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PROCESSING ASYMMETRY BETWEEN SUBJECT AND OBJECT RELATIVE CLAUSES IN ENGLISH AS A SECOND LANGUAGE

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Abstract

ORCs are generally found to be more difficult than SRCs in L1 English processing literature. This eye-tracking study tests this asymmetry in L2 English in terms of reading patterns and accuracy, and reports longer overall reading times, regressions and lower comprehension accuracy for ORCs. This indicates processing ORCs is more difficult for L2 English speakers with L1 Turkish. The incremental processing of the RCs by L2 speakers reflects delayed effects of difficulty, contrasting with previous findings in L1 literature. The findings provide further evidence for the processing disadvantage posed by ORCs, and highlight the differences between L1 and L2 processing dynamics.

Keywords: *language processing, relative clause, SLA, parsing, eye-tracking*

Introduction

Processing of relative clauses has been widely investigated in language processing literature (e.g. Betancort et al., 2009; Caplan et al., 2002; Gibson et al., 1994; Gordon et al. 2001; King and Just, 1991; King and Kutas, 1995; Mak et al., 2002, 2006; Pickering, 1994; Schriefers et al., 1995; Traxler et al., 2002). The motivation for this is not merely to look into the specific structure in language, rather to come up with findings about language processing in general. For instance;

(1) a. The boy that saw the girl went.
    b. The boy that the girl saw went.

Restrictive relative clauses such as the ones in (1) constitute examples of unbounded dependencies in language. In unbounded dependencies, there is no limit on how far apart the two ends can be, (Trask 1999) and logically in relative clauses, the modified noun *the boy* can be endlessly further apart from its position in the relative clause. Consequently, while people read sentences like (1), they need to carry the extracted part *the boy*,

unattached to a verb during the processing of intervening material, which provides researchers with the opportunity to tap into certain dynamics of language processing.

There have been many studies focusing on unbounded dependency constructions in terms of the role of verbal working memory in first language (L1) processing (e.g. Just and Carpenter, 1992; King and Just, 1991; Wanner and Maratsos, 1978; Waters and Caplan, 1992). The psychological reality of gaps and traces has also been extensively tested through unbounded dependencies (e.g. Bever and McElree, 1988; McElree and Bever, 1989; Gibson et al., 1994; Nicol and Pickering, 1993; Nicol and Swinney, 1989; Pickering and Traxler, 2001).

Within L1 processing literature, the general finding with subject and object relative clauses is that the former is processed more easily than the latter in English (e.g. Caplan et al., 2002; Gibson et al., 1994; Gordon et al., 2001; King and Just, 1991; King and Kutas, 1995; Pickering, 1994; Traxler et al., 2002; Weckerly and Kutas, 1999), Dutch (e.g. Frazier, 1987; Mak et al., 2002, 2006), French (e.g. Cohen and Mehler, 1996; Frauenfelder et al., 1980; Holmes and O'Regan, 1981), German (e.g. Mecklinger et al., 1995; Schriefers et al., 1995), and Spanish (Betancort et al., 2009).

In terms of second language (L2) acquisition studies, the majority of studies corroborate subject relative clause (SRC) preference and object relative clause (ORC) disadvantage, in L2 processing (Aydın, 2007; Huili et al., 2011; O'Grady et al., 2003). There are also some studies that found SRC disadvantage (Özçelik, 2006). The common observation that ORCs are disadvantaged in L2 language processing as well as L1 has been attributed to various factors; e.g. word-order (Bever, 1970; Mitchell et al., 1995), frequency (MacDonald and Christiansen, 2002; Wells et al., 2009), hierarchy of grammatical relations (Keenan and Comrie, 1977), perspective shifting (MacWhinney, 1977, 1982), linear distance (Gibson, 1998, 2000), structural distance (O'Grady et al., 2003), and working memory limitations (Gordon et al., 2001) among others. However, it is not yet clear which of these factors account for the findings. Nor is it wholly certain that SRC advantage is a universal phenomenon common to all languages.

