L1-L2 asymmetry in animacy effects in the processing of Japanese relative clauses

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Abstract

Using self-paced reading, this study investigated the role of head animacy in the processing of Japanese relative clauses (RCs). Second language (L2) learners whose first languages (L1) are English and Korean, and Japanese native speakers participated. The results showed that for native speakers, inanimate heads diminished the processing difficulty associated with object RCs. However, head animacy did not have an effect on L2 processing. The Korean group showed the subject-object asymmetry but no effect of head animacy. The English group did not demonstrate the effect of RC type or head animacy. The overall pattern of these results suggests that L2 learners of Japanese are not guided by syntactic and lexical-semantic information in the same way as Japanese native speakers. These findings are interpreted within the constraint-satisfaction models (MacDonald et al., 1994) and are further discussed in the light of the research concerning the transfer of L1 processing routines.
The acquisition and the processing of relative clauses (hereinafter RCs) have been investigated thoroughly in the field of second language acquisition (SLA). A well-established result of these studies is that subject RCs are easier than object RCs in English and several European languages (Croteau, 1995; Eckman et al., 1988; Gass, 1979; Hawkins, 1989; Hyltenstam, 1984). However, in the case of second language (L2) studies on RCs from East Asian languages, findings have been inconsistent. One set of studies argues for the subject advantage (Kanno, 2000; O’Grady, Lee, & Choo, 2003); another set of studies provides contrasting results’ (Jeon & Kim, 2007; Ozeki & Shirai, 2007; Tarallo & Myhill, 1983; Yip & Matthews, 2007). These mixed results raise the question of whether additional factors other than extraction type are in effect. While the results from these studies also varied depending on the learners’ first languages (L1s) (Kanno, 2007; Tarallo & Myhill, 1983) and specific task demands (Izumi, 2007), one of the factors extensively discussed in the literature is head animacy (e.g., Ozeki & Shirai, 2007). Recent studies in adult psycholinguistics also suggest that the subject-object asymmetry may be an artifact of the processing disadvantage associated with object RCs with an animate head (Mak, Vonk, & Schriefers, 2002, 2006; Traxler, 2002). Although noun animacy is an important variable to consider with regard to the acquisition and processing of RCs, as it plays a significant role in assigning grammatical and thematic roles (e.g., Jackendoff, 1972), L2 studies on RCs have yet to fully consider how head animacy may or may not interact with the RC extraction type.

Using a self-paced reading task, the present study examines how native Japanese speakers and two groups of L2 learners (an L1 Korean group and an L1 English group) process subject and object RCs when head animacy was manipulated. Furthermore, we investigated whether the patterns of processing employed by the two groups of L2 learners were different from each other and from those of native speakers.
Theoretical accounts of the subject-object asymmetry

Numerous studies have investigated the acquisition and processing of RCs in the field of SLA. These studies have shown that subject RCs, such as (1a), are easier to acquire and comprehend than object RCs, such as (1b). The gap positions are shown by $e$ with co-indexation indicated by $i$.

(1) a. subject RC

The woman$_i$ [that $e_i$ hit the man] called the police.

b. object RC

The man$_i$ [(that) the woman hit $e_i$] called the police.

Findings are robust in English (Eckman et al., 1988; Gass, 1979). It has often been noted that the observed acquisition and processing patterns are in line with Keenan and Comrie’s (1977) noun phrase accessibility hierarchy (NPAH) (subject > direct object > indirect object > oblique > genitive > object of comparison). It was hypothesized that the difficulty of RC acquisition in an L2 would follow the NPAH, based on the role of markedness (e.g., Doughty 1991; Eckman et al., 1988; Gass, 1979). This extension will be referred as the NPAH effect (following Comrie, 2007) in the present study. We also refer to this effect as the subject-object asymmetry interchangeably since the study only concerns subject and object RCs, which have been examined extensively in the previous RC literature.

In one of the earliest L2 studies on RCs, Gass (1979) demonstrated that the accuracy order paralleled the effect predicted by the NPAH except for genitive RCs. Gass argued that learners performed most accurately with subject RCs, and their difficulty with RC constructions
was in line with the prediction by the NPAH. When learners avoided a particular type of RC, they always substituted it with one higher in the NPAH. Subsequent L2 studies provided supporting evidence for the NPAH effect in English (Doughty, 1991; Eckman et al., 1988; Gass, 1979) and other European languages such as Italian (Croteau, 1995), French (Hawkins, 1989) and Swedish (Hyltenstam, 1984), also demonstrating the subject primacy in production frequency (Mellow, 2006).

The success of the predictions of the NPAH effect in SLA naturally leads to the question of why this typological generalization manifests itself in the degree of difficulty in acquisition and processing. Among SLA researchers, many explanations have been advanced to account for the subject-object asymmetry by appealing to differences in syntactic complexities. One such account is the linear distance hypothesis posited by Tarallo and Myhill (1983) and also by Hawkins (1989), which links increases in processing difficulty to increases in linear distance between the gap and its filler. There are different ways to implement this idea, but one way is to count the number of intervening words (constituents). We follow the way to measure the distance discussed by O’Grady et al. (2003). In English, object RCs as in (2b) are predicted to be more difficult than subject RCs as in (2a) because the extraction site is farther from the head noun phrase (NP) than is the case for subject RCs. The number of intervening words is provided in parentheses.

(2) a. subject RC (1 word)
The woman, [that e; hit the man] called the police.

b. object RC (4 words)
The man, [that the woman hit e;] called the police.

Similarly, the structural distance hypothesis (O’Grady et al., 2003) states that the
difficulty of RC processing is determined by the number of syntactic nodes intervening between the head NP and the gap; in other words, how deeply the gap that corresponds to the head NP is embedded. In English, subject RCs involve two syntactic nodes, whereas object RCs involve three nodes as shown in (3). The numbers and the types of nodes are provided in parentheses.³

(3) a. subject RC (2 nodes: CP and IP)
   The woman_{i} [CP that [IP e_i hit the man]] called the police.

b. object RC (3 nodes: CP, IP and VP)
   The man_{i} [CP that [IP the woman [VP hit e_i]]] called the police.

Both the linear distance hypothesis and the structural distance hypothesis suggest that phenomena such as movements result in greater distances (surface distance or structural distance) between head NPs and gaps in object RCs than in subject RCs in English. Therefore, the processor needs to keep track of the filler for a longer period of time and over more words or constituents when processing object RCs, leading to greater processing costs than with subject RCs.

