

Japanese ESL Learners' Relative-Clause Attachment Preferences for Complex NP Sentences

Ayaka OTAKE

Introduction

There is a domain that even highly advanced L2 English learners can hardly reach — the domain of handling English at a native speaker level. One of the reasons for this might be the difference between how L2 learners and native speakers perceive language. Human parsing mechanisms have been a great concern in the area of psycholinguistics for many years (Frazier 1978, Gibson et al. 1996, Juffs 1998, Clahsen and Felser 2006). Research has been done on L2 and L1 processing, and has discovered some differences between the respective parsing strategies. Since the way that people process languages cannot be directly seen, conditioned sentences were used to indirectly reveal their supposed method of processing. One of the sentence types that is known to be handled divergently among people with different language backgrounds is a sentence with a noun phrase (NP) containing a relative clause (hereafter complex NP sentence). The present study conducted an analysis on how Japanese ESL learners process this type of English sentence in order to see their similarities and dissimilarities with native English speakers. The study aims at obtaining insights that might be used to help L2 learners reach the aforesaid domain.

Previous Studies

Studies investigating the parsing of complex NP sentences have attempted to determine whether the process differs for English speakers and other language speakers. Cuetos and Mitchell (1988) did offline (questionnaire) and online (self-paced reading)

experiments using complex NP sentences such as the one shown in (1). The offline experiment was done to see the outcome of their processing, and the online experiment was conducted to see participants' real-time processing.

- (1) Someone shot the servant of the actress who was on the balcony.

In the sentence above, two NPs (NP1: *the servant*, NP2: *the actress*) are connected with the preposition *of*, and a relative clause (*who was on the balcony*) follows. Results of the experiments showed that English speakers have a preference for interpreting the relative clause as a modifier of the NP2 (low-attachment) online and offline, whereas Spanish speakers showed a different preference, associating it with NP1 (high-attachment) in corresponding Spanish sentences. Building on these findings, Kamide and Mitchell (1997) did an online and offline experiment on Japanese L1 processing. Translated versions of the sentences from Cuetos and Mitchell (1988) were used, as is shown in (2).

- (2) Dareka-ga barukonii-ni iru
 [Someone-Nom balcony-Loc is
 joyuu-no mesitukai-o utta.
 actress (NP2)-Gen servant (NP1)-Acc shot]
 (Adapted from Kamide and Mitchell 1997: 249)

The difference between Japanese and English is that the relative clause precedes the two NPs, and that what was labeled NP2 in the English sentence precedes NP1. The results of the experiments suggested that in L1 Japanese speakers show a preference for low attachment (NP2) online, but show a high attachment (NP1) preference offline. Therefore, attachment preferences for L1 processing in English and Japanese diverge. As for L2 processing, Nakano and Wang (2011) investigated Japanese L2 English learners, and the results indicated that upper-level learners show a preference for high attachments online and offline when the preposition connecting the two NPs is *of*, whereas they show a low attachment preference offline when the preposition is *with*. It seems as if Japanese L2 learners show different attachment preferences from native English speakers for English complex

NP sentences. However, is that true in all cases? In Nakano and Wang (2011), the experimental sentences were designed to have two attachment conditions, with one having a relative clause that matches in meaning for only NP1 (high attachment condition) and another having a relative clause only matching NP2 (low attachment condition), as is shown in (3).

- (3) The runner saw the teacher of the students who was singing a song.
 The runner saw the students of the teacher who was singing a song.

Both sentences were tentatively ambiguous until the auxiliary (was vs. were) in the relative clause was encountered, which matched in number with only one of the two NPs. In the L1 Japanese experiments of Kamide and Mitchell (1997), sentences with attachment conditions were also used, but in their case, the pragmatic content of the relative clause, instead of number agreement, was employed as a disambiguating factor.

Although the preferences of Japanese speakers found in the two studies cannot be straightforwardly compared due to the difference of constituent order between Japanese and English complex NP sentences, the Kamide and Mitchell study suggests the possible value of using pragmatic disambiguation factors for a Japanese L2 online processing experiment. Therefore, the present study uses a pragmatic disambiguation factor to examine Japanese L2 processing.

