Ambiguity Resolution of English Relative Clauses by Persian Learners of English

Nasim Malakooti[1], Mohammad Javad Rezai[1], Laila Samavarchi[1,2]*

Yazd University[1]

Iran Language Institute[2]

laila_samavarchi@yahoo.com

Abstract

Investigating the lack of ultimate native-like attainment in L2 acquisition is among the concerns of psycholinguistic research. Processing differences have been argued to be among the underlying factors influencing the lack of native-like attainment. This study is an attempt to investigate how Persian learners of English resolve ambiguity in processing sentences containing two noun phrases and a relative clause that can be attached either high to NP1or low to NP2.To this end, 30 advanced Persian learners of English participated in two experiments, both on-line and off-line tasks. The results showed that L2 learners exhibit different attachment preferences compared to the native speakers of English. Moreover, the L2 learners do not exhibit L1-based preferences in L2 English in the on-line task, which indicates they are not directly influenced by attachment preferences from their L1. But transfer had an effect in the off-line task as the L2 learners may resort to some metacognitive knowledge. The results of the current study suggest that L2 learners integrate information relevant for parsing differently from native speakers, with the L2 learners relying more on lexical-semantic cues than native speakers and less on phrase-structure rules. The results of study can provide the solutions concerned with the processing problems and nonnative-like attainment in an EFL context like English classrooms in Iran and can also help curriculum designers gain further theoretical insights in finding the ways through which native-like grammatical processing strategies can be acquired in L2 acquisition

Key words: Ambiguity Resolution, Configurationality, Lexical-semantic Rules, Parsing, Predicate Proximity, Recency.

1. Introduction

The processing of ambiguous sentences by first and second language learners in different languages has been the focus of many psycholinguistic studies over the last couple of decades and these studies have led to an increase in our understanding of how children and mature readers or listeners process their native language or their second language in real time. The processing mechanism of ambiguity resolution relates to the way relative clause attachment ambiguities are resolved. Individual languages vary with respect to whether speakers prefer to associate the relative clause with the first or the second potential host NP. Researchers in the domain of syntactic processing have addressed this issue in both first language (Cuetos & Mitchell, 1988; Cuetos, Mitchell, & Corely, 1996; among others) and second language processing (Clahsen & Felser, 2003a,b ; Papadopoulou & Clahsen, 2003; Dekydtspotter, Donaldson, Edmonds, Liljestrand Fultz, & Petrush, 2008). Most of these studies have dealt with how learners process their native language in real time.

The ability to process the linguistic input in real time is crucial for successfully acquiring a language, and yet little is known about how language learners comprehend or produce language in real time. Against this background, many researchers have conducted a detailed study of grammatical processing in language learners using experimental psycholinguistic techniques and compared different populations such as mature native speakers, child first language (L1) learners and adult second language (L2) learners, as well as different domains of language i.e., morphology and syntax. The present study deals specifically with Persian learners of English,

with the aim of explaining how grammatical processing in Persian language learners of English differs from that of mature native speakers regarding the syntactic domain of language.

One area of sentence processing that has been extensively studied with monolingual adults in the past is the way relative clause attachment ambiguities are resolved in sentences such as the following:

Someone shot the servant of the actress who was on the balcony.

Individual languages vary with respect to whether speakers prefer to associate the relative clause with the first or the second potential host NP.

Considering the differences between native speakers and second language learners in the way they process language and the parsing strategies they employ to process sentences many studies have been carried out all which examined the way advanced L2 learners of English from different language backgrounds resolve relative clause attachment ambiguities a phenomenon which is known to be subject to cross linguistic variation.

The present study aims to investigate the way advanced Persian L2 learners of English resolve structural ambiguities in sentences of the above type both in real time and in off-line contexts. Another purpose of this study is to compare the processing strategies used by advanced Persian L2 learners of English to those employed by adult native speakers. The extent to which L1 and L2 processing are similar or dissimilar is explored by contrasting the results from the L2 learners with those from parallel studies with adult native speakers that have previously been conducted by other researchers in this field (Clahsen & Felser, 2006). Because Persian language differs from English in that it belongs to the group of languages for which an NP1 preference has been attested for complex genitive antecedents, investigating L2 learners from

this language background would help in determining whether L2 learners employ L2 processing strategies that are different from those found in their L1 or whether they transfer the NP1 preference from the native language to the L2 which help to elaborate more on the effect of transfer, and cross-linguistic study of this phenomenon. The results from this study could help in better understanding of the processing mechanisms employed by Persian learners which could guide EFL instructors through finding appropriate methods of teaching ambiguous sentences to the learners so that they can gain ultimate native-like attainment in English, and can more efficiently make use of appropriate processing strategies.Furthermore, the present study can shed light onto the suitability of *processing instruction* (PI) in EFL contexts. Processing instruction can give L2 learners explicit information about the target structure and about processing strategies as well as structured input activities which enable learners to drop less than optimal strategies for efficient ones while encountering ambiguous structures in the target language.

2. Review of the Related Literature

2.1 RC Attachment Ambiguity in Second Language Processing

The ways in which structural ambiguities are resolved are crosslinguistically different, indicating that some parsing strategies are language-specific rather than universal, and thus need to be learned through experience (Malakooti, 2010). This section deals with crosslinguistic variations in the parsing of the phenomenon under investigation. Consider sentence (1) below, which is ambiguous in that the relative clause *who was on the balcony* can be construed either high with the first NP *the servant* (NP1 attachment) or low with the second NP *the actress* (NP2 attachment).

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

According to the results from previous psycholinguistic studies, adult native speakers of English tend to associate the relative clause with the second rather than the first NP, that is, with *the actress,* in both off-line (Cuetos & Mitchell, 1988, Dussias, 2001, Fernández, 1999; Gilboy, Sopena, Clifton, & Frazier, 1995) and on-line reading comprehension tasks (Carreiras & Clifton, 1999; Henstra, 1996; Fernández, 2000). In contrast, an NP1 attachment preference was found in numerous other languages considering the same constructions, including Spanish (Cuetos & Mitchell, 1988; Carreiras & Clifton, 1993; Gilboy et al., 1995), Dutch (Brysbaert & Mitchell, 1996), German (Hemforth, Konieczny, & Scheepers, 2000), French (Frenck-Mestre & Pynte, 1997; Zagar, Pynte, & Rativeau, 1997), and Greek (Papadopoulou & Clahsen, 2003; 2006).