Alongside these two configuration-based hypotheses, Fox and Thompson (1990) offer a third explanation for the NPAH effect in a discourse functional perspective. Analyzing RCs found in native English-speaker conversations, Fox and Thompson found a distributional bias in the extraction type and head animacy. Subject RCs frequently occur with animate head NPs, and object RCs tend to occur with inanimate head NPs. Fox and Thompson account for the distributional patterns on the basis of discourse functions. They argue that inanimate referents need to be grounded by animate referents’ possessing them and/or manipulating them so as to be relevant in discourse (e.g., the shop that John owns). Thus, object RCs with inanimate heads tend to have human referents for thematic agents. Human referents, on the other hand, tend to occur
with subject RCs. Human referents also need to be grounded in discourse; however, human referents are not necessarily thematic objects to be grounded, but can ground themselves by acting on other humans (e.g., *the man that knows John very well*). Similar distributions have recently been found in larger corpus analyses of different languages, such as Dutch, German (Mak et al., 2002; 2006), and English (Roland, Dick, & Elman, 2007).

Recent studies in adult psycholinguistics empirically tested whether such a distribution of RC type and head animacy has an effect on real time processing. Mak et al. (2002) investigated how native speakers of Dutch process sentences that contain RCs. When RC heads had animate referents, their participants took a longer time to read object RCs than they did subject RCs. Nevertheless, when object RCs had inanimate heads, the previously observed processing cost diminished, and there was no difference in reading times between subject RCs with animate heads and object RCs with inanimate heads. To account for these results, Mak et al. argue that inanimate entities are also good candidates for thematic patients or objects in general. The semantic cue in the form of animacy immediately guides the analysis of the RCs supported by the discourse function and following frequency distributions in previous linguistic experience. Similar patterns in the processing of RCs with head animacy manipulations were observed in other languages, such as English (Traxler, 2002), French (Baudiffier, Caplan, Gaonac'h, & Chesnet, 2011), and Spanish (Betancort, Carreiras, & Sturt, 2009).

These observations suggest an interaction between syntactic complexity and head animacy in RC processing. Following the claim of the constraint-satisfaction models of sentence processing, according to which syntactic processing is achieved not only through structural properties, but also through the interaction of semantic, lexical, and discourse-level constrains (MacDonald, Pearlman, & Seidenberg, 1994; McRae, Spivey-Knowlton, & Tanenhaus, 1998;
Tanenhaus & Trueswell, 1995), both structural and semantic factors are predicted to operate in RC processing. In this view, the degree of difficulty in processing is strongly influenced by the frequency in speakers’ linguistic experience (e.g., Gennari & MacDonald, 2008). Therefore, in the case of RC acquisition and processing, one can predict that the difficulties with object RCs observed in previous studies were, in part, due to the fact that the test sentences did not match the object RCs that native speakers and L2 learners had experienced in their input and their own productions. Many L2 studies of RCs have employed animate head NPs for RC heads and for embedded NPs in RCs keeping linguistic conditions as consistent as possible (Aydin, 2007; Kanno, 2000; O’Grady et al., 2003; Tarallo & Myhill, 1983), while other studies have not controlled for animacy (Doughty, 1991; Eckman et al., 1988), as noted by Ozeki and Shirai (2007). The kinds of accounts that have been proposed for the subject-object asymmetry usually regarded processing of subject RCs with animate heads as a baseline condition from which to observe comprehension difficulty in processing of object RCs with animate heads. An infrequent configuration (i.e., object RCs with animate heads) compared against more available and frequent structures (i.e., subject RCs with animate heads) can result in processing disadvantage associated with object RCs with animate heads.

Three accounts summarized above (the linear distance, the structural distance, and the discourse functional accounts) offer different explanations for the subject-object asymmetry and for the animacy effects found in languages with head-initial RCs to be discussed below. The present study aims to investigate how these theoretical accounts extend to RCs in Japanese, where the typological properties, such as being a head-final language and the prenominal position of RCs, render it an important testing ground for the adequacy of these hypotheses. In the next section, we present an overview of literature on Japanese RCs.
Japanese RCs

Japanese RCs have various characteristics that differ from English RCs. The position of the RCs is prenominal, and there are no relativizers to demarcate the beginning of the RC (Kuno, 1973). The words and the word order in structures such as (4a) and (4b) are identical except for the case markers attached to the embedded NPs in the RC, and the two sentence types differ in final sentence meaning. Because of these linguistic properties, the predictions of the linear distance hypothesis and the structural distance hypothesis vary in Japanese. It is predicted that subject RCs are more difficult than object RCs according to the linear distance hypothesis, as in (4).

(4) a. subject RC (2 words)

[ei otokonohito-o tataita] onnanohitoi-ga keisatsu-o yonda.

\(man_{ACC} \text{hit}_{PAST} \ woman_{NOM} \ police_{ACC} \ call_{PAST}\)

“The woman that hit the man called the police.”

b. object RC (1 word)

[onnanohitoi-ga e; tataita] otokonohitoi-ga keisatsu-o yonda.

\(woman_{NOM} \text{hit} \ man_{NOM} \ police_{ACC} \ call_{PAST}\)

“The man that the woman hit called the police.”

The structural distance hypothesis, however, predicts that subject RCs are easier than object RCs in Japanese, as in (5).

(5) a. subject RC (2 nodes: CP and IP)

\([CP \ ei [IP \ otokonohito-o tataita]] \ onnanohitoi-ga keisatsu-o yonda.\)

\(man-ACC \text{hit} \ woman-NOM \ police-ACC \ called\)

“The woman that hit the man called the police.”
b. object RC (3 nodes: CP, IP, and VP)

\[ \text{[CP onnanohito-ga [IP e1 [VP tataita]]] otokonohito-ga keisatsu-o yonda.} \]

woman-NOM hit man-NOM police-ACC called

“The man that the woman hit called the police.”

Interestingly, we already have good evidence from studies on East Asian prenominal RCs that there are empirical complexities in this area. Kanno (2000) observed the NPAH effect in L2 Japanese. Examining how learners of Japanese with L1 English comprehend RCs, Kanno employed a picture selection task and found that participants performed more accurately on subject RCs than object RCs. She interpreted the results to confirm the structural distance hypothesis in Japanese. Corresponding results were obtained in Korean (O’Grady et al., 2003), which shares many characteristics with Japanese: the prenominal position of RCs, postnominal case markers, and SOV word order.

In contrast, some studies that have investigated the acquisition of prenominal East Asian RCs did not necessarily support the predictions of the NPAH. Tarallo and Myhill (1983) cross-linguistically investigated RC acquisition by English-speaking learners who learn different languages. Using a grammaticality judgment task, they found that acquisition of a language with prenominal RCs (Chinese and Japanese) did not follow the predictions of the NPAH, in that learners judged object RCs more accurately than subject RCs, while acquisition of languages with postnominal RCs (German, Portuguese, and Persian) followed the order predicted by the NPAH.