The Present Study

The previous studies (Kamide and Mitchell 1997, Nakano and Wang 2011) have left a lot of uncertainties as to Japanese L2 learners' preferences. Regarding online processing, Japanese L2 learners showed a particular high attachment preference only when the preposition connecting the two NPs was *of*. Therefore, the present study uses *of* as the connector of the two NPs in the experimental sentences.

Materials

The stimulus materials for the experiment were designed as shown in example (4). The sentences are divided into seven regions (abbreviated as r) by slashes.

(4)

HA/Ambiguous

r1 r2 r3

(a) The police / found / the fingerprint of the criminal /
 r4 r5 r6 r7
 that was / wiped / from / the jewel box.

HA/Unambiguous

(b) The police / found / the criminal's fingerprint / that was
 / wiped / from / the jewel box.

LA/Ambiguous

(c) The police / found / the fingerprint of the criminal / that
 was / arrested / for / stealing expensive jewelry.

LA/Unambiguous

(d) The police / found / the young criminal / that was /
 arrested / for / stealing expensive jewelry.

Sentence (a) has a relative clause (*that was wiped from the jewel box*) that pragmatically fits only with the first NP (*the fingerprint*), and since the sentence is ambiguous up to the verb (*wiped*) in the relative clause, it is labeled as a HA (high attachment) / Ambiguous sentence. Sentence (c) is a low attachment biased correlate to sentence (a), with a relative clause pragmatically adequate only with the second NP (*the criminal*), and it is labeled as LA / Ambiguous. In order to provide a baseline for comparison, unambiguous counterparts for both sentence (a) and (c) were added, making a set of four sentences. Sentence (b) is an unambiguous version of sentence (a), using a possessive construction (*the criminal's fingerprint*) to eliminate ambiguity. Sentence (d) is an unambiguous version of sentence (c), which only has a single noun modified by an adjective in region 3 (*the young criminal*). Twenty-four sets of the quadruplet sentences (a total of 96 sentences) were prepared. (The complete set of experimental sen-

tences can be found in the Appendix.) Filler sentences (96 sentences) were also included to add variation to the items participants read. The experimental sentences were randomized, and comprehension questions (yes/no questions) were presented after the experimental sentences in which subjects had a 50% chance of randomly selecting the correct answer. An example question for (4a) is shown in (5).

- (5) Comprehension Question
Did the police find the fingerprint?

Predictions

In the experiment, the reading time (RT) for the disambiguation point (region 5) is the key to indirectly observing the processing methods of participants. The predictions for the experiment are shown in (6) below.

- (6)
- (a) The RTs for region 5 will be shorter in the unambiguous conditions (4b, 4d) compared to ambiguous conditions (4a, 4c), since the unambiguous condition has only one site to which the relative clause may attach, and no hesitation will occur for attachment selection. ($4a > 4b$, $4c > 4d$).
 - (b) If Japanese L2 learners have a high-attachment preference, the RT for LA conditions will be longer than for HA conditions, since they will be impeded by reading the verb in region 5 in the LA/ambiguous condition more than in the HA/ambiguous condition ($4a-4b < 4c-4d$).
 - (c) If Japanese L2 learners have a low-attachment preference, the RT for HA conditions will be longer than for LA conditions, since they will be impeded by reading the verb in region 5 in the HA/ambiguous condition more than in the LA/ambiguous condition ($4a-4b > 4c-4d$).

The above predictions will be discussed in the results section.

Participants

Twenty-six advanced Japanese-speaking learners of English (mean age 19.1, range 18–21), all of them undergraduate students at the University of Tokyo, participated in this experiment. All participants had good vision and were uninformed of the exact purpose of the study. Twenty-four of the participants began studying English grammar at the age of 12, one at the age of ten, and for the other the age is unknown. Of the 14 participants who remembered the age of their first exposure to English, the earliest was at the age of two (mean age 9, range 2–12). One of the participants was a bilingual speaker, having resided in the United States for nine years. The participants' proficiency in English was assessed after the main experiment using a standardized proficiency test which measures acquisition of grammar and vocabulary (Oxford Quick Placement Test). All participants scored 68% or higher (range 68–93%, corresponding to B1-C2 levels in the CEFR) in this test, showing that they are at least upper-intermediate to highly advanced learners of English.

