

Table 4. Clause structures and the sequence of case particles of experimental sentences in canonical order.

Type of subordinate clause	P(hrase) 1	P2	P3	P4	P5	P6
Comp	NP-nom	[s NP-nom	NP-acc	V]-Comp	NP-dat	V
Ncomp	NP-nom	[NP[s NP-nom	NP-acc	V]	NP]-dat	V
Adjunct	NP-nom	[NP[s NP-nom	NP-acc	V]-when/because]	NP-dat	V
Relative	NP-nom	[NP[s NP-nom	NP-acc	V]	NP]-dat	V

Table 5. Experimental sentences for four types of subordinate clauses in three word-orders. The subordinate verbs and their (thematic) objects are represented by underline, and the heads of the constituents relevant here are in bold-face (the direct English translations are for explanatory purposes, and they can be awkward).

P(hrase) 1	P2	P3	P4	P5	P6
		I. Verbal complement clause (Comp)			
		a) Canonical order			
Tanaka-ga name-nom	[s Akechi-ga name-nom	shakkin-o debt-acc	hensaishita]-to paid back-Comp	bengoshi-ni lawyer-dat	shoogenshita. testified
		"Tanaka told the lawyer as the testimony that Akechi had paid back the debt"			
		b) Scrambled order			
Shakkin-o	[s Tanaka-ga	[s Akechi-ga	hensaishita]-to	bengoshi-ni	shoogenshita]
		"The debt, Tanaka told the lawyer as the testimony that Akechi had paid back"			
		c) Relativized order			
[s Tanaka-ga	[s Akechi-ga	hensaishita]-to	bengoshi-ni	shoogenshita]	shakkin.
		"The debt that Tanaka told the lawyer as the testimony that Akechi had paid back"			
		II. Nominal complement clause (Ncomp)			
		a) Canonical order			
Takagi-ga name-nom	[NP[s Uchida-ga name-nom	shiNyuu-o close friend-acc	damashita] betrayed	jijitsu]-ni fact-dat	ochikonda. got depressed
		"Takagi got depressed at the fact that Uchida had betrayed the close friend"			
		b) Scrambled order			
ShiNyuu-o	[s Takagi-ga	[NP[s Uchida-ga	damashita]	jijitsu]-ni	ochikonda]
		"As for the close friend$_i$, Takagi got depressed at the fact that Uchida had betrayed him/her$_i$"			
		c) Relativized order			
[s Takagi-ga	[NP[s Uchida-ga	damashita]	jijitsu]-ni	ochikonda]	shiNyuu.
		"The close friend$_i$ who Takagi got depressed at the fact that Uchida had betrayed him/her$_i$"			
		III. Adverbial adjunct clause (Adjunct)			
		a) Canonical order			
Tanaka-ga name-nom	[PP[s Tsuchiya-ga name-nom	kootsuujiko-o traffic accident-acc	okoshita]-node] caused-because	jiko-genba-ni accident scene-dat	kaketsuketa. rushed to
		"Tanaka rushed to the accident scene because Tsuchiya had caused a traffic accident"			
		b) Scrambled order			
Kootsuujiko-o	[s Tanaka-ga	[PP[s Tsuchiya-ga	okoshita]-node]	jiko-genba-ni	kaketsuketa]
		"As for the traffic accident$_i$, Tanaka rushed to the accident scene because Tsuchiya had caused it$_i$"			
		c) Relativized order			
[s Tanaka-ga	[PP[s Tsuchiya-ga	okoshita]-node]	jiko-genba-ni	kaketsuketa]	kootsuujiko
		"The traffic accident$_i$ that Tanaka rushed to the accident scene because Tsuchiya had caused it$_i$"			
		IV. Relative clause (Relative)			
		a) Canonical order			
Suzuki-ga name-nom	[NP[s Kishida-ga name-nom	yubiwa-o ring-acc	katta] bought	hoosekiten]-ni jewelry store-dat	tsutometeita. worked

Continued

		"Suzuki had worked at the jewelry store where Kishida bought a ring"			
		b) Scrambled order			
Yubiwa-o	[$_S$ Suzuki-ga	[$_{NP}$[$_S$ Kishida-ga	katta]	hoosekiten]-ni	tsutometeita]
		"As for the ring$_i$, Suzuki had worked at the jewelry store where Kishida bought it$_i$"			
		c) (Double) relativized order			
[$_S$ Suzuki-ga	[$_{NP}$[$_S$ Kishida-ga	katta]	hoosekiten]-ni	tsutometeita]	yubiwa.
		'The ring$_i$ that Suzuki had worked at the jewelry store where Kishida bought it$_i$"			

3.1.3. Procedure

The stimulus sentences were auditorily presented to the participants by the self-paced sentence-by-sentence listening method. The participants were asked to make grammatical judgments on the sentences by pressing one of the two buttons ("grammatical" or "ungrammatical"). The practice session included nine trials and the presentation order of the stimulus sentences was randomized for each participant. Participants took about twenty minutes to complete the experiment.

The predictions for our experiment are summarized in (13).

13) a) Description of Japanese island effect

If a complex NP and an adverbial adjunct clause behave as island in Japanese, Ncomp, Adjunct, and Relative in scrambled (and relativized) order will be judged grammatical less often than when they are in canonical order.

b) Processing effect on discontinuous dependency

If the grammatical judgments are affected by the difference in processing cost due to the different time-series of a head and the discontinuous elements between English and Japanese, the sentences in relativized order will be judged grammatical less often than those in scrambled order. The island effect in relativized order will be noticeable, as in English.