Do Japanese native speakers and L2 learners of Japanese show the same sensitivity to the discourse constraints of RCs in their production? A corpus study in L2 Japanese by Ozeki and Shirai (2007) noted that there was a correlation between type of RC and head animacy, similar to
what has been discussed in Fox and Thompson (1990). Examining a corpus of 90 L2 Japanese learners’ ACTFL (American Council on the Teaching of Foreign Languages) oral proficiency interviews (KY corpus: Kamada, 2006) and a baseline comparison data from Japanese native speakers, Ozeki and Shirai found in their Study 1 that L2 learners demonstrated a strong tendency to associate subject RCs with animate heads and object RCs with inanimate heads. Native speakers of Japanese also produced object RCs almost exclusively with inanimate heads; however, they used subject RCs freely both with animate heads and inanimate heads.

The distributional patterns found in Ozeki and Shirai’s oral production data parallel L2 textbook input. Looking at the types of RCs that are found in seven postsecondary Japanese as a foreign language textbooks, Yabuki-Soh (2013) found that 85.5% of subject RCs analyzed had animate heads and that all of the object RCs identified were accompanied by inanimate heads. Furthermore, Yabuki-Soh also analyzed the compositions written by native speakers of Japanese as baseline data. She found that native speakers also used object RCs predominately with inanimate heads, but that they did not show a strong tendency to associate subject RCs with animate heads. These findings are comparable to those of Ozeki and Shirai. The textbook results from Yabuki-Soh clearly show a correlation between RC types and head animacy found in the crucial components of language input that learners are exposed to, and further suggest that learners’ linguistic experience shapes their production preferences.

In order also to test the effect of animacy in RC processing and acquisition in an experimental setting, Ozeki and Shirai (2007) conducted a sentence-combining experiment (Study 2). Participants were 50 L2 learners of Japanese with L1 Cantonese, and they were given two sentences (e.g., (a) koon-de otokonoko-ga hon-o yondeiru. “A boy is reading a book in the park.” (b) sono otokonoko-wa watasi-no otooto-da. “The boy is my brother.”). Then, they were
asked to combine them using relativization (kooen-de hon-o yondeiru otokonoko-wa watasi-no ototo-da. “The boy who is reading a book in the park is my younger brother” [subject RC with animate head]). The results showed that there was no significant difference between subject RC and object RCs in terms of accuracy. However, examination of the error patterns revealed that participants tended to erroneously produce subject RCs in the place of targeted object RCs and oblique RCs, especially when the RCs had animate heads. That is, when a target is an oblique RC with animate head such as, haha-ga miti-o kiita otokonohito, “the man that my mother asked for directions”, participants produced a subject RC instead, such as haha-ni miti-o kikareta otokonohito, “the man who was asked for directions by my mother” changing the verbs of passivization (p. 186). Ozeki and Shirai interpreted this passivization strategy as evidence that L2 learners found object and oblique RCs more difficult than subject RCs only if the head NP is animate. Furthermore, less proficient learners were not able to produce subject RCs with an inanimate head NP.

Similar results were reported by Jeon and Kim (2007), who analyzed oral production data from L2 learners of Korean and demonstrated that the learners produced numerous errors when they were expected to use an object RC with an animate head; they erroneously produced subject RCs with animate heads instead. Ozeki and Shirai (as well as Jeon and Kim), argue that L2 learners appear to have a bi-directional association of subject RCs with animate heads, and object RCs with inanimate heads, at some point in their linguistic development. As Ozeki (2005) indicated, this may have had an effect on learners’ comprehension performance in some of the previous studies; when learners were asked to judge RCs whose heads and embedded NPs are both animate, they inclined to the subject RC interpretation, because of this animacy association.

It is worth noting that the empirical evidence for the animacy effect is not robust. Both
Ozeki and Shirai and Jeon and Kim based their claims on error analyses and distributions in spontaneous production data. Interpretation of these results needs to be done with caution, because it is not clear how participants’ error and spontaneous speech data can test the construct of processing difficulty, and incorrect responses for an item could be due to various reasons other than processing difficulty. Such processing can be best measured through online processing studies. Recently a growing number of L2 research have employed online methodologies, such as a self-paced reading task or eye-tracking methods (Dussias, 2003; Felser, Roberts, Marinis, & Gross, 2003; Frenck-Mestre & Pynte, 1997; Hoover & Dwivedi, 1998; Juffs & Harrington, 1995; Papadopoulou, 2005; Williams, Möbius, & Kim, 2001). The results obtained from these psycholinguistically-oriented studies inform us about the moment-by-moment operations of the processing mechanism and elucidate the relationship between L2 learners’ grammatical knowledge and processing mechanisms, which cannot be depicted by offline measures alone. If the subject-object asymmetry is a reflection of a processing challenge, and if animacy is an influential factor for RC processing, evidence must be found in online processing measures as well.

**L1 transfer**

Participants of the current study are L2 Japanese learners with L1s of either English or Korean. A brief cross-linguistic description of the linguistic structure of Japanese, English, and Korean will highlight some of the differences in RCs across these languages. Table 1 demonstrates relevant linguistic properties, such as head direction and word order. Whereas English is a head-initial language with SVO word order, Korean is a head-final language with SOV word order, as is Japanese. RCs in Korean are prenominal and there is no relative pronoun. Relativization is
signaled by a set of adnominal verbal suffixes that express the tense of the embedded clause in Korean. These two different learner groups provide us with a testing ground to explore a possible L1 effect. Juffs (2005) argues that when considering L1 transfer in L2 processing, not only L1 grammar but also L1 processing preferences should factor into research. The L1 sentence processing research suggests that the L1 sentence processing routines reflect the structural demands of the L1 (Miyamoto, 2002; Yamashita, 1997).

For L1 and L2 processing routines, the cue-based processing approach from the competition model is the main claim that we draw from to define processing preference in the current study (MacWhinney, 2008). The cue-based processing approach argues that the parser is driven by surface cues such as word order, grammatical markings, prosodic cues, and information about grammatical class. In this view, parsing is the process of searching for candidates to fill the role slots. In English, these slots are generated by verbs (Bates & MacWhinney, 1982). In Japanese, they are generated initially by case-marking postpositions. Adult native speakers of both Japanese and Korean predominately rely on case-markers (Ito, Tahara, & Park, 1993; Kilborn & Ito, 1989). Kilborn and Ito (1989) found that learners of Japanese with L1 English rely more on SOV word order than Japanese native speakers. Since the SOV schema is the canonical word order of Japanese, but not of English, Kilborn and Ito argue that learners apply their L1 predominant cue (i.e., word order) rather than tracking surface constituent orders. Their results suggest that shifting cue reliance from L1 to L2 is difficult, at least at the early stage of learning (see also Sasaki, 1994).