Procedure

In order to investigate the online parsing strategies of the participants, a nonaccumulative, moving-window self-paced reading task was conducted using Linger. Participants were asked to sit in front of a computer screen and read sentences in a segment-by-segment fashion. The division of segments was done as seen in (4). Participants were instructed to read the sentences at a normal speed while understanding them, since the task was not a competition. Dotted lines indicating the number and length of each word in the sentence were shown on the screen before the actual words appeared. By pressing the space key, participants could see the actual words replacing the dotted lines segment by segment. (A "+" mark first appeared in front of every sentence to direct the participants' attention to the part of the sentence that was about to appear. An example image is shown in Figure 1.) Of the seven segments presented for reading each sentence, region 5 always contained the disambiguating verb. The two NPs (NP1 or NP2) were presented as a single segment in region 3, since presenting them separately would cause participants to have a

biased attachment preference for NP2, which would be more easily kept in their short-term memory. To ensure that the experimental sentences were correctly understood, half of the sentences were followed by comprehension questions, and participants were asked to press the F key for yes, and J key for no. The F and J keys were labeled with a circle and a cross respectively, for convenience. After participants went through about half the sentences, a message recommending a short break appeared, and participants could rest as long as they needed. Following the break, participants finished the self-paced reading task and then moved on to taking the OQPT (Oxford Quick Placement Test). The two tasks were finished within an hour.

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Figure 1. Dotted Lines Shown on the Linger Screen

Results

Analysis was conducted by using R, a statistical software program for data calculation. The reading time (RT) for each region in the experimental sentences is shown in Figure 2.

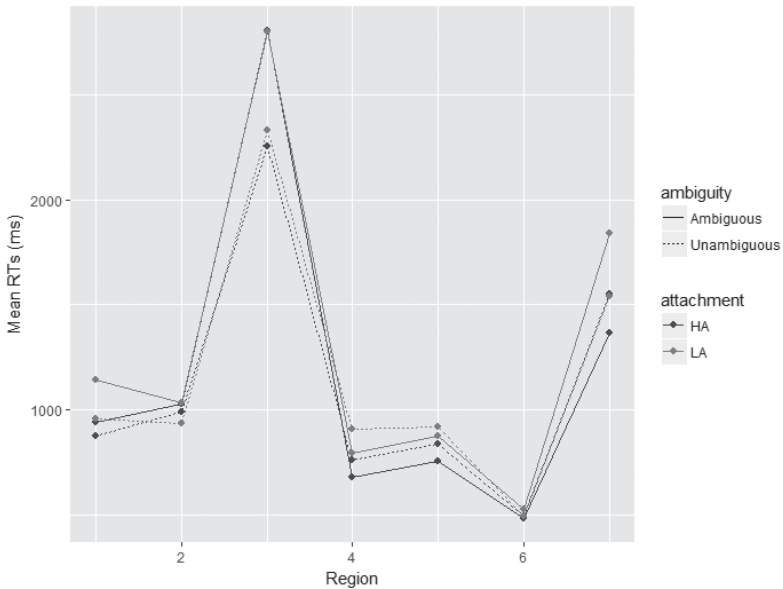


Figure 2. Reading Time of Each Region in Experimental Sentences

The average percentage of correct answers for the comprehension questions was over 93% for all sentence conditions, indicating that participants paid good attention while reading the experimental sentences, giving validity to the overall results.

Detailed results for the target region (region 5) and the spill-over region will be presented in order, below. (There are cases in which the anticipated reaction is not seen immediately in the target region, but in regions coming after it. Such regions are called spill-over regions, and in my analysis, region 7 was chosen.)

Critical Region (Region 5)

As for region 5, RTs which are unnaturally long ($RT > 3000$ ms) were removed before the formula was applied (an exclusion of 2% of the total data), and by adopting a backward stepwise selection (following Baayen 2008), the final formula for analysis was determined as $\text{lmer}(\text{rt} \sim \text{cf1} * \text{cf2} + \text{zwordlen} + (1 + \text{cf1} + \text{cf2} | \text{subj}) + (1 + \text{cf2} | \text{set}), \text{REML} = \text{F}, \text{data} = \text{subdata.trim25})$. Data trimming was also done after formula selection ($\text{sd} = 2.5$). The two factors, cf1 and cf2, represent ambiguity (ambiguous/unambiguous) and

