

Experience and the Processing of Relative Clauses by Korean Learners of English

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1. Introduction

Previous research on sentence processing by monolingual speakers of English shows that object relative clauses (object RCs; as in [1b]), are harder to comprehend than subject relative clauses (subject RCs; as in [1a]). A possible explanation for this difficulty is that the greater distance between the “filler” (e.g., *the novelist* in [1]) and the “gap” (indicated by underscores) makes object RCs more difficult than subject RCs for reasons relating to processing and memory cost (Gibson, 1998; Gordon, Hendrick, & Johnson, 2001; King & Just, 1991).

- (1) a. The novelist_i that ______j admired the poet **wrote** two masterpieces last year.
b. The novelist_i that the poet admired ______j **wrote** two masterpieces last year.

For example, King and Just (1991) found that processing of object RCs required greater working memory than processing of subject RCs. In particular, monolingual speakers of English with higher working memory capacity read significantly faster in the vicinity of the main verb (e.g., *wrote* in [2b]) than those with lower working memory capacity. Gibson and his colleague (Gibson, 1998; Grodner & Gibson, 1995) also suggested that the greater number of intervening words between the filler and the gap in object RCs makes them more difficult to process than subject RCs.

However, other researchers (Gennari & MacDonald, 2008; MacDonald & Christiansen, 2002; Wells, Christiansen, Race, Acheson, & MacDonald, 2009) have pointed to the role of experience in processing, noting the rarity of patterns such as (1b) in which the direct object RC has an animate head, as well as the fact that object RCs manifest an OSV-like word order. In other words, subject RC constructions that display a word order pattern similar to simple transitive sentences, i.e. an SVO-like word order, are easier to process than object RC structures that have an OSV-like word order. If this is the case, performance on sentences with object RCs such as (1b) should improve in response to additional experience of the right type. This suggestion is supported by empirical research on first language (L1) sentence processing (MacDonald & Christiansen, 2002; Wells et al., 2009). For example, Wells and his colleagues examined the role of experience in the processing of relative clauses. In their study, two groups (with a total of 97 native speakers of English) completed a pre-test, two input enhancement sessions, and a post-test. The group receiving relevant experience demonstrated a decrease in reading speeds that was greater for object relative clauses than for subject relative clauses, whereas the group receiving irrelevant input did not. The group receiving experience with subject and object RCs read significantly faster at the main verb of object RCs (e.g., *wrote* as in [1b]) in the post-test than in the pre-test. This finding implies that the infrequent structure of object relative clauses causes processors greater difficulty with object relatives. Although there is some evidence supporting the positive effect of input enhancement on native speakers, the effect of such input enhancement has never been investigated for second language (L2) sentence processing. To address this lack, the present study examined the hypothesis that the more exposure to relevant input

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L2 learners have, the better they will process object relative clauses. Specifically, the study addresses two research questions.

- 1) Will L2 learners' comprehension of object relative clauses improve in response to enhanced input?
- 2) Will L2 learners' exposure to enhanced input lead to a decrease in processing speed (as measured by reading times)?

2. The study

2.1. Participants

Forty native speakers of Korean, all undergraduate students and second language learners of English at Korea University in Seoul, participated in this study. They received compensation for their participation in four sessions. At the time of the study, they were all high-intermediate learners of English with average TOEIC scores of 862 out of 990.

2.2. Materials

2.2.1. Materials for the pre-test and post-test

For the self-paced reading pre- and post-tests, 32 pairs of sentences with subject and object RCs were manipulated. All the words in a given pair remained the same for both sentences; the only difference was the word order, as in Table 1. The main verb (e.g., *wrote*), which immediately followed the RC, was always the seventh word in the sentence. The material after the main verb contained four words; for example, an object of the main verb (e.g., *two masterpieces*) and an adverb phrase (e.g., *last year*). Each experimental sentence contained 11 words. The semantic bias of embedded verbs (e.g., *admired*) in all sentences was manipulated, such that the two animate nouns were reversible; for example, in Table 1's sentences, it is semantically feasible that the poet could admire the novelist and vice versa. Region 7 (*wrote* in Table 1) is called the critical region because it is where the processor looks for the original position (the gap) of the filler (*the novelist* in Table 1); the critical region is where the relative slowdown in reading time is expected to appear because of an increase in the processing load.

Table 1. Sample items in the pre-test and post-test

Conditions	Regions										
	1	2	3	4	5	6	7	8	9	10	11
Subject RCs	The	novelist	that	admired	the	poet	<i>wrote</i>	two	masterpieces	last	year.
Object RCs	The	novelist	that	the	poet	admired	<i>wrote</i>	two	masterpieces	last	year.