In the case of Japanese RCs, there are limited overt syntactic cues indicating relativization. The surface position of the syntactic gap does not necessarily denote thematic
roles, because one cannot tell if a missing element is a gap, a constituent displaced by scrambling, or an ellipsis (Kuno, 1973). We test whether the Korean learners make use of case-marking cues for processing the L2 Japanese in the same way as they use these cues for their L1 (Y. Kim, 1999) and native speakers of Japanese use them for processing Japanese (Kamide, Altmann, & Haywood, 2003; Yamashita, 1997), whereas English learners need to adjust their dominant cue from the verb-driven and the word order cues, which they use for their L1 to the case-markers in L2 Japanese. The L1 Korean RC structure and the case-marking based processing skill overlap with Japanese and facilitate the emergence of L2 Japanese processing skill in L1 Korean learners of Japanese, whereas the L1 English RC structure and verb-driven processing skill interfere with the emergence of L2 Japanese processing skill in L1 English learners of Japanese.

**Research questions**

This study was designed to investigate online processing of Japanese RCs by L2 learners and native speakers of Japanese and to examine the effect of animacy in RC processing. Based on a review of the literature, three types of RCs were considered relevant for the present study: subject RCs with animate heads, object RCs with animate heads, and object RCs with inanimate heads. The extraction type (subject RCs or object RCs) was manipulated to examine whether the subject-object asymmetry can be observed in the processing of Japanese RCs. The condition with object RCs with inanimate head was included in order to investigate the effect of head animacy in the processing and acquisition of object RCs. Subject RCs with inanimate heads were avoided, because transitive sentences with inanimate agents often involve the causative morphology, -sase or -se, which may result in an additional parsing process and may be too difficult for the L2 learner group tested in this study. Two different learner groups, with L1 Korean and L1 English,
allow us to explore whether L1 effects L2 processing. The major research questions that we explored are the following:

1. Do L2 learners and native speakers of Japanese process subject RCs more easily than object RCs in self-paced reading of sentences involving RCs?
2. Does any difficulty observed in object RCs diminish when the heads of object RCs are inanimate?
3. Is there any difference in the processing of RCs depending on learners’ L1s?

Following the claim of the constraint-satisfaction models of sentence processing, we predict that both native Japanese speakers and L2 learners show less difficulty comprehending object RCs with inanimate heads than object RCs with animate heads, because object RCs with inanimate heads are highly frequent in native Japanese spoken discourse (Ozeki & Shirai, 2007) and in textbook input (Yabuki-Soh, 2013). It is also worth noting that object RCs with inanimate heads are non-reversible, while object RCs with animate heads are reversible. With the cross-linguistic analysis in mind, our assumption is that L1 processing routine of Korean-speaking learners should pose little or no interference or conflict with emerging L2 Japanese processing skill when they process Japanese RCs, whereas the word order and verb-driven processing routine of English-speaking learners is more likely to interfere with L2 Japanese processing. Thus, English-speaking learners need to adjust their processing preference to the use of case-marker-based processing. Because of the major change in the processing routine, it is assumed that English-speaking learners will have more difficulty, and because of that their processing preference is delayed and/or reduced.

Method
Participants

The participants in this study were native speakers of Japanese ($n=17$) and L2 learners of Japanese ($n=37$). Native speakers of Japanese participated to provide a baseline. L2 participants were undergraduate students from a private university in the United States and formed two groups: one with L1 Korean ($n=17$) and one with L1 English ($n=20$). See Table 2 for demographic and language background information of participants.

L2 learners were approximately at the intermediate-low to the intermediate-mid levels in the ACTFL proficiency guidelines (American Council on the Teaching of Foreign Languages, 2012). They were American college students with 240 to 360 hours of classroom instruction or equivalent in Japanese. To assess their functional proficiency in the L2, all L2 participants completed a language background survey designed to tap into several aspects of language proficiency and L2 learning background by self-report (i.e., language dominance, level of proficiency in the four language skills, number of years the L2 was studied, and length of stay in Japan). The questionnaire responses revealed that the L1 English and L1 Korean learners of Japanese had studied Japanese for an average of three years at the time of the experiment. Except for only one participant who spent four months in Japan, the participants’ experience with the Japanese language prior to the current study had been limited almost exclusively to university classroom settings. Separate t-tests were performed on the scores from each group. Except that the Korean group rated their speaking skill significantly higher ($M = 4.829$, $SD = 2.651$) than the English group did ($M = 4.737$, $SD = 1.447$), $t(34) = .124$, $p = .024$, learning experiences and self-rated functional proficiency in writing, listening, and reading are roughly matched between the two L2 learner groups ($p > .083$).
In order to ensure that all L2 participants had the grammatical knowledge to perform the task, we administered a paper-and-pencil grammar test. The test uses a fill-in-the-gap format and covers various case-markers that are relevant to the experiment. An example is given in (6).

(6) 先週、さとうさんがケーキ ( ) を食べた ( ) どこですか。

Last week, Mr. Sato-NOM cake-(case blank) ate shop-(case blank) where is-COP

“Where is the shop where Sato-san ate cake last week?”

There were 20 items in total and there was no time limit. A dichotomous scoring method was used and one point was given for each correct response. Only participants who correctly performed at least 75% of the grammar items were included in the data analysis. As a result, data for one participant from the L1 English group were excluded. On average, the remaining 36 participants scored 89.5% on the grammar task (range: 75% – 100%). There was no statistically significant difference in the scores of the L1 Korean group (\( M = 17.588, SD = 1.839 \)) and the L1 English group (\( M = 18.157, SD = 2.088 \)), \( t(34) = .864, p = .531 \). Results from the questionnaire and the grammar test are presented in Table 2.

**Materials**

The conditions under investigation were: subject RC with animate head, object RC with animate head, and object RC with inanimate head. Examples follow:

(7) a. subject RC with animate head

apaato-de yasashii ruumumeito-o oikaketa kodomo-ga kouen-de hon-o yonda

apartment-LOC kind roommate-ACC chased child-NOM park-LOC book-ACC read

“The child that chased the kind roommate in the apartment read the book in the park.”

b. object RC with animate head
apaato-de yasashii ruumumeito-ga oikaketa kodomo-ga kouen-de hon-o yonda
apartment-LOC kind roommate-NOM chased child-NOM park-LOC book-ACC read
“The child that the kind roommate chased in the apartment read the book in the park.”
c. object RC with inanimate head
apaato-de yasashii ruumumeito-ga yonda zasshi-ga kouen-de ame-de nureta
apartment-LOC kind roommate-NOM read magazine-NOM park-LOC rain-INSTR got-wet
“The magazine that the kind roommate read in the apartment got wet in the park.”