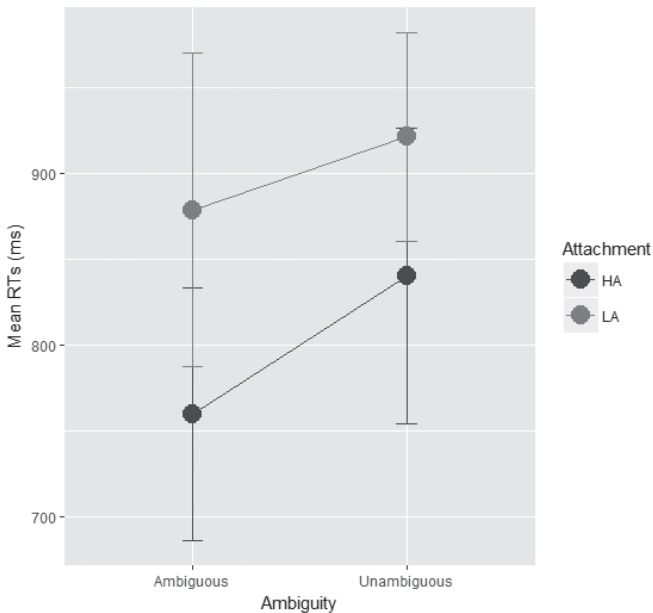


Figure 3. Reading Time of Region 5

attachment (HA/LA) respectively. Zwordlen is a factor for considering the variation in word length between the experimental sentences. The RTs of region 5 are shown in Figure 3 and Table 1.

Figure 3 shows the mean reading times of region 5 in each sentence condition. Contrary to the assumption, reading times of the unambiguous sentences are longer than those of ambiguous sentences for both HA and LA conditions. It can also be seen that the reading times of LA sentences are longer than those of HA sentences. The exact values of RTs of region 5 are shown in Table 1.

Table 1. Exact Values of RTs for Region 5

Ambiguity	Mean RT
(a) HA/Ambiguous	759.4493
(b) HA/Unambiguous	840.1697
(c) LA/Ambiguous	878.6750
(d) LA/Unambiguous	921.2996

Table 2. Fixed Effects of Region 5

	Estimate	SD	df	t-value	p-value
(Intercept)	1134.26	70.87	39.40	16.006	< 2e-16 ***
Ambiguity	67.51	44.43	540.20	1.519	0.129
Attachment	24.08	80.41	24.60	0.299	0.767
Word length	689.97	86.97	99.00	7.933	3.33e-12 ***
Ambiguity: Attachment	14.17	88.79	538.40	0.160	0.873

Table 2 shows the fixed effects of region 5. Since the focus is on the average RTs of participants, the values in the fixed effects are the object of interest. SD and df stand for standard deviation and degrees of freedom respectively. Next to them are the t-value and p-value. The p-value can be calculated by combining df and t-value, and it is the most important data here, since it represents the significance of a factor. Significance is expressed with asterisks in the p-value slot. It can be seen that there are no main effects of both ambiguity and attachment, and the interaction cannot be seen as well. Participants' attachment preference is unidentifiable from the RTs of the critical region. Therefore, an analysis on the regions which come after the critical region (region 5) was also done in the search for a spill-over effect.

Spill-over Region (Region 7)

As for region 7, RTs which are longer than 4000 milliseconds were removed before the formula was applied (an exclusion of 3% of the total data), and by adopting a backward stepwise selection, the final formula for analysis was determined as $lmer(rt \sim cf1 * cf2 + zwordlen + (1 + cf1:cf2 | subj) + (1 + cf1:cf2 | set), REML = F, data = subdata.trim27)$. Data trimming was also done after formula selection ($sd = 2.5$). As in the case of region 5, the two factors ($cf1$ and $cf2$) represent ambiguity (ambiguous/unambiguous) and attachment (HA/LA) respectively, and $zwordlen$ is a factor for considering the variation in word length between the experimental sentences. The RTs of region 7 are shown in Figure 4 and Table 3.