Attachment preferences can be accounted for based on different parsing principles and rules which are discussed in the following.

2.1.1 Phrase-structure based parsing principles

Within Gibson and Pearlmutter's (1998) multiple-constraint model of sentence processing, attachment preferences are determined by the relative strength of a number of interacting structural and non-structural factors in a given language. According to Gibson, Pearlmutter, Canseco-Gonzalez, and Hickock (1996), the NP2 preference that is typically found in English can be accounted for by assuming that in highly configurational languages like English, ambiguous modifiers are integrated into the current parse in accordance with the locality principle of Recency, which favors attachment of an ambiguous phrase to the most recently

processed constituent, which is similar to the Late Closure Strategy proposed earlier by Frazier (1979) and Frazier and Fodor (1978).

Configurational languages do not allow verbs and their complements to be non adjacent and they have a fairly rigid word order in comparison with the non-configurational languages which exhibit extremely free word order variation. The locality principle of *Recency* can be defined as following:

Recency: Attach new incoming material to the most recently processed phrase if grammatically possible.

Another phrase-structure principle is applied in languages in which an NP1 disambiguation is preferred, based on which ambiguous modifiers will be preferentially attached to constituents as structurally close as possible to a predicate phrase. This rule is the locality principle of *predicate proximity*. The locality principle of *Predicate Proximity* can be defined as follows: Attach as structurally close as possible to the head of a predicate phrase. Hence, according to this rule the relative clause is attached to the overall object NP as in example (1) above.

In languages such as Greek, German, Spanish and French this rule is strong enough to outrank the locality principle of *Recency*. That is an NP1 attachment has been shown to be the preferred option. For the equivalents of (1) in the above-mentioned languages, native speakers preferentially associate the relative clause with the initial NP in the complex (compare Hemforth et al., 2000, for German, and Papadopoulou & Clahsen, 2003, for Greek).

Gibson et al. (1996) hypothesized that, although both recency and predicate proximity may be part of a universal sentence processing mechanism, languages may be parameterized in that the

relative strength of the predicate proximity strategy is linked to the degree of (non)configurationality of a given language. That is, in nonconfigurational languages such as German or Greek which allow verbs and their compliments to be nonadjacent, the verb may be more active during processing than it is in a highly configurational language such as English, so it is more likely to attract ambiguous modifiers.

2.1.2 Lexical Factors Influencing Parsing

Lexical semantic factors are proved to influence modifier ambiguity resolution in addition to the locality-based parsing principles according to the evidence found from the observation that for complex NPs linked by thematic preposition such as *with,* NP2 disambiguation appears to be universally preferred over NP1 disambiguation in both off-line (Gilboy et al., 1995) and on-line experiments (Frenck-Mestre & Pynte, 2000; Traxler, Pickering, & Clifton, 1998; among others). Considering the studies carried out by Gross (2002) and Papadopulou and Clahsen (2006) in German and Greek respectively, an NP2 preference for NPs joined by a thematic preposition has been confirmed although an NP1 preference has been attested in these languages for complex genitive antecedents which suggests that the lexical bias is strong enough to override any phrase-structure based locality principle that favors NP1 attachment. And the second NP is preferred based on the lexical semantic rules.

One way to account for the NP2 attachment preference in sentences containing NPs which are linked by thematic preposition *with* has been offered within the framework of *construal theory* (Frazier & Clifton, 1996), according to which associating modifying phrases with constituents outside the current thematic domain is costly, and hence dispreferred. Since prepositions like *with,* unlike mere case assigners such as *of* in example (1) above, create a local thematic domain

of their own, the ambiguous relative clause should preferentially be associated with the second NP, *the actress*, based on the construal theory.

If the second NP is a genitive-marked or prepositional object of the first NP, however, the current thematic processing domain is the overall object NP, so that from the point of view of the construal hypothesis, either NP1 or NP2 may serve as the antecedent for an ambiguous relative clause.

2.2 Previous Studies

Many researchers have performed extensive experiments dealing with the issue of ambiguity resolution in sentences containing a relative clause with two possible NP antecedents and a considerable amount of research has been carried out investigating the same issue cross-linguistically, some of which are briefly discussed in the following.

Different studies investigate the ambiguous attachment of the relative clauses in French and in English. Research has suggested that RC attachment may be resolved differently by native speakers of the two languages: native speakers of French tend to choose NP1 so they generally favor high attachment of RCs (Baccino, De Vincenzi, & Job, 2000; Frenck-Mestre, 1997; Frenck-Mestre & Pynte, 2000; Zagar et al., 1997), whereas native speakers of English generally prefer low attachment of RCs (Fodor, 2002).

Papadopoulou and Clahsen (2003) compared the relative clause attachment preferences of Spanish, German, and Russian L2 learners of Greek with those of Greek native speakers. The L2 learners of Greek showed different relative clause attachment preferences from the native speakers, they also didn't exhibit L1-based preferences in L2 Greek, so this study provided

strong evidence against the transfer of L1 processing strategies. They did not find evidence that the L2 learners exhibited a preference for NP1 or NP2 attachment in the genitive condition, with thematic prepositions, however, both NSs and NNSs preferred low attachment to NP2, so it was suggested that L2 learners integrate information for parsing differently from native speakers and L2 learners rely more on lexical cues compared to the native speakers and less on purely structurally-based parsing strategies.

Felser, Roberts, Gross, and Marinis (2003) investigated the way German and Greek adult second language (L2) learners of English resolve relative clause attachment ambiguities. The results indicated that the L2 learners do not process ambiguous sentences of this type in the same way as adult native speakers of English do. Although the learners' disambiguation preferences were influenced by lexical-semantic properties of the preposition linking the two potential antecedent noun phrases (of vs. with), there was no evidence that they applied any phrase structure-based ambiguity resolution strategies.