Sixty-four fillers not containing relative clauses were constructed to be similar in length and syntactic complexity to the experimental sentences; they included 32 conjoined sentences (e.g., *Todd questioned the teacher and left the classroom for another job*) and 32 bi-clausal sentences (e.g., *Sandra moved a cabinet because the office was crowded with chairs*). Each list for the pre-test and post-test contained 16 sentences containing relative clauses (8 subject RCs and 8 object RCs), along with 32 fillers (16 conjoined constructions and 16 bi-clausal constructions). Thus, participants read 48 sentences in each test. After reading each sentence, participants were asked to answer a yes/no comprehension question. The ratio of yes/no answers was counterbalanced.

2.2.2. Materials for the input enhancement sessions

In order to test the role of experience in processing RCs, two sets of stimuli were developed: one set for the Relative Clause group and the other for the Control group. The stimuli for the Relative Clause group consisted of 64 subject relative clauses and 64 object relative clauses as in Examples (a)

and (b) in Table 2, along with 64 complex filler sentences not containing relative clauses (e.g., *Unless a patient takes his medicine regularly, he is unlikely to make fast progress toward full recovery.*). Considering L2 learners' limited lexicon, some relative clause sentences were taken from popular English grammar textbooks used in Korea. In addition, some words were replaced with items that were more likely to be comprehensible to the participants. The length of the subject and object relative clauses was variable.

Table 2. Sample items for input enhancement sessions

Conditions	Input Enhancement Sessions
Subject RCs	a. The circus performer that entertained the audience did some new tricks during the break.
Object RCs	b. The plumber that the electrician helped retired after twenty years on the job.
SCs	c. Recent estimates show that there are more than two million bird-watchers in the United States.
CSs	d. The circus performer entertained the audience and did some new tricks during the break.

Note. SCs = sentential complement sentences; CSs = conjoined sentences.

The stimuli for the control group consisted of 64 sentential complement sentences (SCs) and 64 conjoined sentences (CSs), as in Examples (c) and (d) in Table 2, along with the same 64 fillers used in the Relative Clause group's stimuli. The sentential complement sentences were taken from English grammar textbooks used in Korea, and the conjoined sentences were adapted from sentences in the Relative Clause group's stimuli; 64 relative clause sentences used for the Relative Clause experience group were reformulated as conjoined sentences. For example, the subject relative clause sentence, *The circus performer that entertained the audience did some new tricks during the break* was reformulated as the conjoined sentence, *The circus performer entertained the audience and did some new tricks during the break*. Thus, the two sets of materials for the input enhancement sessions differed in terms of sentence structures, but were similar in their topics and content words.

While the pre-test and post-test used a self-paced reading paradigm with yes/no comprehension questions, the input enhancement sessions used a true/false judgment task. After reading a sentence, participants were asked to judge whether a statement was true or false based on the information in the sentence. The number of true/false answers was counterbalanced.

For these sessions, four lists were created for each group. Two lists were presented in each of the two input enhancement sessions. For the Relative Clause group, each list included 16 subject relative clause sentences, 16 object relative clause sentences, and 16 fillers. For the Control group, each list included 16 sentential complement sentences, 16 conjoined sentences, and 16 fillers. In total, each participant read 192 sentences (64 subject relative clauses, 64 object relative clauses, and 64 fillers) before and after a test.

2.2.3. Proficiency and language background questionnaire

Each participant completed a C-test and a language background questionnaire; the information thus gathered allowed the study to control for participants' English proficiency. I adapted the C-test used in Schulz's (2006) dissertation. The C-test used for this experiment consisted of 40 items, each consisting of half of a word plus a blank. The highest possible score was 40. Participants whose scores were between 40 and 27 were classified as advanced, and those whose scores were from 27 to 16 were classified as intermediate.

2.3. Procedure

Forty learners of English participated in four sessions on separate days (with at least three days between sessions) as in Table 3. Participants read 16 subject RCs and 16 object RCs with 64 fillers in Session 1 (the pre-test) and Session 4 (the post-test) in a word-by-word self-paced paradigm. During Sessions 2 and 3, half the participants, who had been randomly assigned to the Relative Clause group,

read 64 subject RCs and 64 object RCs with 64 fillers. The other half, randomly assigned to the Control group, read 64 sentential complement and 64 conjoined sentences with 64 fillers. All participants were given feedback on accuracy during the input enhancement sessions.