For subject RCs with animate heads and object RCs with animate heads, RC heads and
embedded NPs were always two nouns with the feature [+human] (e.g., man, woman, friend,
roommate). These two nouns are reversible; lexical and pragmatic clues do not suffice to
determine the grammatical role of these NPs. For object RCs with inanimate heads, RC heads
were nouns with the feature [-human], and embedded NPs with [+human], and they were non-
reversible. Verbs that denote transitive actions such as “kick” and “hit” were chosen. The fifth
word (e.g., child in (7a) and (7b), and magazine in (7c)) serves as the head of the RC. At the
head of the RC, readers are required to draw a clause boundary and link the RC to a matrix verb
phrase. This is the critical segment, where we compare whether the reading times differ
dependning on the experimental conditions. The role of the RC within the matrix sentence was
fixed as the subject role. The type of matrix verbs was different; for the subject RC with animate
head and object RC with animate head conditions, RC was the subject of a transitive verb in the
matrix sentence. For the object RC with inanimate head condition, RC plays the subject of an
unaccusative verb in the matrix sentence. This difference should not affect the interpretation of
any effects, because the crucial comparison would be at the RC heads.
It is argued that differences in reaction times among experimental conditions may be observed, not exactly at the position where the sentential conditions differ, but one word or word region later, and this delayed effect is called a spill-over effect (Just, Carpenter, & Woolley, 1982). Previous L2 processing research has observed spill-over effects (Marinis, Roberts, Felser, & Clahsen, 2005). In our experiment, in all conditions, RC heads were followed by the same locative postpositional adverbial phrase (e.g., *in the park* in (7)), which modifies the sentence-final matrix verb. The reading times of this locative postpositional phrase were collapsed with that of the RC head to take into account spill-over effects. Hereafter we call this combined region the critical region. Similarly, reaction times for the beginning of the sentence are usually not an accurate reflection of the actual amount of reading time. To accommodate the initial reading effect, we included a locative postpositional phrase and adjective phrase. These locative postpositional phrases modify the actions in the RCs, and adjective phrases were simple adjectives that describe personal traits (i.e., kind, smart, busy).

The vocabulary used in all experimental items was basic, and was all drawn from the textbook used in the first year Japanese courses at the university where the study was conducted in order to ensure that the participants would be familiar with the words in the target sentences. Also, all the stimuli were written in Japanese phonograms (hiragana and katakana) in order to eliminate the possibility of slowdown due to an additional word recognition process required in kanji (Chinese character) reading or kanji accompanied by furigana, the pronunciation guide phonogram (hiragana) characters.  

Sixty target sentences, 20 per condition, were then presented in a pseudorandomized order along with 68 filler items (53% of experimental items) belonging to a different experiment in order to divert the participants’ attention from the objective of the experiment. These
distractor sentences are similar to the experimental stimuli in length and in complexity, such as ditransitive constructions and associated scrambling (e.g., *kireina onnanohito-ga nemui okyakusan-ni iyaiya keeki-o hakonda*; beautiful woman-NOM sleepy customer-DAT cake-ACC unwillingly served; The beautiful woman unwillingly served the sleepy customer the cake).

**Procedure**

Participants performed the non-cumulative self-paced reading task and read sentences word-by-word (Just et al., 1982). A stimulus sentence initially appeared as a row of dashes, and participants were instructed to press a button to reveal each subsequent word of the sentence. When participants pressed a button, the first word appeared, replacing the corresponding dashes. When participants pressed the button again, the first word reverted to a dash, and the second word appeared in place of the corresponding dash. In this way, each subsequent button-press revealed a new word and removed the preceding word. The time between two button-presses was recorded as the reading time for each word. The experiment was conducted with the E-Prime program running on a Windows computer (Schneider, Eschman, & Zuccolotto, 2002). Sentences were followed by comprehension questions in order to avoid participants’ pressing the button blindly. Questions in yes-no format asked participants to identify various parts of the sentence. These questions were to be judged, half of them as yes and the other half as no. No feedback was given. The experiment took approximately 15–20 min for native speakers of Japanese to complete and 20–25 min for L2 learners.

**Analysis**

Accuracy rates on the comprehension questions following the experimental items from
the self-paced reading task were calculated in order to judge whether participants paid attention during the self-paced reading task and were able to comprehend the target sentences. The L2 learners with L1 English scored 62.1% ($SD = 6.7$), learners with L1 Korean scored 69.6% ($SD = 11.74$) and the native speakers 77.2% ($SD = 7.0$). For the reading time data, only sentences for which participants correctly answered the comprehension questions were analyzed. Reading times were discarded if they were three standard deviations away from the mean for each word position in each experimental condition. All other things held constant, reading times are subject to word length and to individual differences in reading speed. Residual reading times were derived for each word on the basis of a linear regression equation that computes reading time for each individual as a function of word length. Thus, a participant’s residual reading time for a given word of length expresses how fast that word was read compared to that participant’s average reading time for other words of length. A negative residual reading time means a comparatively fast reading time. This practice of using residual reading times effectively reduces variability due to individual differences in reading times (Ferreira & Clifton, 1986). In this paper, where we report statistical comparisons, only the residual reading times are considered.

**Results**

We analyzed the critical region involving the RC heads where syntactic disambiguation takes place, and the critical region also included the following locative postpositional phrase. In order to find a baseline pattern of results, we analyzed the native speaker group separately from two L2 learner groups. For the native speaker group, a one-way within-subject analysis of variance (ANOVA) was performed on the reading times of the critical region as a function of extraction types: subject RCs with animate heads, object RCs with animate heads, and object RCs with
inanimate heads. There was a significant difference on the native speakers’ reading times among the types of RCs, \( F(2, 30) = 14.20, p < .001, \) partial \( \eta^2 = .48. \) In order to find the pattern of differences on the reading times among the types of RCs, post hoc pair-wise analyses were performed using the Bonferroni adjustment. Object RCs with animate heads were read more slowly \( (M = 200.56 \text{ ms}, SE = 34.39) \) than subject RCs with animate heads \( (M = 74.15 \text{ ms}, SE = 30.10) \) and object RCs with inanimate heads \( (M = -29.14 \text{ ms}, SE = 35.64), p = .005 \) and \( p < .001, \) respectively. There was no significant difference between subject RCs with animate heads and object RCs with inanimate heads \( (p = .16). \) The native speakers’ results suggest that processing Japanese RC is affected by the NPAH if RC heads are animate, but head animacy play a role in processing object RCs.