On the other hand, Rah and Adone (2010) investigated German L2 learners' PP attachment preferences in a production task wherein participants were required to complete ambiguous sentence beginnings as spontaneously as possible. The findings of this study suggested that "learners' processing is highly native-like and the learners did not over-rely on a recency principle of attaching new material to the most recently processed element" (p.146).

Furthermore, Pan, Schimke, and Felser (2014) studied the effect of referential contexts on native and non-native readers' interpretation of ambiguous relative clauses. The results of the self-paced reading task indicated that there was a difference between native English speakers'

and non-native German and Chinese-speaking ESL learners' disambiguation preferences, indicating that non-native speakers are biased by discourse information.

In the Iranian context, Marefat and Farzizadeh (2018) investigated English learners processing strategies in the languages they know and the effect of working memory on the processing strategies employed. The results indicated that English learners same strategies as native English speakers and that their attachment preferences were not modulated by working memory in L2.

The findings of above-mentioned studies on L2 attachment preferences on complex genitives are inconclusive in that some studies suggested that L2 speakers show attachment preferences in the L2 that are not transferred from the L1, and some others suggest that L2 learners do not show sensitivity to either L1 or TL attachment preferences. Furthermore, some other studies reported that transfer has an effect. In line with the previous studies carried out so far, this study attempts to investigate the processing behavior of Persian speaking learners of English through the way they resolve ambiguities, since the attachment preferences are different in Persian and English languages, in that an NP1 preference has been attested for Persian whereas English native speakers prefer to attach RC low. The results would provide further evidence considering whether learners' attachment preferences are influenced by their L1 or the target language, which can lead to an investigation of the effect of transfer.

To address the above issues, the following empirical questions are addressed in the current study:

1- Do adult L2 learners employ the same sentence processing strategies as native speakers of the target language?

2- To what extent are language learners capable of using and integrating phrase structure and lexical-semantic information during processing?

3- Is there any evidence that adult L2 learners transfer processing strategies from their L1?

3. Method

This section deals with the methodology of two experiments: both off-line and online tasks followed by the process of data collection and data analysis.

3.1 Participants

Thirty-three (13 female and 20 male) advanced Persian-speaking learners of English participated in Experiment1 (mean age 25.53, range 22-37) all of whom were naïve with respect to the purpose of study. The participants were selected through convenience sampling because of their convenient accessibilty and proximity to the researchers. All had had previous formal education in English in Iran, for a period ranging from 4 to 7 years and were B.A. or M.A. graduate students majoring in English teaching (TEFL) or English literature.

The subjects' general level of proficiency in English was assessed prior to the main experiment using a standardized proficiency test (Oxford Quick Placement Test).

3.2 Instruments

Three types of instruments were used in the process of data collection in this study: A test of proficiency, and the instruments for the two main experiments which were the questionnaire and the self-paced reading task. The Oxford Quick Placement Test (OQPT) was used to check the participants' proficiency levels. The instruments used in the two main experiments were similar but not identical. Below a brief introductory section is devoted to each task and the way they are implemented.

3.2.1 The Oxford Quick Placement Test

The Quick Placement Test is a flexible test of English language proficiency. It is quick and easy to administer and is ideal for placement testing and examination screening. The test takers are allocated 30 minutes to complete the task. All the questions are in the multiple-choice format and the answers are recorded directly onto the answer sheet. The test consists of two parts: Part 1 (question 1 through 40) is taken by all students. Part 2 is for higher ability students who can have at least 35 correct answers in the first section. In the present study the OQPT was administered to see whether the subjects could participate in the experiment and whether they were in the appropriate proficiency level. Judging from the subjects' performance in the proficiency test, 33 subjects who got 48 plus proficiency grade were chosen from among 35 people who took the test, and participated in the two main experiments.

3.2.2 Off-line Task

The questionnaire comprised 80 sentences in total, including 40 experimental sentences and 40 filler sentences. Of the fillers, some of the sentences were ambiguous and some were unambiguous, all the experimental sentences were ambiguous and of the form NP-V-[NP1-P-NP2]-RC, where V is the matrix verb, P is preposition, and RC is the relative clause. In other words, all the experimental sentences involved a main clause headed by a transitive verb in the past tense, whose complex NP object was followed by a subject relative clause. Both NPs and the auxiliary in the relative clause appeared in the singular. There were two versions of each sentence, in the 20 of the experimental sentences the two noun phrases in the NP complex were joined by the genitive preposition *of* and in the other 20 experimental sentences the thematic preposition *with* was used to link the two critical noun phrases in the NP complex, as illustrated by (4a) and (4b) respectively.

(4) *a. The dean liked the secretary of the professor who was reading a letter*.

   b. The dean liked the professor with the secretary who was reading a letter.

In order to make sure that the experimental sentences sound equally natural in both the *of* and the *with* conditions, the relative ordering of NP1 and NP2 in the *with* conditions were reversed. Accordingly, the two different sets of the experimental sentences each set containing 20 sentences with the thematic preposition *with* and 20 sentences with genitive preposition *of* were created, and all these experimental sentences and filler sentences were randomly put in the questionnaire adapted from Felser et al. (2003) and Papadopoulou and Clahsen (2003).

3.2.3 Self-paced Reading Task Materials

The moving window technique, one of the online tasks, has been used extensively in online processing studies in the area of SLA, in quite a few studies such as the ones conducted by Juffs and Harrington (1995, 1996); Marinis, Felser, and Clahsen (2002); Felser, Marinis, Clahsen (2003); and Papadopoulou and Clahsen (2003, 2005).