This study aims to test whether there is any processing asymmetry between subject and object relative clauses while reading in L2 English. There is a need to examine this issue as the majority of the studies in this area of research have used off-line measures and tests, such as sentence-picture matching (Aydın, 2007; O'Grady et al., 2003; Özçelik, 2006). It is neces-

sary to investigate the on-line and time-locked dynamics of relative clause processing to see how much difficulty occurs, and where in the sentence it occurs, so that a comprehensive evaluation of the reading process can be made. For this reason, the universality of ORC disadvantage is addressed here. As ORC disadvantage is often reported in L1 processing literature, testing whether it is observed in L2 processing might reveal insights into the extent to which L1 and L2 processing dynamics overlap.

1.1 *Previous Findings on Head-Final Relative Clause Processing*

Among the head-final languages in which relative clause (RC) processing asymmetry was tested, we can count Basque (Carreiras et al., 2010), Chinese languages (Chen et al., 2008; Hsiao and Gibson, 2003; Lin and Bever, 2006; Qiao, 2012), Japanese (e.g. Ishizuka, 2005; Ueno and Garnsey, 2008), Korean (e.g. Kwon et al., 2006; Kwon et al., 2010), and Turkish (Bulut, 2012). Though the majority of studies conducted both in head-initial and head-final languages confirm ORC disadvantage, some studies suggest the opposite, SRC disadvantage (Carreiras et al., 2010; Chen et al., 2008; Hsiao and Gibson, 2003; Lin and Garnsey, 2011; Qiao et al., 2012).

As well as these first language processing studies focusing on relative clauses, substantial research has been carried out in first as well as second language acquisition. Within the research on the acquisition of Turkish as a first language, for example, the common finding was SRC preference (Hermon et al., 2007; Özcan, 1997; Özge et al., 2008; Kükürt, 2004; Slobin, 1986). Similarly, in the majority of second language (L2) acquisition studies, SRC preference has been observed (Aydın, 2007; Doughty, 1991; Eckman et al., 1988; Gass, 1979, 1980, 1982; Hamilton, 1994; Huili et al., 2011; O'Grady et al., 2003; Özçelik, 2006; Wolfe-Quintero, 1992). Some of these studies focused on comprehension and others production of relative clauses. Below some of these studies on RC processing in L2 are considered.

1.1.1 *Studies on Relative Clause Processing in L2.* Studies on relative clause processing in a second language are not as abundant as those in first languages, but a proliferating literature is forming which focuses on the dynamics of second language processing. Some of this research is discussed here.

O'Grady et al. (2003) carried out a second language processing study, in which they investigated relative clause comprehension in Korean. The study was intended to account for L2 processing of subject and object relative clauses. In their study, the researchers compared two hypotheses which

account for the asymmetry between SRC and ORC constructions, by appealing to relative distance between the head and the gap, in terms of either structural or linear distance. The linear distance hypothesis (Gibson, 1998, 2000) explains the asymmetry between SRC and ORC processing in terms of the linear distance between the filler (head noun) and the gap. However, the structural distance hypothesis (O'Grady et al., 2003) predicts the opposite, ORC disadvantage, as gaps in ORCs are syntactically deeper than SRCs, whatever the language. Korean, a language with pre-nominal RCs provides an opportunity to differentiate between the two accounts. The linear distance between the head and the gap is greater in Korean SRCs than that in ORCs, whereas in terms of structural distance, the opposite holds true. In their experiment, O'Grady and colleagues used a picture selection task with English-speaking learners of Korean as well as a control group of native speakers of Korean. Participants listened to recordings describing a person or an animal and then had to identify, from a series of pictures, the person or animal described.

The results indicate that ORCs were comprehended less successfully than SRCs, which corroborated the majority of studies conducted in L1 processing research (e.g. Caplan et al., 2002; Gibson et al., 1994; Gordon et al., 2001). Therefore, the findings of this experiment were evaluated as providing evidence for accounts of RC processing favoring structural distance.

Aydın (2007) conducted a study on Turkish relative clause processing by L2 learners and agrammatic aphasics. In the study, processing of SRCs and ORCs was investigated within the framework of structural distance hypothesis and linear distance hypothesis, as in O'Grady et al. (2003). Turkish relative clauses are pre-nominal; i.e. right-headed, and there is no overt complementizer or any wh-element, unlike English, as illustrated in (2) below.