Turning next to the results from the L2 learner groups. For the English group, we performed a separate one-way ANOVA. There was no statistically significant difference in the reading times of the critical region depending on three extraction types, \( F(2, 36) = 1.281, p = .290, \) partial \( \eta^2 = .066. \) For English group, different types of RC structure did not result in different processing performance. For the Korean group, a separate one-way ANOVA was performed on the reading times. There was a significant difference on the reading times from the critical region as a function of the extraction type, \( F(2, 32) = 4.521, p = .019, \) partial \( \eta^2 = .220. \) In order to find the pattern of differences on the reading times among the types of RCs, post hoc pair-wise analyses were performed using the Bonferroni adjustment. Subject RCs with animate heads \( (M = -70.513 \text{ ms}, SE = 50.798) \) were read significantly faster than object RCs with animate heads \( (M = 255.746 \text{ ms}, SE = 116.720, \) respectively), and than object RCs with inanimate heads \( (M = 114.018 \text{ ms}, SE = 66.845), p < .037. \) There was no other significant difference, \( p > .959. \) The three participant groups’ processing patterns are plotted in Figure 1.
The results from the self-paced reading experiment have shown that object RCs were more difficult to process than subject RCs for the native speaker group and the Korean group. However, the English group did not show the same pattern. The different RC types did not affect the L1 English group’s reading times on the critical region. Animacy had an effect on the processing of object RCs by native speakers, but not by either of the L2 learner groups. The results can be summarized as follows (> indicates significantly faster processing time):

Native speakers: Subject RC-animate = Object RC-inanimate > Object RC-animate
L1 Korean: Subject RC-animate > Object RC-inanimate = Object RC-animate
L1 English: Subject RC-animate = Object RC-inanimate = Object RC-animate

Discussion

The goals of the present study were to investigate whether object RCs are more difficult to process than subject RCs in Japanese and to examine whether head animacy affects the processing of RCs by two groups of L2 learners (with L1 English and L1 Korean backgrounds) and by a baseline group of Japanese native speakers. By comparing the processing patterns demonstrated by these participant groups, we investigated whether L2 learners’ processing patterns are similar to that of native speakers, and whether learners’ L1 have an effect on their processing.

The first research question asked whether Japanese native speakers and L2 learners process subject RCs more easily than object RCs. The results showed that native speakers demonstrated greater processing difficulty in object RCs with animate heads than subject RCs with animate heads. These results are in line with previous studies that demonstrated the subject-
object asymmetry by native speakers of Japanese when two protagonists were both animate (e.g., Miyamoto & Nakamura, 2003). The results from the Korean group demonstrated the subject-object asymmetry as identified in previous L2 studies, when RC heads were animate NPs (e.g., Kanno, 2000; O’Grady et al., 2003). However, the processing patterns of the L1 English group were different from those of native speakers and from learners with L1 Korean; they did not exhibit a significant effect of extraction type on the reading times.

The second research question asked whether any difficulty observed in object RCs diminished when the heads of object RCs are inanimate. Native speakers demonstrated significantly slower reading times when processing object RCs with animate heads compared to subject RCs with animate heads, but such a difference in processing difficulty between subject RCs and object RCs disappeared when object RCs were headed by inanimate NPs. Our results demonstrated that the animacy manipulation of the RC head clearly had an effect on processing of Japanese RCs by native Japanese speakers, providing supporting evidence for the effect of animacy on object RCs addressed in recent RC studies in other languages (e.g., Mak et al., 2002).

In line with the correlations between extraction type and head animacy identified in the analysis of spoken (Ozeki & Shirai, 2007) and written (Yabuki-Soh, 2013) discourse, our results demonstrated that the observed correlation fits with the processing ease associated with object RCs with inanimate heads for native Japanese speakers.

In contrast, the animacy of the head did not have an effect on the processing of object RCs by either L2 learner group. We predicted that L2 learners would make great use of the animacy information when processing object RCs with inanimate head, as it is argued that learners associate object RCs and inanimate heads (Jeon & Kim, 2007; Ozeki & Shirai, 2007) and learners find it easier to process non-reversible RCs (Kanno, 2007). Our results showed,
however, that neither group showed such facilitative effect of animacy in processing object RCs.

The third research question asked whether there is any difference in the processing of RCs depending on learners’ L1. By comparing two groups of L2 learners whose L1s have different linguistic profiles and processing preferences (i.e., word order, position of RCs, and processing cues), our results show that L2 learners’ processing patterns varied depending on their L1s. While the English group did not show the subject-object asymmetry, the Korean group did. Provided that functional proficiencies of both groups were matched, we argue that learners with L1 Korean are able to rely on transfer, and they achieve comparatively nativelike processing for subject and object RCs with animate heads. The absence of the subject-object asymmetry in the English group suggests that the learners have difficulty integrating linguistic elements into an appropriate structural representation in real time processing, and therefore have to resort to non-nativelike strategies. It is important to note that we only analyzed the sentences for which participants answered comprehension question correctly, and thus it is safe to say that they understood the thematic role relationships of the sentences correctly. Therefore, the issue appears to reside in parsing sentences in real time. Without the appropriate structural representation constructed in real time processing, the differences in the structural complexity between subject RCs and object RCs cannot manifest itself in the reading times. The differences in the processing patterns between the two L2 groups suggest that the transfer and/or interference of the L1, or more specifically, of the L1 processing routines, influences the emergence of L2 Japanese processing skills.

In evaluating the implications of these findings, we return to the three hypotheses reviewed earlier. The linear distance hypothesis, which predicts that object RCs are easier to process than subject RCs in Japanese, cannot account for the pattern of the data obtained from
our native speaker participants. The structural distance hypothesis predicts that subject RCs are easier to process than object RCs. The results from the native speakers and learners with L1 Korean are partially consistent with the structural depth hypothesis in that subject RCs with animate heads are easier to process than object RCs with animate heads. However, these two configurational accounts do not offer reasons why processing difficulty should be reduced when object RCs have inanimate heads. The prediction derived from Fox and Thompson’s discourse function account for RCs assumes that subject RCs with animate heads and object RCs with inanimate heads are easier to process, whereas object RCs with animate heads are difficult to process because that configuration is rare in natural language use. This observation is consistent with our finding from native Japanese speakers in that they have more difficulty processing the animate referent as the object of the RC, and therefore as a thematic patient. Hence our findings are compatible with this aspect of the discourse functional account for RCs.

Fox and Thompson argue that that the distribution of RC type and head animacy is derived from the fact that subjects refer to given and generally animate entities, and that objects tend to be inanimate, because they are associated with certain thematic roles (e.g., Du Bois, 1987; Jackendoff, 1972). In a prototypical transitive clause, the subject functions as an agent of an action that affects the entity encoded in the direct object. For this reason, even when it is relativized, readers still prefer to interpret the head of RC to be a thematic agent in subject RCs. In contrast, comprehenders experience a surprise effect when the head of the object RC is animate, since the animate NP is a poor candidate for thematic patient/theme (MacWhinney & Pleh, 1988). Note, however, that the “degree of goodness” for thematic agent and patient varies depending on the relationship between verbs and their arguments (Levin & Rappaport-Hovav, 2005). Looking into the properties of the verb in RCs in the experimental items in the current
study, we will now discuss the different types of processing cost resulting from the relationship between heads and RCs. In doing so, we will base our reasoning on the claim of the constraint-satisfaction models for sentence processing, as the models offer insight into processing difficulties with respect to the competitions among multiple structures.