For the current study, the stimulus materials for the self-paced reading task comprised 130 sentences in total, including 10 practice sentences and 120 experimental sentences. Of the experimental sentences, 40 sentences were ambiguous and 80 were temporarily ambiguous, the ambiguous experimental sentences included the same sentences as those which were used in Experiment I. The temporarily ambiguous sentences were actually the unambiguous versions of the ambiguous sentences. Two versions of each ambiguous sentence were created which led to a total of 80 unambiguous sentences. All these sentences contained a relative clause

modifying either the head of the overall object NP (= NP1 Attachment) or the embedded noun phrase (= NP2 Attachment). Disambiguation was forced by number marking on the auxiliary (was vs. were). The two critical NPs were joined by either *of* or *with.* Having two prepositions and two NP antecedents results in a total of four experimental conditions as follows:

(5) a. NP1 Attachment (of)

The dean liked the secretary of the professors who was reading a letter.

b. NP2 Attachment (of)

The dean liked the secretary of the professors who were reading a letter.

c. NP1 Attachment (with)

The dean liked the professors with the secretary who were reading a letter.

d. NP2 Attachment (with)

The dean liked the professors with the secretary who was reading a letter.

The order of the two critical NPs was reversed in other conditions, and the relative ordering of singular and plural NPs was counterbalanced across all four conditions. All the experimental sentences were pseudo-randomized and mixed.

3.3 Procedure

Procedural details of the off-line questionnaire and the on-line self-paced reading task are given in the following respectively.

3.3.1 Questionnaire Study

Subjects were instructed to read the sentences carefully and then to indicate for each sentence which of two possible interpretations they considered the more appropriate one. Although the participants were able to read the sentences more than once, they were asked to make their choices as spontaneously as possible. An example of the questionnaire items is represented in (6) below for illustration.

(6) *The dean liked the secretary of the professor who was reading a letter.*

    i. the secretary was reading a letter

    ii. the professor was reading a letter

In half of the choices, NP1 in the complex appeared first, and in the other half, it appeared second, to avoid the subjects developing a strategy for answering the questions. The participants were asked not to devote more than forty minutes to complete the task, and they mostly finished the task in less than 40 minutes.

3.3.2 Self-paced Reading Task

In order to investigate how the subjects process sentences in real time we implemented a self-paced reading task. In this task the (non-cumulative) moving-window technique described by Just, Carpenter and Wooley (1982) was applied.

The online experiment was carried out in the psycholinguistic room in Yazd University, about 1 week after conducting the first experiment. All the participants came to this room one subject at a time and took part in the experiment. Subjects were seated in front of a 17" monitor, and

instructed to read the sentences as quickly and as carefully as possible, after pressing the spacebar the experiment began. They were all gone through the practice experiment first which contained 10 sentences of the types under investigation, after they got familiar with the process of the experiment the main task began with a short break between the two experiments.

In the main task all the sentences were presented in a segment-by-segment fashion using noncumulative moving-window technique in which each segment was presented on the monitor screen while dashes replaced the other segments. The subjects pressed the spacebar in order to receive the subsequent words or phrasal segments up to the end of the sentence. Each sentence was divided into five segments as indicated in (7) below.

(7)   *The dean liked / the secretary of the professors / who / was / reading a letter.*

The complex noun phrase was presented as one segment so as to minimize the possibility of the initial NP fading from short-term memory during the processing of the second one, which might bias the subjects towards NP2 attachment. The auxiliary verb always appeared as the fourth segment which was actually the disambiguating segment in the temporarily ambiguous sentences because this segment guided the subjects through choosing one of the NPs for the sake of agreement between the subject and the verb.

The last segment was a yes-no comprehension question to ensure that the subjects paid attention to the task and comprehended the sentence properly, These questions were randomly assigned to 60 out of 120 sentences used in the experiment, all the ambiguous sentences and

some of the temporarily ambiguous sentences were followed by a comprehension question of the type shown in (8).

(8) *Was the secretary reading a letter?*

To answer the questions, the subjects were instructed beforehand to press Y key if the answer to the question was *yes*, and press N key if the answer was *no*, they had to press the spacebar in case there was no question to receive the next sentence.

The end of each sentence was indicated by a feedback. Then the next sentence was presented if there was no question. An accurate response was followed by the feedback *good job*, and for incorrect responses the displayed feedback was *incorrect.* Receiving feedback would give the subjects an opportunity to get ready for the next sentence or to pay more attention to the task while they received a negative feedback. The self-paced reading experiment lasted approximately 30-40 minutes per person.

4. Results

The following section presents the results from two experiments investigating relative clause attachment preferences among Persian advanced learners of English using both off-line and on-line tasks, and the manner in which advanced Persian-speaking L2 learners of English resolve relative clause attachment ambiguities in the target language.

4.1 Attachment preferences among native speakers of Persian

To examine attachment preferences among Persian speakers, experimental sentences with a grammatical structure similar to those under investigation with a genitive preposition were constructed. Two examples of such sentences are given in (9) below:

(9) دانش آموز از منشی هنرپیشه که روزنامه می خواند، عکس گرفت .

رئیس دانشکده با منشی پروفسور که مشغول نوشتن نامه بود، تماس گرفت .

A questionnaire was developed containing 10 sentences of the above structure and was given to 10 Persian native speakers.95% of the participants showed an NP1 preference and only 5% tend to attach RC to the second NP (NP2). So, a preference for NP1 attachment was reported for genitive constructions in Persian like numerous other non-configurational languages, including Spanish, Dutch, French and Greek.