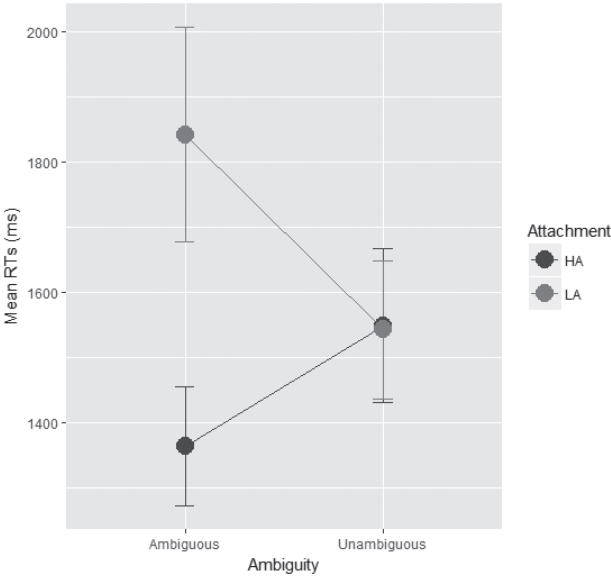


Figure 4. Reading Time of Region 7

Figure 4 shows the mean reading times of region 7 in each sentence condition. The reading time for ambiguous sentences in the LA condition is the longest, and that for ambiguous sentences in the HA condition is the shortest. Unambiguous sentences in both HA and LA conditions show nearly the same RTs. The exact values of the RTs of region 7 are shown in Table 3.

Table 3. Exact Values of RTs for Region 7

Ambiguity	Mean RT
(a) HA/ Ambiguous	1364.056
(b) HA/Unambiguous	1548.936
(c) LA/ Ambiguous	1841.661
(d) LA/Unambiguous	1543.188

Table 4. Fixed Effects of Region 7

	Estimate	SD	df	t-value	p-value
(Intercept)	1062.59	135.97	55.10	7.815	1.72e-10 ***
Ambiguity	-54.69	76.27	514.60	-0.717	0.4737
Attachment	175.32	76.83	518.70	2.282	0.0229
Word length	533.35	76.83	266.50	6.942	2.94e-11 ***
Ambiguity: Attachment	-464.75	197.32	32.30	-2.355	0.0247 *

Table 4 shows the fixed effects of region 7. It can be seen that there are no main effects for either ambiguity or attachment. However, a significant interaction can be seen. To further understand the factors influencing the attachment preference of participants, pairwise analyses were conducted for region 7.

Table 5 shows the results for a pairwise analysis for determining the difference between HA sentences (Ambiguous/Unambiguous). The analytical formula used was `lmerfla<-lmer(rt~cf1+(1|subj)+(1|set), data=subset(subdata.trim27, f2=="HA"))`. No significant difference can be seen between the two conditioned sentences.

Table 5. Result of Pairwise Analysis for Region 7 (HA sentences)

	Estimate	SD	df	t-value	p-value
(Intercept)	1461.34	113.82	27.61	12.839	3.7e-13 ***
HA	175.47	112.53	214.07	1.559	0.12

Another pairwise analysis for the LA condition (Ambiguous/Unambiguous) was conducted, and Table 6 shows the results. The analytical formula used was `lmerflb<-lmer(rt~cf1+(1|subj)+(1|set), data=subset(subdata.trim27, f2=="LA"))`. It can be seen that a fairly significant difference was

found between the two conditioned sentences.

Table 6. Result of Pairwise Analysis for Region 7 (LA sentences)

	Estimate	SD	df	t-value	p-value
(Intercept)	1691.13	156.69	35.12	10.793	1.06e-12 ***
LA	-294.95	106.31	231.05	-2.774	0.00598 **