Four participants made mistakes when judging the control sentences over 70% of the time; their responses were excluded from the subsequent analysis because we judged their linguistic performance to be inadequate for the purposes of the experiment. The mean proportions of the grammatical judgments for the four types of subordinate clauses and the three word-orders are presented in **Figure 4**. A two-factor ANOVA was performed with the type of subordinate clause and word-order as within factors.

As a result, the main effects of the type of subordinate clause and word-order were significant [type of subordinate clause: [F_1 (3, 99) = 83.11, MSe = 0.04, $p <$ 0.0001, F_2 (3, 51) = 54.98, MSe = 0.03, $p <$ 0.0001; word-order: F_1 (2, 66) = 116.98, MSe = .09, $p <$ 0.0001, F_2 (2, 34) = 239.81, MSe = 0.02, $p <$ 0.0001]. The interaction between the type of subordinate clause and word-order was significant [F_1 (6, 198) = 12.77, MSe = .03, $p <$ 0.0001, F_2 (6, 102) = 10.95, MSe = 0.02, $p <$ 0.0001]. In the paired comparisons for canonical and scrambled orders, the mean proportions for Ncomp, Adjunct, and Relative in scrambled order
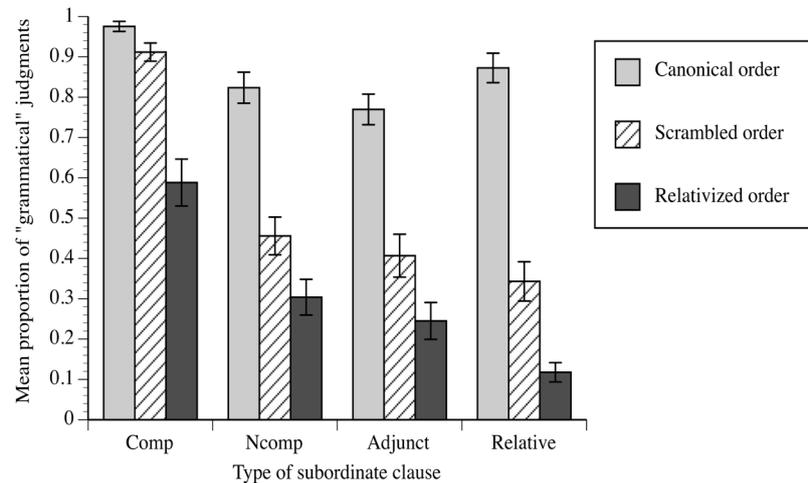
Figure 4. Mean proportions of grammatical judgments for four types of subordinate clauses and three word-orders with error bars as standard errors.

were significantly lower than the mean proportions of those in canonical order. Furthermore, the mean proportion for Relative was significantly lower than that for Ncomp in scrambled (and relativized) order. For each type of subordinate clause, the mean proportion for relativized order was significantly lower than that for scrambled order. The island effect in relativized order was quite noticeable, as predicted.

4. Discussion

The lower proportions of grammatical judgments for Ncomp, Adjunct, and Relative in scrambled order than that in canonical order indicate that a complex NP and an adverbial adjunct clause impose constraints on discontinuous dependency in Japanese. The island effect is thus present in Japanese, though it is weak. The more severe island effect in Relative than that in Ncomp parallels the effect in English. This response pattern suggests that the island effect is cross-linguistic. Furthermore, the greater island effect in relativized order than that in scrambled order verifies our hypothesis. We found no significant difference in the grammatical proportion for Comp between canonical and scrambled orders. Here we should focus on the relatively low proportion of grammatical judgments for Comp in relativized order (58.8%). We should note that a similar response is observed in Kluender and Kutas (1993). Kluender and Kutas (1993) performed a rapid serial visual presentation experiment, asking participants to make grammatical judgments of English sentences, some of which are given in (14). Example (14a) is a yes-no question without a discontinuous dependency. Examples (14b) and (14c) include a discontinuous dependency, crossing the boundary of a verbal complement declarative in (14b) and that of an indirect question in (14c). An indirect question behaves as island in English. The mean proportion of grammatical judgments for (14a) was 93%, and that for (14) was 18%. We should note that the mean proportion for (14b) was only 55%, though the sen-

tence is judged to be grammatical in syntactic theory.

14) a) Yes-no question

Can't you figure out if you should tell the boss about the mistake before the meeting?

b) Discontinuous dependency for verbal complement declarative

What did you figure out that [$_S$ you should tell the boss about before the meeting]?

c) Discontinuous dependency for indirect question

What can't you figure out [$_S$ who should tell the boss about before the meeting]?

The results of Kluender and Kutas (1993) suggest that the biclausal discontinuous dependency for a verbal complement declarative in English can be fairly costly. Because the processing time-series of a head and the two discontinuous elements for our Comp in relativized order was manipulated to correspond to English, the relatively low proportion for Comp in the word-order is not surprising[2]. We assume that biclausal discontinuous dependency is syntactically constrained cross-linguistically. Our results, however, suggest that some part of the apparent syntactic phenomenon can be attributed to processing factors.

Conflicts of Interest

The author declares no conflicts of interest regarding the publication of this paper.

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[2]We should, however, note that because the presentation method differs between Kluender and Kutas (1993) and our experiment, we cannot make a strict comparison between the two studies.

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