4.2 Off-line Task Results

Type of preposition (*of* vs. *with*) was considered as the independent variable with two values NP1 and NP2. The dependent variable was the subjects' performance in each condition i.e. *of condition* vs. *with condition,* and their NP attachment preferences. Table 2 presents the mean percentage of different responses provided by the subjects for each of the two antecedent types.
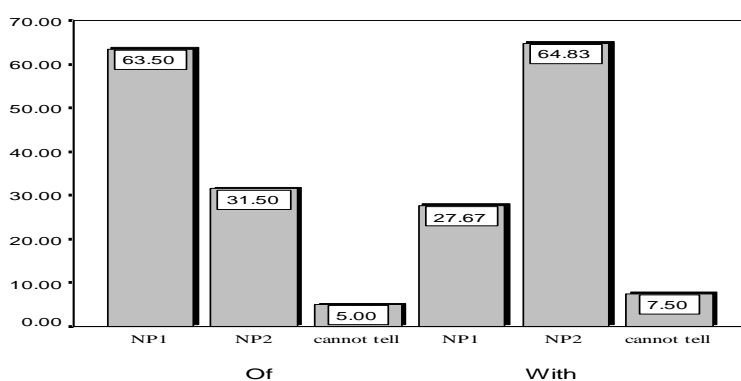
Table 1

Mean Percentages of NP1 and NP2 Responses Per Condition

Condition	Response	Mean	SD
	NP1	63.50	29.94
OF	NP2	31.50	
	Cannot tell	5.00	15.75
	NP1	27.66	26.31
WITH	NP2	64.83	29.92
	Cannot tell	7.50	19.10

The performance of the subjects in the two conditions was compared regarding their NP attachment preferences. As indicated in the above table, there was a clear difference between the two experimental conditions, in that NPs linked by *with* elicited a much higher number of NP2 responses (64.83%) than did the *of* condition, which produced a higher number of NP1 responses (63.50%). In contrast NP1 preference in *with* condition (27.66%) and NP2 preference in *of* condition (31.50%) were lower. Figure 1 presents the mean percentages of the three possible types of responses provided for each of the two antecedent types.

Figure 1

Mean Percentages of Responses in of and with Conditions

It can be noticed from the above figure that the subjects treated the two conditions differently, in the *of* condition there was an NP1 attachment preference as the subjects' native language, Persian. In contrast, NP2 was the preferred attachment in the *with* condition.

A repeated-measure ANOVA on the percentages of NP2 attachments with the factor preposition (*of* vs. *with*) revealed a significant main effect of preposition, $F(1, 29) = 24.46$, $p<$ .0005. Wilks' lambda = .542.

A pairwise comparison of the preposition (*of* vs. *with*) on the percentages of NP2 responses showed that the percentage of NP2 responses were significantly higher in *with* condition than *of* condition, p < .0005, with the mean difference 33.33.

Similarly, a repeated-measure ANOVA on the percentages of NP1 attachments with the factor preposition (*of* vs. *with*) revealed a significant main effect of preposition, $F(1, 29) = 28.67$, p< .0005. Wilks' lambda = .503.

A pairwise comparison of the preposition (*of* vs. *with*) on the percentages of NP1 responses showed that the percentage of NP1 responses were significantly higher in the *of* condition than *with* condition, p < .0005, with the mean difference 35.83.

Two more paired sample t-tests were conducted to compare NP1 vs. NP2 attachment preferences in both *of* and *with* conditions separately. Considering *of* condition, a paired-sample t-test was conducted to compare the subjects' NP1 vs. NP2 attachment preferences in this condition. There was a statistically significant difference between NP1 attachment preferences (M= 63.50, SD= 29.94) and NP2 attachment preferences (M= 31.50, SD= 27.88) in *of* condition, $t(29) = 3.147$, p< .004. The eta squared statistic (.25) indicated a large effect size.

Similarly, a paired-sample t-test was conducted to compare the subjects' NP1 vs. NP2 attachment preferences in the *with* condition. There was a statistically significant difference between NP1 attachment preferences (M= 27.66, SD= 26.31), and NP2 attachment preferences

(M= 64.83, SD= 29.92) in the *with* condition, t (29) = 3.83,   p< .001. The eta squared statistic

(.33) indicated a large effect size.

3.3 On-line Task Results

As the aim of the current experiment was to investigate the participants' on-line disambiguation

preferences, statistical analysis was performed only on the reaction time data. The basic

statistical analysis on the reaction time results and the subjects' answer accuracy were

conducted by the E Prime software. They were then transferred to the SPSS software for both

descriptive and inferential analyses.

The overall response accuracy rate was good, with the subjects answering 89.77 % (SD = 5.44)

of the questions to the experimental items correctly, indicating that they were paying attention

to the task. See Table 2 below.

Table 2

Subjects' Mean Response Accuracy

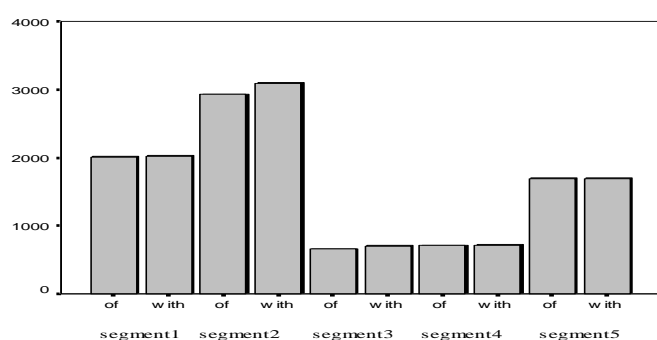|	N	Minimum	Maximum	SD
Response Accuracy	30	78.33	89.77	5.44

The group's mean reaction times to each segment for the six conditions were then calculated.

To eliminate individual outliers, the mean reaction times per subject were compared with that

of group's mean and those which were above 2 SD from the group's mean were removed,

leading to the exclusion of two subjects. The remaining data from 30 subjects were included in

the statistical analysis. The mean reaction times related to the first forty ambiguous

experimental sentences as Group 1 are provided in Table 3 below. Here and in the following,

all reaction times are given in milliseconds.

Table 3

Mean Reaction Times Per Condition for all Segments in Group 1

Condition	Segment1	Segment2	Segment3	Segment4	Segment5
Of	2009	2924	653	706	1690
With	2019	3083	705	717	1684

The above table shows the mean reaction times in all segments in both *of* and *with* conditions, in almost all the segments processing took longer in *with* condition than *of* condition but as explained below this difference is not significant. Figure 2 represents the reaction times to each segment per condition. As can be seen from the following figure the differences in reaction times in each condition are not significant.