Discussion

Although no attachment preferences could be seen from the RTs of the critical region (region 5), those of the spill-over region (region 7) have provided results that tend to verify the predictions. In predictions (6b) and (6c), it was assumed that if participants showed a preference for high attachment, the reading times for the four conditions would be $4a-4b < 4c-4d$, or, alternately, they would be $4a-4b > 4c-4d$ if participants showed a preference for low attachment. That is to say, the RT differences between the ambiguous/ unambiguous sentences in the HA and LA conditions, respectively, is the key to revealing the attachment preferences of participants. From the pairwise analyses of region 7, it became clear that there is a significant difference between the RTs of the LA conditions while there is none between those of the HA conditions. This result corresponds to the $(4a-4b < 4c-4d)$ situation, and therefore means that the participants have shown a high attachment preference in the experiment. This result is supportive of the findings in Nakano and Wang (2011). As for the prediction in (6a), contradictory results have been shown, since unambiguous sentences were read more slowly than the ambiguous sentences in both HA and LA conditions at region 5, and in HA conditions at region 7. Possible reasons for this result may be attributed to the mixed attachment preferences between the participants, resulting in a different processing burden in reading the selected regions in the ambiguous sentences. In other words, the fact that the sentence is ambiguous may have been a cause for a processing difficulty for some participants but not for others. In addition, as for the HA conditions, there is a possibility that the possessive form in region 3 used in the unambiguous sentences caused more processing effort to the participants, compared to the *NP of NP* form in the

corresponding region in ambiguous sentences. This may be one of the reasons for the longer reading times for the following regions (5 and 7) in unambiguous sentences. However, since this is only an assumption, further investigation is required on this point.

Conclusion

In the previous studies, Japanese L2 English learners were reported to demonstrate a high attachment preference in processing complex NP sentences online when the disambiguating factor is the number agreement for verbs. The present study conducted an experiment using a pragmatic disambiguating factor instead, and revealed that Japanese L2 English learners show the same high attachment preference in this situation as well. Future experiments using other factors should be considered in order to further investigate the processing mechanisms of Japanese L2 learners and thus obtain clues for improvements in Japanese English education.

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Appendix

The police found the fingerprint of the criminal that was wiped from the jewel box.

The police found the criminal's fingerprint that was wiped from the jewel box.

The police found the fingerprint of the criminal that was arrested for stealing expensive jewelry.

The police found the young criminal that was arrested for stealing expensive jewelry.

The girls noticed the plane of the man that was crashing on the grass runway.

The girls noticed the man's plane that was crashing on the grass runway.

The girls noticed the plane of the man that was jogging in the park yesterday.

The girls noticed the thin man that was jogging in the park yesterday.

The citizens saw the gun of the soldier that was imported from Russia very recently.

The citizens saw the soldier's gun that was imported from Russia very recently.

The citizens saw the gun of the soldier that was injured in a recent war.

The citizens saw the armed soldier that was injured in a recent war.

The neighbors watched the house of the millionaire that was built near the thick forest.

The neighbors watched the millionaire's house that was built near the thick forest.

The neighbors watched the house of the millionaire that was awarded in a golf competition.

The neighbors watched the old millionaire that was awarded in a golf competition.

The children found the nest of the bird that was destroyed by the heavy windstorm.

The children found the birds' nest that was destroyed by the heavy windstorm.

The children found the nest of the bird that was born in the northern islands.

The children found the small bird that was born in the northern islands.

The members talked about the ring of the lady that was removed from her index finger.

The members talked about the lady's ring that was removed from her index finger.

The members talked about the ring of the lady that was eating in a French restaurant.

The members talked about the fashionable lady that was eating in a French restaurant.

The zookeepers saw the banana of the monkey that was cultivated in the big plantation.

The zookeepers saw the monkey's banana that was cultivated in the big plantation.

The zookeepers saw the banana of the monkey that was captured in a faraway jungle.

The zookeepers saw the playful monkey that was captured in a faraway jungle.

The residents checked the temperature of the room that was heightened at that very moment.

The residents checked the room's temperature that was heightened at that very moment.

The residents checked the temperature of the room that was reformed by a house builder.

The residents checked the deserted room that was reformed by a house builder.

The fans saw the hair of the actress that was brushed before the filming started.

The fans saw the actress's hair that was brushed before the filming started.

The fans saw the hair of the actress that was murdered in a horror movie.

The fans saw the experienced actress that was murdered in a horror movie.

The ministers heard about the letter of the president that was typed by an anonymous person.

The ministers heard about the president's letter that was typed by an anonymous person.

The ministers heard about the letter of the president that was elected for two terms successively.

The ministers heard about the lazy president that was elected for two terms successively.

The visitors saw the eggs of the penguin that will hatch in a few days.

The visitors saw the penguin's eggs that will hatch in a few days.

The visitors saw the eggs of the penguin that will swim in the new pool.

The visitors saw the adorable penguin that will swim in the new pool.