(2) a. Subject relative clause
[e_i kadın-*ı* sev-en] $adam_i$
[e_i woman-ACC love-SPart] man_i
'the man who loves the woman'

b. Object relative clause
[kadın-ın e_i sev-diğ-i] $adam_i$
[woman-GEN e_i love-OPart-3sg] man_i
'the man who the woman loves'

Aydın (2007) tested the two accounts of relative clause processing, linear distance and structural distance hypotheses. As outlined earlier, LDH (Gibson, 1998, 2000) explains the asymmetry between SRC and ORC processing in terms of the linear distance between the filler (head noun) and the gap. As seen in (2), the filler and the gap $adam_i$ and e_i are further apart linearly in (2a) than in (2b) with more intervening words; therefore, LDH predicts that in Turkish, ORCs like (2b) are processed more easily than SRCs like (2a). However, SDH (O'Grady et al., 2003) predicts that ORCs are processed with more difficulty as object gaps are syntactically deeper than subject gaps, whatever the language.

Aydın (2007) sets out to shed light on this issue by means of a picture selection task. Second language learners of Turkish took part in the study. The participants were divided into two groups, based on their performance in a placement test: intermediate and basic. There was a third group composed of agrammatic aphasics. Just as in O'Grady et al. (2003) a picture selection task was carried out, in which each participant was given a booklet. The participants listened to SRC and ORC constructions in Turkish as in (2) above. According to the description given in the recording, they had to choose a person or an animal shown in the pictures.

The results showed that the intermediate-level group answered SRCs more correctly than ORCs, whereas the other groups (basic-level and agrammatic aphasics) did not show a significant difference between SRCs and ORCs. SRC preference in the intermediate group is taken to provide support for SDH, which predicted SRC preference because of structural distance, rather than LDH, which predicted ORC preference because of linear proximity.

The findings of Aydın (2007) contradict those of Özçelik (2006), who found ORC preference in a similar population sample with a similar task. Özçelik (2006) studied comprehension of RCs by L2 learners of Turkish through picture selection tasks. There were three groups in the study: L1 speakers of English, L1 speakers of SOV languages, and L1 speakers of Turkish. The results indicate that ORCs were understood better than SRCs, contradicting the findings of Aydın (2007) on Turkish and those of O'Grady (2003) on Korean. As the linear distance between the filler and the gap is greater in SRCs, the linear distance hypothesis was supported with this finding, although several other factors are also considered in Özçelik (2006).

Huili et al. (2011) tested the processing asymmetry in ORCs and SRCs in L2 English with native speakers of Chinese. Using a self-paced reading experiment, they analyzed reading times and comprehension question accuracy to investigate whether there is any processing asymmetry between SRCs and ORCs. Their results indicate that there is indeed a processing disadvantage associated with ORCs, in relation to both reading time and data comprehension, corroborating the majority of studies in L1 and L2 language processing.

Overall, it can be understood from the literature review that though the majority of studies in L1 and L2 processing, as well as L1 acquisition, found an ORC disadvantage, there are some studies with contradictory findings. RC processing asymmetry across world's languages remains an as-yet not fully understood phenomenon. The literature in L2 focusing on RC processing has mainly used off-line tasks to tap into processing dynamics, which need to be replicated through on-line tasks that provide a rich source of information about the ongoing processing of language. Moreover, off-line tasks may have certain drawbacks in making generalizations about time-locked processing dynamics because, as Cowles (2011: 38) points out, "…if you ask someone to respond in some way at the end of a sentence, all kinds of things have already happened—processes related to retrieving word meaning, building and interpreting structure, understanding who did what to whom, integrating information with previous knowledge…". This study aims to test the purported RC processing asymmetry by means of an on-line eye-movement study, to provide deeper insight into the ongoing and time-locked nature of language processing.

2. Experimental Study

2.1 *Method*

2.1.1 *Participants.* 18 undergraduate students from the School of Foreign Languages at Hacettepe University took part in the experiment. All of them were native speakers of Turkish and were taking English classes of C1 level, according to the Common European Framework. They have been learning English since elementary school with intensive language classes at high school, and they all were admitted to a language-related department at Hacettepe University. Therefore, they were assumed to have learned enough English to be accepted as near-proficient L2 speakers and it was thought that they would have no problems understanding the materials used in the experiment. They had normal or corrected-to-normal vision and hearing.