Figure 2

Mean Reaction Times Per Condition in Ambiguous Constructions

A paired-sample t-test was conducted on all the segments separately to compare the subjects' on-line processing of ambiguous sentences in *of* condition vs. *with* condition. There was no significant difference in the mean reaction times per condition for all the segments, i.e., there was no significant effect of preposition on online processing of ambiguous sentences indicating that there was no difference between ambiguous sentences containing genitive *of* or thematic preposition *with* in real time processing. Considering segment four which can be the critical segment in the online task, there was no significant effect of preposition on online processing

of the sentence, and the reactions times in each condition did not differ significantly, p < .573.

Table 4 provides the results of paired sample t-tests in each segment separately.

Table 4

Results of Paired Sample T-tests in all Segments Per Condition in Ambiguous Constructions

		Paired Differences		T	Df	Sig. (2-tailed)
		MD	SD			
Segment 1	OF vs. WITH	-9.8570	398.93189	-.135	29	.893
Segment 2	OF vs. WITH	-159.2500	570.39039	-1.529	29	.137
Segment 3	OF vs. WITH	-52.3890	141.82095	-2.023	29	.052
Segment 4	OF vs. WITH	-11.1753	107.42875	-.570	29	.573
Segment 5	OF vs. WITH	6.6930	294.12221	.125	29	.902

According to the above table none of the segments showed a significant effect of preposition on online processing of ambiguous sentences, since the p value is higher than .05 for each segment.

Comparing these results with the results of the off-line questionnaire, it is implied that Persian advanced learners of English process ambiguous sentences of the same type differently in off line vs. online conditions and do not apply the same parsing strategies. As was mentioned earlier in the off-line processing, there was a significant effect of preposition but no such effect when processing in real time. In on-line processing there is no such effect of preposition. Whether the NPs are linked by the genitive *of* or thematic *with* would not help the reader resolve the ambiguity in the sentence in real time but in off-line condition, type of preposition had a significant effect on ambiguity resolution as was revealed from the subjects' preference of one NP over the other one.

The second group of the experimental sentences consisted of 80 temporarily ambiguous sentences, in which the disambiguation occurred in the fourth segment, where the auxiliary verb determined the NP1 or NP2 attachment preferences. Having two auxiliary verbs and two prepositions, four different conditions were investigated separately. The reaction times to each segment in different conditions are presented in Table 5 below.

Table 5

Mean Reaction Times Per Condition for all Segments in Temporarily Ambiguous Constructions

Condition	Segment1	Segment2	Segment3	Segment4	Segment5
Of-NP1	2029	2973	668	843	1441
Of-NP2	2022	3099	654	796	1523
With-NP1	2015	3175	694	919	1447
With-NP2	1965	3265	646	777	1462

Based on the above table, all these reaction times were described and compared using SPSS software. To analyze the reaction times of the second group of the experimental sentences, repeated measure ANOVAs with the factors preposition (of vs. with) and attachment (NP1 vs. NP2) were performed on the reaction time results for each of the five segments, followed by a pairwise comparison of each segment which compared the reaction times to each segment. A detailed analysis of each segment is presented in the following.

Segment 1

No statistically significant effect of preposition was found for segment 1, $F (1, 29) = 1.13$, $p = .296$, Wilks' Lambda = .962. There was no significant main effect of attachment either $F (1, 29) = .393$, $p < .536$, Wilks' Lambda = .987. Additionally, there was no significant interaction of preposition by attachment, $F (1, 29) = .224$, $p < .64$, Wilks' Lambda = .992.

A pairwise comparison showed that the mean reaction times to segment one in *of* condition was higher than *with* condition with a mean difference of 36.01, but this difference between *of* and *with* conditions was not significant, $p < .296$.

Segment 2

In segment two, there was a significant effect of preposition $F (1, 29) = 8.04$, $p < .008$. Wilks' Lambda $= .783$. The subjects treated both prepositions differently. The results of a pairwise comparison indicated that the reaction times were faster in the *with* condition than in *of* condition which meant the subjects processed this segment faster when the NPs were linked by the preposition *with*. The mean difference turned out to be 184 milliseconds.

Considering the attachment variable, there was no significant effect of attachment in segment 2, $F (1, 29) = 3.22$, $p < .083$. Wilks' Lambda $= .90$. Similarly, no significant interaction of attachment by preposition was found, $F (1, 29) = .128$, $p = .723$. Wilks' Lambda $= .996$.

Segment 3

No statistically significant effect of preposition was found for segment 3, $F (1, 29) = .354$, $p < .556$, Wilks' Lambda $= .988$. Nonetheless, the attachment had a significant effect, $F (1, 29) = 5.159$, $p < .031$, Wilks' Lambda $= .849$. The subjects processed the sentence slightly faster when they attached the relative clause to the second NP (NP2). Mean difference in the reaction times was 31.66.

No significant interaction of preposition by attachment, $F (1, 29) = 1.85$, $p < .184$, Wilks' Lambda $= .940$ was found in this segment.
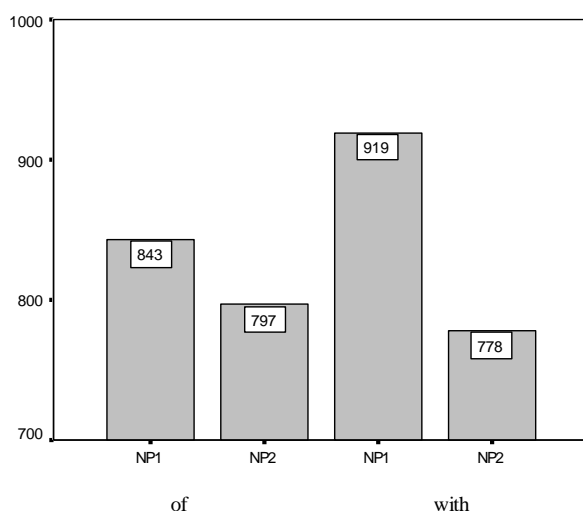
Segment 4

At the disambiguating fourth segment, the ANOVA results showed a non-significant main effect of preposition, $F (1, 29) = 3.67$, $p < .065$, Wilks' lambda $= .887$. The NP2 attachment elicited substantially shorter reaction times than did NP1 attachment for the *with* conditions only (777 vs. 919), with a mean difference of 141.53, $t (29) = 3.78$, $p < .001$. But there was no such significant difference in the *of* condition (796 vs. 843), with a mean difference of 46.50, $t (29) = 1.83$, $p < .078$.