The woman recognized the toy of the boy that was bought at a shop nearby.

The woman recognized the boy's toy that was bought at a shop nearby.

The woman recognized the toy of the boy that was scolded for his bad behavior.

The woman recognized the small boy that was scolded for his bad behavior.

The children saw the tree of the gardener that was planted in the field.

The children saw the gardener's tree that was planted in the field.

The children saw the tree of the gardener that was hired for managing the park.

The children saw the diligent gardener that was hired for managing the park.

The spy heard about the document of the commissioner that was written in beautiful Greek letters.

The spy heard about the commissioner's document that was written in beautiful Greek letters.

The spy heard about the document of the commissioner that was prosecuted for the bribery case.

The spy heard about the young commissioner that was prosecuted for the bribery case.

The woman saw the machine of the researcher that was invented by an old scientist.

The woman saw the researcher's machine that was invented by an old scientist.

The woman saw the machine of the researcher that was asked to fix its defects.

The woman saw the tall researcher that was asked to fix its defects.

JAPANESE ESL LEARNERS' RELATIVE-CLAUSE ATTACHMENT

The man found the gloves of the burglars that were worn at the crime scene.

The man found the burglars' gloves that were worn at the crime scene.

The man found the gloves of the burglars that were sentenced to five year's prison.

The man found the fearless burglars that were sentenced to five year's prison.

The students saw the car of the teacher that was repaired in the school garage.

The students saw the teacher's car that was repaired in the school garage.

The students saw the car of the teacher that was promoted to an assistant headmaster.

The students saw the hardworking teacher that was promoted to an assistant headmaster.

The boy looked at the cake of the patissier that was baked for celebrating his birthday.

The boy looked at the patissier's cake that was baked for celebrating his birthday.

The boy looked at the cake of the patissier that was trained in an overseas program.

The boy looked at the new patissier that was trained in an overseas program.

The girls saw the present of the boy that was opened as soon as it was given.

The girls saw the boy's present that was opened as soon as it was given.

The girls saw the present of the boy that was assigned to score high in the exam.

The girls saw the talented boy that was assigned to score high in the exam.

The people talked about the drawing of the artist that was painted for his young wife.

The people talked about the artist's drawing that was painted for his young wife.

The people talked about the drawing of the artist that was asked to decorate the church.

The people talked about the famous artist that was asked to decorate the church.

The guests saw the potatoes of the farmers that were mashed in a salad bowl.

The guests saw the farmers' potatoes that were mashed in a salad bowl.

The guests saw the potatoes of the farmers that were recruited to help the

community.

The guests saw the cheerful farmers that were recruited to help the community.

The dentist remembered about the tooth of the boy that was brushed by his elder sister.

The dentist remembered about the boy's tooth that was brushed by his elder sister.

The dentist remembered about the tooth of the boy that was appointed to come last week.

The dentist remembered about the little boy that was appointed to come last week.

The man found the glasses of the scientists that were rubbed with pieces of cloth.

The man found the scientists' glasses that were rubbed with pieces of cloth.

The man found the glasses of the scientists that were caught for making dangerous bombs.

The man found the mysterious scientists that were caught for making dangerous bombs.

The crowd watched the card of the magician that was shuffled into piles of other cards.

The crowd watched the magician's card that was shuffled into piles of other cards.

The crowd watched the card of the magician that was invited to show his tricks.

The crowd watched the skillful magician that was invited to show his tricks.

The hunters spotted the cubs of the bears that were playing in the national park.

The students saw the computer of the professor that was working to solve economic problems.

The secretary found the memo of the politician that was searching for a black pen.

The boys looked at the guitar of the musician that was walking to a food shop.

The detective stared at the bag of a man that was smoking on a little balcony.

The man saw the booklet of the photographer that was seeking to publish it massively.

Filler Sentences (Partial data. These are the stimuli for other experiments which were conducted in combination with the present study.)

JAPANESE ESL LEARNERS' RELATIVE-CLAUSE ATTACHMENT

The city that the author wrote regularly about was very famous.

The woman hid behind the door yesterday.

The man realized the goal in his life would be far out of reach.

The recent steep rise in prices prohibited the manager from building his factory.

I wonder which car the man bought the radio for two months ago.