Because Japanese is a head-final language and its RCs are in the prenominal position, on reading an RC head, readers are required to link the head with the RC that they read prior to the head. In this linking, the information posed by the embedded NP (NP in the RC) and the RC verb determines which grammatical role the RC heads are taken to play. In (8a), for subject RCs with animate heads, Japanese readers anticipate that an agent of the verb is relativized. The sequence of *otokonohito-o mita* ‘man-ACC saw’ is most likely interpreted as a part of the agent-patient of an event and the agent is relativized. It is likely that an animate entity, yet-to-be-read relativized NP saw another animate entity (i.e., “man-ACC”), but an inanimate referent cannot see an animate entity, and it is quickly processed as such when they arrive at the head in (8b).

(8) a. subject RC fragment

*otokonohito-o mita …*

*man-ACC saw …*

b. subject RC

*otokonohito-o mita onnanohito-ga….*

*man-ACC saw woman-NOM*

“The woman that saw the man…”

In contrast, when processing a fragment from an object RC as in (9a), readers interpret the sequence of “man-NOM” - “saw” as the agent-theme frame as in (9b), or the agent-patient frame as in (9c).
Thus, the interpretations from the agent-theme frame and from the agent-patient frame compete with each other when the comprehenders read the RC verbs in object RCs. More competing structures result in more uncertainty, which consumes processing resources (e.g., Gennari & MacDonald, 2008). Processing difficulty in object RCs with animate heads may stem from the activation of competing structures. By nature, most of Japanese transitive verbs that take animate referents as thematic patients can normally also take inanimate referents as themes (e.g., miru “see”, as shown in (9a) and (9b)). In fact, in our object RCs with animate head conditions, all 15 verbs used in the experiment can take both patient and theme arguments; 12 of them take both patients and themes equally well in the same meaning (e.g., keru “kick”; tatak "hit”) and 3 of them often take patient arguments (e.g., ijimeru “bully”; homoeru “praise”), but they can also take theme arguments although the precise meanings of the verbs may change (e.g., karada-o ijimeru; body-ACC bully “to trains one’s body rigorously”). In the case of object RCs
with inanimate head, however, the sequence man-NOM read as in (10a) is typically interpreted as a part of an agent-theme frame, and the comprehenders expect an inanimate entity to follow as the theme of the verb, *read* as in (10b).

(10) a. object RC fragment
   otokonohito-ga yonda…
   man-NOM read…

b. object RC with inanimate head
   otokonohito-ga yonda hon-ga yabureta.
   man-NOM read book-NOM tore
   “The book that the man read tore.”

In object RCs with an inanimate head, it is often the case that RC verbs can take only an inanimate theme, which reduces the number of alternative interpretations associated with the event role of the preceding embedded NPs. In our experimental items, all the verbs that were used in this condition can only take inanimate theme (e.g., *yomu*, “read”; *kau*, “buy”; *taberu*, “eat”; *nomu*, “drink”). In addition, because animate NPs can play more event roles than inanimate NPs (Gennari & MacDonald, 2008), we expected that animate-head object RCs would show more competing analyses than inanimate-head object RCs.

The fact that we observed the effects of animacy in native Japanese speakers’ processing but not in two L2 learner groups is interesting, because it points to a possible source of L1-L2 processing differences. Contrary to the previous studies showing L2 learners’ association to head animacy (Ozeki & Shirai, 2007), our results from L2 learner groups showed no effect of animacy. Why, then, are learners not sensitive to animacy? The answer may lie in limited resources. As we indicated above, the English group may have failed to construct appropriate structural
representations during real time processing. However, for the Korean group, it could be the case that they had difficulty immediately integrating the selectional restriction information posed by a RC verb as we discussed earlier, and thus they might not be able to anticipate what classes of RC head NPs (i.e., animate referents or inanimate referents) would follow an RC verb as efficiently as native speakers do. As a result, they appeared to depend on the direct case-role assignment alone guided by case marker information, leading to the presence of the subject-object asymmetry in their processing. This is interesting especially because it was expected that the learners with L1 Korean would benefit from their L1 Korean linguistic properties and processing routines.

Given the results from the current study and following the claim of the constraint-satisfaction model of processing (e.g., MacDonald et al., 1994), we further propose that the differences in L1 and L2 processing are at least partially due to limitations on L2 learners’ available resources with respect to computing alternative competing structures in real time. We argue that L2 learners, who do not have the same processing resources available as native speakers, may not compute alternative structures (i.e., the agent–theme frame vs. the agent–theme frame for object RC with animate head) fully but rather fall back to one single interpretation (i.e., the agent–patient frame for any object RCs). The constraint-satisfaction models predict that object RCs with inanimate heads are easier to process than object RCs with animate heads, because fewer alternative structures need to be computed as the selectional restriction information of verbs inform the processor to thin out alternatives. However, L2 Korean learners in this study processed object RCs with inanimate heads as slowly as object RCs with animate heads. This result suggests that they may not compute and evaluate alternative structures in the same way as native speakers. Of course, our data alone do not provide
independent evidence for L2 learners’ non-nativelike activation of competing structures and its relation to their processing resources. Since the constraint-based models assume that alternative interpretations are partially activated as a function of their frequency in language input, it is therefore important for future studies to investigate different interpretations that readers compute as RCs unfold, using for instance a sentence completion task similar to Gennari and MacDonald (2008).

Several important limitations of the present study require attention. The study suggests that in RC processing, a similarity between L1 and L2 processing routines is an advantage at least at the structural level, but this suggestion must be treated with caution. Because of the overall similarity of the two languages, L1 Korean learners of Japanese probably benefit from the L1-based strategy in learning Japanese in general (Koda, 1989). Although our grammar test did not reveal statistically significant differences in performance between two L2 groups, this test was not designed to measure learners’ overall proficiency in Japanese, but only to ensure that participants were proficient enough to perform the experimental task. In future work, the role of L1 calls for careful research with the participant groups with a matched proficiency assessed by more sensitive and standardized language tests, in order to investigate what particular types of L1 information or processing routine are active and interact with L2 processing skill independently. Further, it is possible that the role of L2 learners’ proficiency in determining the sort of results found here may be limited to a particular proficiency level. We only tested one group of Japanese learners, intermediate-level classroom learners. The pattern of results may differ in the case of learners with higher proficiency. Investigating the developmental trajectory in the use of animacy information will require further research with learner groups of various proficiency levels. A comparison of these L2 learners would reveal whether fundamental
differences in processing subside with increasing proficiency and whether L1 properties instantiate themselves differently as a function of proficiency.\(^6\) We believe such comparisons would provide additional understanding of L2 processing mechanisms and developmental trajectory of L2 processing mechanisms. Finally, despite the advantages that a self-paced reading task demonstrates, the RC-head animacy relationship should be tested via other methodologies to examine whether a task effect exists (Izumi, 2007).