2.1.2 *Materials.* The experimental materials were taken from the first experiment of Traxler et al. (2002) 12 pairs of experimental items with subject and object relative clauses were used in the experiment as illustrated below (see the Appendix for experimental materials):

(3)	Head Noun	RC region	Matrix V. Region	Rest
a.	The banker/	who irritated the lawyer/	played/	tennis every Saturday.
b.	The banker/	who the lawyer irritated/	played/	tennis every Saturday.

Traxler (2002) created the items by changing the order of the words in the relative clauses. In this way, the items were matched for length and frequency across conditions. Moreover, "…both the sentential subject and the noun-phrase in the relative clause were confusable (e.g., both were animate, human, members of professional occupations, stereotypically male, and so forth) and both were good agents for the action described by the matrix verb and the verb in the relative clause." (Traxler et al., 2002: 73), which makes both RC readings plausible.

Two relative clause types (subject-extracted and object-extracted) and four regions of interest were manipulated in a 2x4 design. All the relative clauses in the experiment had two full noun phrases, one head and the other the object or the subject of the RC. As the main aim of the present study is to investigate any asymmetry between subject relative clauses and object relative clauses, certain other factors such as animacy of the nouns (experiment 3 of Traxler et al., 2002) and use of indexical pronouns (e.g. I, you) (Warren and Gibson, 2002) or different types of NPs (Gordon et al., 2004) were not manipulated.

The experimental items were randomized and distributed to two lists. The items were counterbalanced across the two lists such that an equal number of each condition appeared in each list and no participant saw more than one version of each item. Therefore, in each of the two lists, there were 6 subject and 6 object relative clauses, and thus a total of 12 experimental sentences. 12 filler sentences of various syntactic types were also added to each list. An equal number of participants read the first and second lists (9 each; total n=18). Each list started with an instructions page followed by three filler items for practice. Only then were the experimental sentences introduced.

After each sentence, both experimental and filler, a true/false comprehension question appeared on the screen. Comprehension questions about the fillers demanded a general understanding of the sentences. Those about the experimental sentences required the readers to understand the syntac-

tic/semantic relations between the main and embedded NPs and the matrix verb or verb in the embedded clause. One-third of the questions (n=4) referred to the matrix verb and two-thirds (n=8) referred to the verb in the embedded clause. For example, after the sentences in (3) above, participants saw one of the questions in (4) below. Half of the questions were true and half of them were false and they were randomly distributed in the two lists.

(4) a. Question referring to the matrix verb:
The banker played tennis every Saturday. (True, according to both (3a) and (3b))
b. Question referring to the verb in the embedded clause:
The banker irritated the lawyer. (True according to (3a), false according to (3b))

The comprehension questions were included in the eye-tracking study for two reasons. First, a comparison is intended to be carried out between on-line processing involving initial dynamics of sentence processing and off-line processing concerning end-state processing and general comprehension. In addition to this theoretical purpose, the second reason for including comprehension questions is to eliminate the skewed data from the participants who did not carry out the task appropriately.

2.1.3 *Procedure.* A Tobii Technology 1750 integrated eye-tracker with binocular registration (Tobii Technology, Stockholm, Sweden) with a sampling rate of 50 Hz was used in order to collect eye-movement data. The experiment took place in Human Computer Interaction Research and Application Laboratory at Middle East Technical University. Participants were seated in a comfortable reading distance from the computer screen with the integrated eye-tracker. Participants were told to read the sentences silently at their natural pace for comprehension. After calibration, participants started reading the instructions first, and proceeded to read the sentences by pressing a key. Each sentence was presented one at a time on the computer screen in white against black background. The sentences were centered on the screen and had lengths of either one single line or two lines at most. The length of the sentences did not differ across conditions. After a participant read a sentence, s/he pressed a key to move to the next presentation. After each sentence, a true/false comprehension question about the previous sentence appeared. Participants answered the questions by pressing one of the two keys indicated on the keyboard. Tobii Studio software was used to control stimulus presentation and to process the eye-movement data.