Considering attachment, the ANOVA results for this segment showed a significant main effect of attachment, $F (1, 29) = 14.229$, $p < .001$, Wilks' Lambda $= .671$. as well as a significant interaction of preposition by attachment, $F (1, 29) = 5.615$, $p < .025$, Wilks' Lambda $= .838$. As was mentioned earlier the difference between NP1 and NP2 attachment was statistically reliable only for the preposition *with*. These results indicate that whereas the Persian-speaking L2 learners showed a preference for NP2 attachment for NPs linked by *with*, they did not show any on-line attachment preferences at all for relative clauses following complex genitive NPs. The subjects' mean reaction times to the critical segment containing the disambiguating auxiliary i.e., segment four are plotted in Figure 3 below.

Figure 3

Mean Reaction Times to Segment 4 in Temporarily Ambiguous Constructions

The above figure indicated that the subjects produced significantly shorter reaction times to the critical segment for sentences forcing NP2 disambiguation for the *with* condition, but no significant result was achieved if the two critical NPs were joined by the preposition *of*.

Segment 5

In segment five, as in segment one, no statistical effects or interactions were found. No statistically significant effect of preposition was observed, $F (1, 29) = .908$, $p < .349$, Wilks' Lambda = .970. There was also no significant effect of attachment $F (1, 29) = 1.80$, $p < .190$, Wilks' Lambda = .942. Additionally, no significant interaction of preposition by attachment, was observed [$F (1, 29) = .958$, $p < .33$, Wilks' Lambda = .968]

5. Discussion

This section deals with giving preliminary answers to the research questions based on the findings of the results. What follows is a discussion of different processing theories employed by the subjects through different tasks which were applied in this study.

5.1 Processing Strategies Employed by Native Speakers vs. L2 Learners

The pattern of results from the Persian-speaking subjects was remarkably similar to the results obtained from similar on-line tasks among German and Greek learners of English in studies carried out by Felser et al. (2003) and Papadopoulou and Clahsen (2003) among others, but differed from the pattern of results found in numerous earlier studies investigating relative clause attachment preferences among English native speakers. Specifically, whereas native speakers have been found to favor NP2 attachment for complex NPs linked by the case-marking preposition *of*, based on the phrase structure rule of *recency,* advanced Persian learners of English showed no attachment preference at all for ambiguous or temporarily ambiguous sentences containing complex NPs of this type in online experiment and an NP1 attachment preference in off-line task which can be explained based on *predicate proximity* rule. In both off-line and on-line experiments Persian L2 learners of English attachment preferences were different from those of native speakers of English in the *of* condition. In other words, Persian-speaking learners of English do not employ the same sentence processing strategies as native speakers of English. This result is an answer to the first research question which was whether Persian L2 learners employ the same sentence processing strategies as native speakers of the target language or not.

To answer the second research question which is about the extent language learners are capable of using and integrating phrase structure and lexical-semantic information during processing, the theories of L2 processing and parsing strategies are briefly discussed in this section.

5.2 The Application of Phrase-structure Rules vs. Lexical-semantic Information during L2 Parsing

Evidence from both off-line and on-line studies also suggested that adult speakers' attachment preferences are also affected by the type of the preposition linking the two noun phrase, which

led to crosslinguistic NP2 attachment preference for NPs joined by the preposition *with,* indicating that adult L2 learners can access and make use of lexical-semantic information during sentence processing.

The results of this study demonstrated that, like native speakers of English, Persian L2 learners were influenced by the type of linking preposition during processing of relative clause attachment ambiguities, i.e. the subjects used lexical- semantic information when processing ambiguous sentences containing complex NPs joined by *with* in both off-line and on-line tasks. If the learners' NP2 preference reflected their use of purely phrase-structure recency strategy rather than using lexical-semantic rules, an NP2 preference was also expected for complex genitive antecedents as well, but no NP2 preference was found and there was no evidence from the results that L2 learners applied the phrase-structure based locality principle of recency when processing of ambiguous sentences containing complex NPs joined by *of.* In contrast, in the genitive case, the participants preferred NP1 in the off-line task indicating the transfer effect from the subjects' L1, Persian which can be explained by the application of the phrase-structure rule of predicate proximity. In the online task no attachment preference was found. So, according to these findings L2 learners did not show the same attachment preference in the genitive case as native speakers of English who tend attach RC low to the second NP based on phrase structure rule of recency. It is concluded that L2 learners integrate information relevant for parsing differently from native speakers, with the L2 learners relying more on lexical-semantic cues than native speakers and less on phrase-structure rules.

Given that all the subjects were advanced L2 learners based on the proficiency test, it is not reasonable to relate their non-nativelike performance to their insufficient grammatical

knowledge of the construction under investigation; however, this can be defined in terms of processing differences between native speakers and L2 learners.

In the off-line task, the subjects had more processing time than the on-line task and could also reread the sentence which guided them through attaching RC to the initial NP in line with their native language, Persian based on the phrase-structure rule of predicate proximity. Given more time for interpreting ambiguous sentences in the off-line task, advanced L2 learners exhibited the same disambiguation preferences as in their L1. And transfer had an effect in the off-line task as the L2 learners may resort to some metacognitive knowledge. Contrary to the results of the off-line task in the on-line condition the subjects had shorter processing time, and they did not have the chance to reread the sentence as it disappeared from the monitor screen the moment they read it, so due to the increased working memory demands the subjects did not show any attachment preferences. In this case, transfer did not have any effect and neither of the phrase structure rules of recency and predicate proximity was applied, and since the two NPs were linked by the genitive *of* there was no lexical semantic cue for the subjects to attach the RC low to the second NP based on lexical-semantic information. However, the learners performed similarly to native speakers only on sentences containing the thematic preposition with, for which no cross linguistic variation is attested so far.