**Conclusion**

In the current study, we examined the online processing of Japanese RCs by two groups of L2 learners (L1 Korean or L1 English) and native speakers of Japanese. The results showed that the native speakers of Japanese processed subject RCs more easily than object RCs when RC heads are animate. However, the processing cost in the object RCs diminished when heads were inanimate, and native speakers processed object RCs with inanimate heads as fast as subject RCs with animate heads. The L2 learners, however, showed a different pattern of results; the patterns of processing by the English group did not differ according to RC type or head animacy, whereas the Korean group depended more on the structural information, namely case makers, leading to the demonstration of the subject-object asymmetry, yet their processing performance was not affected by animacy. These findings suggest that incremental integration of multiple sources of information, such as structural and lexical semantic information, may not easily be achievable by intermediate-level learners. The current study shows that L2 speakers (the Korean group) can demonstrate the subject-object asymmetry in a similar way to native speakers only where animate heads were concerned. Nevertheless, their ability to employ nativelike processing strategies may remain inadequate with respect to the lexical semantic domain. Therefore, these
results underscore the difficulty in integrative processing, specifically, integrating lexical semantic and structural information in real time processing of Japanese.
Notes

1 An earlier study, Schachter (1974) used an elicited composition task, and found that L1 Arabic and L1 Farsi learners produced more RCs than did L1 Japanese and L1 Chinese learners of English. Schachter argued that these differences in the production of RCs were due to the L1-L2 differences in branching direction.

2 Gass (1979) found that her L2 learner performed genitive RCs with the second highest accuracy, following subject RCs. The extraction site in the genitive RC relativization varies depending on the phrase structure position of the possessed NP (e.g., the woman whose daughter went to school; the woman whose name we know). Gass herself pointed out (also pointed out by Hamilton (1995); Ozeki & Shirai (2007)) that most of the genitive RCs in her task involved possessed subject RCs and object RCs.

3 Inflectional abbreviations used in this paper: NOM, nominative case; ACC, accusative case; DAT, dative case; LOC, locative case; PAST, past tense; COP, copula. Phrase structure abbreviation CP corresponds to complementizer phrase, IP corresponds to inflection phrase, and VP corresponds to verb phrase.

4 The measurement of proficiency plays an important role in the interpretation and the comparison of results from the L2 groups. However, existing proficiency measures (e.g., Japanese Language Proficiency Test) in Japanese are labor-intensive and time-consuming and they may not necessarily be practical for L2 processing studies. The cloze test used was one simple way to exclude data from L2 learners, whose grammatical knowledge does not reach the level of comprehending RCs.

5 When difficult, ambiguous, or rare kanji characters are presented in text, furigana are often used to assist the reader. We considered this option; however, furigana usually takes the
form of hiragana characters printed above using a smaller font or to the side of the kanji, as in

大学 or 大学（だいがく）, ‘university’, which could introduce variations in the reading times.

Furthermore, the nature of furigana processing is largely under-researched. Thus, we opted for presenting the test materials all in kana.

6 Our comprehension questions asked participants to identify various parts of the sentences, such as the agent of the RCs, the agent of the matrix clauses, and adverbial phrases. Identifying thematic roles between reversible referents is not easy, and some previous studies reported comprehension accuracy rates of learners with highly advanced proficiency can be low. Our L2 learner participants were intermediate-level learners, and thus it is possible that they have had a difficulty answering some of the comprehension questions in real time; especially because when they were asked to answer these questions they were not able to go back to check the experimental stimuli.

7 The results were different for the statistical tests that were performed on raw reading time. The large variance diminishes the effect: There was no significant difference in reading time across experimental conditions in L2 groups, $F(2, 36) = .580, p = .565$; $F(2, 32) = 2.606, p = .089$, L1 English group and L1 Korean respectively.

8 We thank an anonymous reviewer for pointing out this possibility.
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University Press.


Table 1

*Languages under Consideration and their Structural Properties*

<table>
<thead>
<tr>
<th>Language</th>
<th>Word order</th>
<th>Position of RC</th>
<th>Head direction</th>
<th>Processing cue</th>
</tr>
</thead>
<tbody>
<tr>
<td>Japanese</td>
<td>SOV</td>
<td>Prenominal</td>
<td>Head-final</td>
<td>Case marker</td>
</tr>
<tr>
<td>Korean</td>
<td>SOV</td>
<td>Prenominal</td>
<td>Head-final</td>
<td>Case marker</td>
</tr>
<tr>
<td>English</td>
<td>SVO</td>
<td>Postnominal</td>
<td>Head-initial</td>
<td>Word order</td>
</tr>
</tbody>
</table>
Table 2

*Language Background Questionnaire Data from L2 Participant*

<table>
<thead>
<tr>
<th>Measures</th>
<th>L1 English (11 males, 9 females)</th>
<th>L1 Korean (9 males, 8 females)</th>
<th>t</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (years)</td>
<td>21.053 2.248</td>
<td>20.176 1.551</td>
<td>1.377</td>
<td>.787</td>
</tr>
<tr>
<td>Years of study (years)</td>
<td>2.500 1.027</td>
<td>3.647 3.180</td>
<td>0.165</td>
<td>.071</td>
</tr>
<tr>
<td>L2 immersion experience (months)</td>
<td>0.316 1.376</td>
<td>0.235 0.970</td>
<td>0.165</td>
<td>.719</td>
</tr>
<tr>
<td>L2 speaking</td>
<td>4.737 1.447</td>
<td>4.824 2.651</td>
<td>0.180</td>
<td>.024</td>
</tr>
<tr>
<td>L2 listening</td>
<td>5.263 1.910</td>
<td>5.824 2.186</td>
<td>0.488</td>
<td>.488</td>
</tr>
<tr>
<td>L2 reading</td>
<td>5.316 1.600</td>
<td>5.176 1.845</td>
<td>0.818</td>
<td>.818</td>
</tr>
<tr>
<td>L2 writing</td>
<td>4.947 1.393</td>
<td>4.882 1.409</td>
<td>0.913</td>
<td>.913</td>
</tr>
<tr>
<td>Grammar score</td>
<td>18.211 1.988</td>
<td>17.588 1.839</td>
<td>0.531</td>
<td>.247</td>
</tr>
</tbody>
</table>

*Note.* Reading, writing, listening and speaking ability were rated on a 10-point scale where 1 indicates the lowest and 10 indicates the highest level of ability.
Figure 1. Residual reading times in the critical region as a function of experimental conditions. L1 English, L1 Korean and Japanese native speakers. SR, subject relative clause; OR, object relative clause. * $p < 0.05$. 