2.2 *Results*

2.2.1 *Comprehension Results.* Following previous eye-tracking studies (e.g. Warren and Gibson, 2002), four of the 18 participants who scored less than 70% (>7 errors) in the comprehension questions (both experimental and filler sentences) were not included in the analysis of both the comprehension questions and the eye-movements. Thus, in comprehension analysis, data collected from 14 participants was used.

The results indicate that the true/false questions about the object relative clauses (M = .46, SD = .50) were answered less correctly than the subject relative clauses (M = .91, SD = .27) and this finding was statistically significant and very robust [$t(83) = 6.80$, $p < .001$]. In other words, 46% of the ORCs were answered correctly, compared to 91% accuracy for SRCs.

The comprehension results show that it is harder to provide the correct answer for object relative clauses to such an extent that the participants were performing at chance level. The results indicate that in off-line or end-state processing of L2, there is a significant discrepancy between SRCs and ORCs to the advantage of the former.

2.2.2 *Reading Time Results.* Recordings of two participants were discarded because of excessive head movements during the experiment which resulted in the loss of more than 30% of the eye-tracking data, as a result of which 12 participants were included in the analysis of eye-movement data.

Three reading time measures are reported here: total fixation duration, first fixation duration and visit count. *Total fixation duration* measures the sum of the duration for all fixations in both first-pass reading and other re-readings within a region, hence it reflects the total time that is necessary to process the target word in the specific sentential context. *First fixation duration* measures the duration of the first fixation on a region, hence reflecting any spillover effect from the previous region (Rayner and Pollatsek, 2006). *Visit count* measures the total number of visits (including the first fixation and all subsequent regressions) within a region, hence it reflects the difficulty of integrating a previous part of text with the rest of the sentence, which leads to regressions to that part of the sentence. This interpretation is substantiated by the observation that long regressions across word boundaries (more than 10 letter spaces back) occur because of comprehension difficulties and that good readers are very accurate in regressing to the part of text that cause the comprehension difficulty (e.g. Frazier and Rayner, 1982). Table 1 shows the dependent measures for the four areas of interest by condition.

Table 1. Dependent measures for the four areas of interest

Areas of Interest	Relative Clause Type	Dependent Measures					
		Total fixation duration		First fixation duration		Visit count	
		Mean	SD	Mean	SD	Mean	SD
Head Noun	Subject Relative	0.68	0.46	0.21	0.06	2.04	0.76
	Object Relative	0.67	0.50	0.19	0.05	2.05	1.00
Relative clause	Subject Relative	1.77	0.94	0.19	0.05	3.16	1.13
	Object Relative	2.13	1.57	0.20	0.05	3.77	1.19
Matrix verb	Subject Relative	0.77	0.28	0.25	0.06	2.60	0.63
	Object Relative	0.95	0.30	0.26	0.08	3.15	0.77
Rest	Subject Relative	1.39	0.60	0.24	0.05	2.57	0.91
	Object Relative	1.90	0.69	0.23	0.04	3.49	1.11

The data suggests that object relative clauses were processed with more difficulty than subject relative clauses, which was confirmed by statistical analyses. The data was first subjected to two-way ANOVA with two RC types and four regions as within-subjects factors. Total fixation duration showed a marginally significant difference between SRCs and ORCs [F (1,13) =4.529, p = .053]. First fixation duration did not reveal a statistical difference between the two RC types [F (1,13) = .116, p = .73]. Finally, visit count data showed a robust difference between the RC types [F (1,13) = 4.899, p = .006].

Post-hoc analyses with paired t-tests were carried out with the three dependent measures to reveal differences between regions across conditions.

2.2.2.1 *Total Fixation Duration.* Significantly more total fixation duration on the matrix verb was observed in the ORC condition (M = .95, SD = .30) than in the SRC condition (M = .77, SD = .28) [t (13) = 2.70, p = .018]. Similarly, total fixation duration on the rest region was significantly more in the ORC condition (M = 1.90, SD = .69) than in the SRC condition (M = 1.39, SD = .60) [t (13) = 3.41, p = .005].Head and RC regions did not reveal any statistical differences (p = .90; p=.27).