Table 3. Experimental Procedure

Experience Group	Sessions			
	1	2	3	4
	Pre-test	Input Enhancement	Input Enhancement	Post-test
Relative Clause	Relative Clauses	32 SRs, 32 ORs, 32 Fillers	32 SRs, 32 ORs, 32 Fillers	Relative Clauses
Control	Relative Clauses	32 SCs, 32 CSs, 32 Fillers	32 SCs, 32 CSs, 32 Fillers	Relative Clauses

Note. SRs= subject relatives, ORs=object relatives, SCs= sentential complement sentences, CSs = Conjoined sentences.

The C-test and language background questionnaire were administered in the first sessions. Participants were informed that they would be shown the first half of a number of words and that they would be given 10 minutes to complete all the words. Following the C-test, they were asked to fill in the language background questionnaire. Each session took approximately 30 to 40 minutes.

2.4. Results

All participants in both groups successfully completed their respective input enhancement sessions (i.e., implicit learning). Analyses were conducted on comprehension task response accuracy and reading times as dependent measures. All data from participants whose accuracy was less than 75% were excluded. Six participants (three in the Relative Clause group and three in the Control group) were excluded, leaving 34 participants' data to be included in the analysis. Participants' background and English proficiency are shown in Table 4.

Table 4. Participants' language background and English proficiency

Experience Group	M:F ratio	Mean Age	C-test (40)	Length of Instruction in English (years)	Converted TOEIC Score (990)
Relative Clause	3:14 (N=17)	21.45	22.29 (5.65)	9.76	862 (100.31)
Control	4:13 (N=17)	22.35	25.88 (5.94)	11.24	876 (86.69)

Note. Standard deviation is represented in parentheses.

There was a significant difference between the two groups in their scores on the C-test ($p < .05$) and the length of instruction in English they had received ($p < .05$). Even though the Control group's proficiency was relatively higher, the participants in both groups were classified as intermediate L2 learners.

2.4.1. Accuracy

Participants' mean accuracy rates on the comprehension questions for the subject relative clauses, object relative clauses, and filler sentences in the pre- and post-tests are shown in Table 5. Both groups had accuracy rates for fillers of at least 90% during the test sessions, indicating that all participants attended to comprehension while doing the self-paced reading. In the pre-test, the two groups showed similar accuracy rates on subject and object RCs. The Control group's accuracy rates on subject RCs were higher than on object RCs, but the difference was not significant. On the other hand, the L2 learners in the Relative Clause group unexpectedly had high accuracy rates on both RC types on the pre-test. This situation indicates a ceiling effect, which might have been caused by their relatively high English proficiency. Nevertheless, both groups' results on the post-test showed a difference in their

accuracy on the two types of RCs, especially the Control group, for whom the difference was marginally significant ($p < .07$), with higher accuracy rates on subject RCs than on object RCs.

Table 5. Mean comprehension accuracy rates (standard deviation) on pre- and post-tests: Relative Clause and Control groups

Experience Group	Test Sessions					
	Pre-test (Session 1)			Post-test (Session 4)		
	Subject RCs	Object RCs	Fillers	Subject RCs	Object RCs	Fillers
Relative Clause	84% (0.15)	84% (0.14)	90% (0.04)	90% (0.11)	87% (0.14)	94% (0.04)
Control	87% (0.18)	81% (0.16)	88% (0.04)	88% (0.15)	79% (0.18)	95% (0.05)

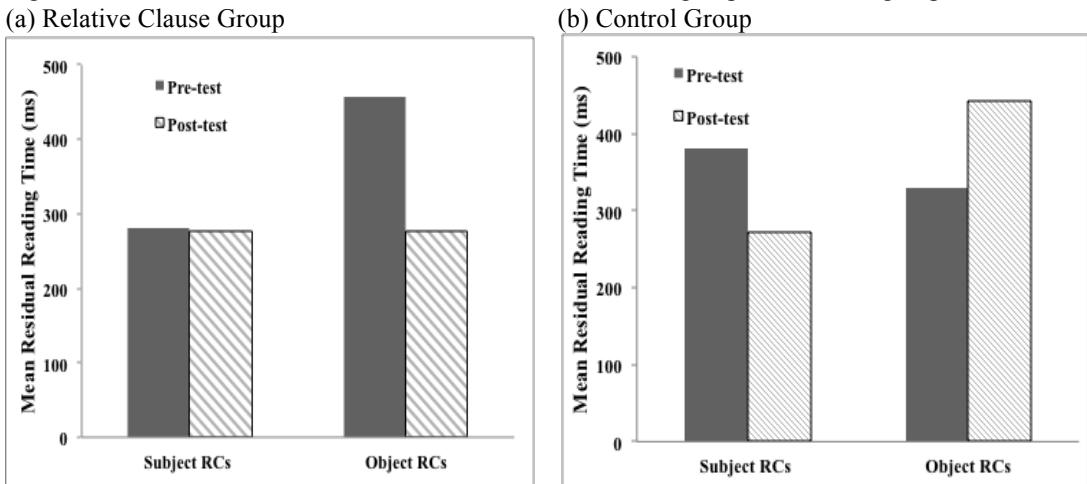
The main interest in this study was the difference in the participants’ performance before and after the input enhancement sessions. Overall, participants’ mean accuracy rates improved on both subject and object RCs from the pre-test to the post-test, except for the Control group’s accuracy rate on object RCs. In particular, on the post-tests, the Relative Clause group improved their accuracy on object RCs more than the Control group, $F(1,32) = 3.395, p = 0.07$.