As it is proved that L2 learners rely on lexical-semantic information during processing, in the absence of lexical or contextual cues in the genitive constructions, they transferred NP1 attachment preference from their L1 for disambiguation in the off-line task and no attachment preference was found in the on-line task.

5.3 The Role of Transfer in L2 Processing

The subjects in this study were advanced L2 learners. So, they already possess a fully developed processing system for their L1, accordingly the processing strategies from the L1 can be transferred to the L2. There was evidence from the results of the off-line task which suggested that Persian-speaking L2 learners of English have transferred the NP1 preference for complex genitive NPs from their native language. But there was no such transfer effect in the studies carried out in other languages such as Spanish, Greek and German.

The results from this study is in line with previous other studies considering the *with* condition, in which L2 learners are sensitive to lexical biases provided by the linking preposition *with,* so they rely more on lexical-semantic rules and less on the phrase structure rules, as a result there is no effect of transfer in the *with* condition in both on-line and off-line tasks.

One more condition to be discussed is the genitive case in the on-line task. Based on the results of our study and the previous studies done by the other researchers no effect of transfer was found in this condition, in other words, L2 learners did not show any clear attachment preference for relative clauses preceded by complex genitive NPs, regardless of the preferences found in either the target language or their native language.

Given Clahsen and Felser's suggestion that L2 learners do not make use of phrase-structure information during L2 processing to the same extent as native speakers do, this can be concluded that in the absence of any lexical cues provided by the linking preposition, L2 learners postpone associating an ambiguous relative clause with either of the two antecedent NPs until other cues to interpretation become available, rather than transferring the structure-based predicate proximity strategy from their native language to the L2.

The results of the current study are incompatible with the results found by Smith (2016) in which it was found that L2 Japanese speakers resolved NP-of-NP attachment ambiguity similar to native speakers, and that participants' native language has no effect on their ambiguity resolution preferences. Moreover, the results refute the findings of the study by Marefat and Farzizadeh (2018), claiming non-native speakers disambiguate relative clauses similar to native speakers. In contrast, this study helped reveal that L2 learners of English resolve ambiguities in a non-native-like fashion, indicating that L2 learners rely more on lexical-semantic cues than native speakers and comparatively less on phrase-structure rules

To sum up, considering the genitive case, Persian L2 learners of English transferred phrase structure rule of predicate proximity in the off-line task but no such effect was found in the on-line task. In a similar vein there was no transfer while a thematic preposition was employed.

6. Conclusion

Advanced Persian-speaking learners of English examined in this study exhibited a strong NP2 bias for the *with* conditions, in both off-line and on-line experiments. This is the same pattern that was observed by Clahsen and Felser (2006a, b, c) in L2 learners of English from different language backgrounds such as German and Greek. Moreover, English native speakers showed a similar attachment preference in this condition. However, the patterns of relative clause attachment preferences in the *of* conditions varied in the off-line task from the on-line experiment, in that, an NP1 attachment preference in the off-line task, and no attachment preference for complex genitive antecedents in the on-line task, were demonstrated. In contrast, native speakers of English preferred to attach RC low to the second NP (NP2).

The results indicate that, despite their high level of competence in English, advanced Persian learners of English did not process ambiguous relative clauses with complex genitive antecedents in the same way as adult native speakers do.

The findings suggest that advanced Persian L2 learners are able to make use of lexical-semantic information to disambiguation during processing. Considering the phrase structure locality principles, although there was no evidence from this study concerning Persian L2 learners' acquisition of the recency preference for complex genitive antecedents that is found in English, the subjects transferred the predicate proximity strategy from their L1, Persian in the off-line experiment. It has to be noted that no such transfer effect was found while on-line processing of the genitive constructions.

Taken together, these findings imply that, adult Persian learners of English like other L2 learners are less guided by universal, least effort based parsing principles during sentence processing and depend more on the surface form for interpretation.

6.1 Implications and Suggestions for Further Research

The present empirical study is the first study, to the best of the researchers' knowledge, investigating the way Persian learners of English resolve ambiguities in sentences containing a relative clause which can be attached either high to the first NP or low to the second NP. It can give helpful insights into the way grammatical processing occurs among Persian learners of English and examines the extent to which Persian L2 learners processing mechanisms and strategies correspond to those applied by native speakers, the results of which can help

curriculum designers gain further theoretical insights in finding the ways through which native-like grammatical processing strategies can be acquired in L2 acquisition which can consequently lead to ultimate native-like attainment. This highlights the importance of processing instruction which aims at giving the learners explicit knowledge about the processing strategies and the target structure to help them better acquire the second language. Furthermore, the findings of this study give rise to the solutions concerned with the processing problems and nonnative-like attainment in an EFL context like English classrooms in Iran. Finally, the study emphasizes the importance of the processing issue in L1 and L2 acquisition studies and implies that to gain native-like attainment in a foreign language requires not only a complete grammatical knowledge but also native-like processing is a crucial factor.

The following suggestions are made for the further studies which can contribute to the ongoing research in the area of grammatical processing. First of all, this study was mainly restricted to the learners at the high level of proficiency and within a particular age range. However, there is yet to be known about how Persian learners at different ages in different levels of proficiency process grammatical ambiguities, which can be investigated in later studies.

Secondly, the processing of other ambiguous structures including garden path constructions could further be studied to shed more light on the processing strategies employed by Persian learners of English. Moreover, the administration of some other tasks such as grammaticality judgment task can further illuminate more information on the subjects' underlying intuition on the constructions under investigation. The fourth limitation concerns individual differences in working memory capacity that may also influence ambiguity resolution (MacDonald, Just & Carpenter, 1992; Mendelsohn & Pearlmutter, 1999). This is worth investigating in later studies

considering groups of learners with different memory spans. Finally, it should be mentioned that more studies need to be carried out investigating processing issues among Persian native speakers.

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