2.2.2.2.2 *First Fixation Duration.* First fixation durations did not reveal any significant difference between conditions (Head region, p =.20; RC region, p=.53; Matrix verb region, p=.28; rest region, p=.41).

2.2.2.2.3 *Visit Count.* In the head region, there was no statistical difference between conditions (p=.95). In the RC region, there were statistically more visits in ORC (M = 3.77, SD= 1.19) than in SRC (M=3.16, SD = 1.13) [t (13) = 2.23, p = .044]. In the matrix verb region, again ORC (M = 3.15, SD = .77) received significantly more visits than SRC (M = 2.60, SD = .63) [t (13) = 2.99, p = .010].Finally, in the rest region there were significantly more visits in ORC (M = 3.49, SD = 1.11) than in SRC (M = 2.57, SD = .91), [t (13) = 3.79, p = .002].

The results show that ORCs were harder to process than SRCs, as revealed by total fixation duration and visit count, in a number of regions of interest.

3. Discussion

The findings of the present study corroborate the oft-observed ORC disadvantage in L2 processing. (Doughty, 1991; Eckman et al., 1988; Gass, 1979, 1980, 1982; Hamilton, 1994; Huili et al., 2011; Wolfe-Quintero, 1992), while contradicting some others (Özçelik, 2006). The reading time results on each region are interpreted below.

3.1 *Head Noun*

Not surprisingly, the reading times on the head nouns did not significantly differ across conditions as the difficulty posed by the RC type became salient in relative clause regions. This result can also be taken as a control condition.

3.2 *Relative Clause*

The total reading duration and the first fixation duration on the RC region did not differ significantly between conditions. The latter result is expected, because the first words in the RC region in each condition was the same (who), which is probably the site where the first fixations land in the RC region if the word is not skipped. The fact that total reading times did not differ in the RC region across conditions contradicts the findings of similar research in L1 processing. (e.g. Gordon et al., 2001; Traxler et al., 2002; Traxler et al., 2005) This difference can be due to the shallow processing of RCs by L2 learners, hence leading them not to follow fixed expectations like native speakers, or not to focus on local inconsistencies.

This idea is supported by the shallow-structure hypothesis of Clahsen and Felser (2006) which claims that although adult L2 learners are guided by lexical-semantic cues during parsing in a similar way to native speakers, they are less constrained by syntactic information. Hence, the processing differences between the two are attributed to the shallow nature of the syntactic representations that L2 learners compute during comprehension, rather than to the absence or lack of grammatical competence. Interestingly, in our study, the visit count data showed that L2 readers made regressions to the RC region more in ORC. This suggests that the readers became aware of the comprehension difficulties after the main locus of processing difficulty, which led them to go back and re-read the RC region. This is again consistent with Clahsen and Felser's (2006) approach.

3.3 *Matrix Verb*

First fixation duration in the matrix verb region did not reveal any significant differences between conditions. Since the spillover time is defined as the first fixation duration following a target region, (Balota et al., 1985; Calvo and Meseguer, 2002) this measure is included to explore any residual effects of processing the critical RC region. The statistical analyses showed that, in the matrix verb region there was no difference in first fixation duration between conditions, which indicates that the readers did not slow down immediately after reading the RC region. However, the total fixation duration as well as visit count data, show that after the first-pass reading of the matrix verb, the participants made more regressions and fixated longer in the ORC condition. These results again support the inference that L2 readers are delayed in the parsing process and carry out a shallow analysis of the sentence at first, for which they try to compensate by re-reading. Moreover, as the matrix verb carries the thematic information which maps the NPs in the sentences to their thematic subject and object roles, it is likely that readers fixated more in the matrix verb region and made more regressions to the area in the ORC condition. This finding is also consistent with L1 processing of relative clauses in English (e.g. Traxler et al., 2002) and points to a shared processing mechanism/strategy in language processing in L1 and L2.

3.4 *Rest*

The rest region refers to the remaining sentence elements after the matrix verb, which corresponds to the object and/or adjuncts of the matrix verb in our materials. This area was included in the analysis because the readers were expected to show the effects of processing difficulty after the

critical RC up to the end of the sentence due to delayed parsing and/or the continuing effects of difficulty. First fixation durations of both conditions were not statistically different, indicating that there were no spillover effects from the preceding matrix verb region. Total fixation duration and visit duration data revealed processing difficulty for ORC compared to SRC, which shows that participants made more regressions and re-read the rest region more in ORC than in SRC.