2.4.2. Self-paced reading times

To eliminate reading time outliers, raw reading times (RTs) were trimmed in the following ways. First, any reading time longer than 2500ms was replaced with 2500ms; this replacement point was determined by plotting all the raw RTs, from shortest to longest. Next, reading times more than ± 2.5 standard deviations above or below the mean were removed: this affected 1.35% of the data. Residual reading time transformations were then done on the raw RTs to factor out effects from differences in word length and reading speed. Residual reading times for each participant were obtained by calculating each region’s expected reading time (from a linear regression equation according to word length) and subtracting it from the raw RTs (Ferreira & Clifton, 1986).

The data analysis, using residual reading times, focused on Region 7 (i.e., the critical region). Crucially, the Relative Clause group’s residual reading times at the main verb (e.g., *wrote* in Table 1) were significantly faster in the post-test than in the pre-test for object relative clauses, according to a paired sample *t*-test, $t(33) = -6.164, p < .001$ (2-tailed), as shown in Figure (1a). This result indicates that, as predicted, the input effect was significantly greater for object RCs than for subject RCs, even though participants were exposed to the same numbers of subject and object RCs during the input enhancement sessions.

Figure 1. Mean residual RTs at the main verb: Relative Clause group and Control group



As can be seen in Figure (1b), the Control group, which was exposed only to sentences not containing relative clauses, showed an increase in residual reading times for object relative clauses but a decrease in residual reading times for subject relative clauses from the pre-test to the post-test. However, in neither case was the difference significant

The results of this study confirm that frequency effects are relevant to the difficulty of object RCs in L2 processing, as they have been shown to be in L1 processing by previous studies. The findings suggest both that L2 learners are sensitive to their previous linguistic experience in comprehending sentences, and that remedial input can help them overcome frequency-related processing difficulty.

3. Concluding remarks

In this study, I investigated the effect of additional input on L2 learners' processing of relative clauses. The frequency effect appeared in the processing of object relative clauses, but not subject relative clauses. The findings showed that the Relative Clause group's reading times at the critical region of object relative clauses significantly decreased from the pre-test to the post-test (Figure [1a]). In addition, the Relative Clause group improved their accuracy rates on the object relative clauses, while the Control group did not. The overall results are consistent with previous studies' results on L1 processing (See Wells et al., 2009).

These findings have various implications for second language acquisition (SLA). While some literature on sentence processing and acquisition has discussed the frequency effect associated with previous experience (Ellis, 2002; Pearlmutter & Macdonald, 1995; Seidenberg & MacDonald, 1999), no prior study has directly tested it. This study showed that even a small amount of additional input (e.g., 128 relevant sentences) improved L2 learners' performance; that is, the infrequent pattern of object relative clauses is easier to comprehend after exposure to additional input. As this study has shown, the frequency of input may facilitate L2 learners' processing and acquisition. Of course, frequency is not the only factor in learning language, but its role in successful processing and acquisition by L2 learners should be reconsidered.

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Proceedings of the 12th Generative Approaches to Second Language Acquisition Conference (GASLA 2013)

edited by Jennifer Cabrelli Amaro,
Tiffany Judy, and Diego Pascual y Cabo

Cascadilla Proceedings Project Somerville, MA 2013

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Lee, On-Soon. 2013. Experience and the Processing of Relative Clauses by Korean Learners of English. In *Proceedings of the 12th Generative Approaches to Second Language Acquisition Conference (GASLA 2013)*, ed. Jennifer Cabrelli Amaro et al., 100-105. Somerville, MA: Cascadilla Proceedings Project. www.lingref.com, document #2987.