The fact that first fixation duration data did not reveal any significant difference between SRC and ORC in either one of the regions of interest suggests that L2 readers are not hindered by the difficult object relatives during first-pass reading as L1 readers are. That is, reading difficulty is not shown immediately after seeing the critical ORC, or even while processing the subsequent materials. Rather, L2 readers tend to overlook the upcoming complexities and show only delayed effects of parsing problems. This implies that L2 processing involves different dynamics of processing, with incremental information affecting the parse tree at different time windows. Of course, the first fixation duration used here is not the same as first-pass reading time, which is defined as "the sum of all the fixations beginning with the reader's first fixation in a region until the reader's gaze leaves the region" (Traxler et al., 2005: 208) and which is identical to gaze duration. (Rayner et al., 1989; Rayner, 1998) Therefore, it might be possible that readers actually show processing difficulty in the first-pass reading, but the effect is reflected in the other fixations in the region but still in the first-pass. Granted that such a caveat exists, still our results strongly suggest that in both spillover regions (matrix verb and rest) following the critical RC region, readers did not show any first fixation biases between conditions, whereas they would be expected to do so if they were incrementally affected by the upcoming parse information.

Both off-line accuracy results and online reading time data showed that ORCs were processed with more difficulty than SRCs. This processing difference between relative clause types can be explained by a number of processing accounts. Linear Distance Hypothesis, (Gibson, 1998, 2000) for example, proposes that in ORCs, the head noun must be kept in memory for a longer time than in SRCs, leading to increased working memory demands. This may have made processing the sentence overall harder for ORCs; hence the necessity to go back and reanalyze the previous segments that could not be kept in memory due to limited memory space. Equally plausibly, the deeper position of objects in the syntactic tree may

have made ORCs hard to process, as the Structural Distance Hypothesis (O'Grady et al., 2003) puts forward.

Another reason why more regressions were initiated to the RC and matrix verb regions in ORCs may be the fact that the RC verb and the main verb in ORCs are adjacent to each other, hence complicating the process of analyzing the argument structure in the sentence. In the sentences used in this study, the ORC verbs were immediately followed by the main verb, which is not the case for SRCs as the RC verb comes after the complementizer 'who'. This difference may have caused the observed processing asymmetry because L2 readers may be making use of superficial strategies during reading such as watching out for the locations of NPs and VPs. Such a superficial analysis is also evidenced by the lower comprehension accuracy levels for ORCs, showing that the arguments are not attached to their verbs correctly.

In terms of comprehension accuracy, ORCs are strongly disadvantaged, with accuracy rate at chance level. This shows that even near-proficient learners as were tested in the present experiment have a very poor understanding ORCs, reflecting the level of complexity associated with the structure. The comprehension findings indicate that end-state processing is affected by RC type, as well as ongoing processing revealed by eye-movement data. Therefore, the processing asymmetry between ORCs and SRCs seems to be robust enough to be revealed by both measures.

Turkish being a head-final language with pre-nominal relatives, there does not seem much ground for a transfer to occur from L1 to L2 in terms of RC processing. Turkish relative clauses come before their head noun and there is no complementizer that corresponds to English *who, which*, or *that* (Göksel and Kerslake, 2005). The verb in the RC is typically not inflected for tense and aspect and takes a certain participle that indicates object relativization or subject relativization. In Turkish ORCs, the subject NP also takes genitive case marking. These typological features render Turkish quite different from English, limiting the scope for transfer from processing Turkish RCs to English ones. However, the word order in Turkish might have affected the results. The canonical word order in Turkish is SOV, as illustrated in (5) below:

(5) *Öğrenci* *makale-(y)i* *oku-du-Ø.*
Student article-ACC read-PAST-3rdP
'The student read the article.'

Therefore, L2 learners might be making use of the processing strategy in Turkish of treating the second NP as the object of the sentence; if that's the case, the NP in the relative clause in ORCs might be initially analyzed as the object of the embedded clause. Such a surface strategy is consistent with the views on transfer of parametric values from L1 to L2 such as White (e.g. 1990, 1991, 1992). The shallow parsing view of Clahsen and Felser (2006) also accounts for such a surface strategy, as ORCs might constitute a subset of complex structures where detailed parsing representations cannot be built easily by L2 readers. Moreover, although the participants were assumed to be near-proficient in English, their comprehension scores showed that they made many more errors in ORCs than in SRCs. Indeed, they performed at chance level in ORC condition. Besides, two-thirds of the comprehension questions tested understanding of thematic relations between the NPs and the embedded verb, as is shown in (4b) above. If the participants used the transfer strategy and misanalyzed the second NP in ORCs as the object of the embedded verb, they would show decreased comprehension accuracy for ORC, which they did. Of course, another interpretation of the low accuracy scores for ORC would be the confusability of the NPs and their thematic roles. This is especially because the sentences did not convey semantic and pragmatic context enough to cue thematic attachment, since the sentential subjects and the embedded NPs were equally plausible agents for the embedded verb, as explained in the section 2.1.2. The participants might have confused the thematic roles in off-line processing due to poor recall or inadequate comprehension.

The universality of SRC preference is corroborated by this study. The majority of studies in L1 and L2 literature have produced similar processing patterns across languages. However, regarding the processing dynamics and availability of parse representations, there appear to be striking differences between L1 and L2 readers.

Finally, it should be conceded that the present study did not include a large population sample and a large material set. To arrive at more informed conclusions about the patterns that L2 learners follow during language processing, obviously larger sample size and material sets should be incorporated, which is sometimes difficult due to the demands of the experimental method adopted.

4. Conclusion

It is found out that while reading in L2 English, L1 speakers of Turkish had more difficulties with object relative clauses than with subject relative

clauses. This processing disadvantage against ORCs was reflected in both comprehension question accuracy and reading times. Many more errors, higher reading times and higher rates of regressions were found to be associated with ORCs, in relative clause and matrix verb regions as well as the following region.

This finding is similar to the majority of research in L1 processing literature, where the general finding is ORC disadvantage. Within L2 processing literature, too, the common finding has been ORC disadvantage not only in L2 English, but also in other languages such as Turkish and Korean.

However, the current findings also highlight the processing differences between L1 and L2, in terms of the availability of incremental parse information and of the depth of processing. The findings here support accounts claiming that L2 processing involves computation of shallow syntactic representations.

The current article leaves the question of the source of these processing differences between ORC and SRC unanswered, as the main focus was the comparison of L1 and L2 readers. It is necessary to tease apart the factors contributing to this processing bias in both L1 and L2, some of which are linguistic (e.g. word order, frequency, structural and linear distance) and some which are part of general cognitive mechanisms (e.g. working memory). It is hoped that future research will shed more light on the extent to which these processes overlap and interact in L1 and L2 processing.

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Appendix

The materials were taken from the first experiment of Traxler et al. (2002).

The banker who irritated the lawyer played tennis every Saturday.
The banker who the lawyer irritated played tennis every Saturday.

The pilot who complimented the flight attendant asked for a date.
The pilot who the flight attendant complimented asked for a date.

The businessman who married the secretary invited the bookkeeper to the party.
The businessman who the secretary married invited the bookkeeper to the party.

The doctor who ignored the nurse drove a little red convertible.
The doctor who the nurse ignored drove a little red convertible.

The mechanic who divorced the waitress cheated on her often.
The mechanic who the waitress divorced cheated on her often.

The burglar who scared the policeman robbed three houses in one night.
The burglar who the policeman scared robbed three houses in one night.

The editor who angered the writer fired the entire staff.
The editor who the writer angered fired the entire staff.

The prisoner who attacked the guard provoked the riot.
The prisoner who the guard attacked provoked the riot.

The director who admired the dancer gave her the leading role.
The director who the dancer admired gave her the leading role.

The hiker who passed the fisherman got lost and had to be rescued.
The hiker who the fisherman passed got lost and had to be rescued.

The tenant who despised the landlord phoned the newspaper to complain.
The tenant who the landlord despised phoned the newspaper to complain.

The soldier who assisted the civilian received a medal from the army.
The soldier who the civilian assisted received a medal from the army.

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