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Transformational Ambiguity Resolution in Persian

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ABSTRACT

In recent years, there has been an increasing interest in studying how ambiguous sentences are processed in different languages. However, far too little attention has been paid to studying the processing of Persian ambiguous sentences. Therefore, the present study is an attempt to study the processing of transformational ambiguous sentences in Persian in which the main verb refers to either of the preceding noun phrases. The main objective is to find out the attachment preference of Persian speakers when reading such sentences. The presented sentences to the participants were semantically consistent with either high or low attachment resolution. That is, the main verb was referring to either the first noun phrase (NP1) or the second noun phrase (NP2). To investigate the nature of this process, an on-line technique was used. Employing Rapid Serial Visual Processing (RSVP) technique, the reaction times and grammatically judgment of 72 Persian native speakers (37 male and 35 female) who were randomly selected were recorded and analyzed. The results of accuracy of judgments and reaction times indicated that Persian speakers use high attachment strategy for this type of ambiguity. The findings of this study are compatible with the results of previous offline studies on parsing preference of native Persian speakers. It also added that Persian speakers use purely structure-based parsing strategies rather than constrained-based models of sentence processing.

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1. Introduction

Studying how people process language is an important arena of research in linguistics and psycholinguistics (Gibson, 1991). Psycholinguistics as a branch of cognitive psychology is concerned with the nature of processes of the brain in comprehending and producing language (Moyne, 1985). With regard to the language comprehension, some aspects of the language a person receives are not explicit, leading to vagueness and confusion, and prevent comprehending what was meant by speaker or writer. Therefore, studying how language users cope with these kinds of sentences can be an important issue in language comprehension paradigm. Such sentences with unclear meaning or interpretation are called ambiguous sentences.

In the Persian language, as asserted by Bateni (1970), there are three types of ambiguity. The first type is lexical ambiguity which refers to one word with more than one meaning, for example, the Persian word شانه */šaneh/* could mean 'comb' or 'shoulder of a person'. When this word is used out of context, it is ambiguous. The second type of ambiguity is structural ambiguity which consists of grouping ambiguous words like یک زن و مرد جوان /jek zæn-o mærd-e ĵavān/ a young man and woman' which could mean 'a young man and a woman' or 'a young man and a young woman'. The third type is the transformational ambiguity. The notion of transformational ambiguity in English was first introduced by Lyons (1975) and defined as 'ambiguous constructions which depend on the deeper connexions' (p. 249). Since in speech, the context and the stress pattern can tell us how to interpret the utterance, it is present only in written language (Crystal, 1971, as cited in Ögeyik, 2019). According to Lyons, transformational ambiguity neither excludes nor implies surface structure ambiguity. A sentence is transformationally ambiguous if and only if it is derived from two or more distinct underlying structures. That is, one surface structure is related to two different deep structures. Chomsky's famous example in English, "Flying planes can be dangerous" can mean either that "Planes which are flying can be dangerous" or that "To fly planes can be dangerous". As an example in the Persian language, the sentence 'خانم دکتر به فاطمه گفت که باردار است' */xānom doktor be Fateme goft ke bārdār æst/* (The doctor (female) told Fateme that she is pregnant) could refer to deep structure 1 'خانم دکتر به فاطمه گفت که فاطمه باردار است' */xānom doktor be Fateme goft ke Fateme bārdār æst/* (The doctor (female) told Fateme that Fateme is pregnant) or it could refer to deep structure 2 'خانم دکتر به فاطمه گفت که خودش باردار است' */xānom doktor be Fateme goft ke xodeš bārdār æst/* (The doctor (female) told Fateme that she herself is pregnant). Readers/hearers interpret such sentences with reference to one of the deep structures of the sentence. This selection of one interpretation rather than the other (i.e., the parsing preference) is determined by the preference of native speakers to first NP or to the second NP.

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To date, a very small number of studies have investigated the processing of different kinds of ambiguous sentences in Persian (Asadollahfam, 2010; Davodi, Nasiri & Taheri, 2015; Marefat & Arabmofrad, 2008; Marefat & Meraji, 2005); however, to the best of the researcher's knowledge, no research has been found that investigated the processing of Persian transformational ambiguous sentences in which the main verb is semantically related to NP1 or NP2. Therefore, this study is an attempt to find the tendency of Persian speakers in interpreting this kind of ambiguous sentences.

2. Review of the Literature

Models of Sentence Processing

Most of the psycholinguistic sources distinguish two main theories of sentence processing: syntax-first (or garden-path) and constraint-based (lexicalist) approaches (Cargill, Dale, Farmer, Hindy & Spivey 2007; Green & Mitchell, 2006; Kempen & Vosse, 1989; Pickering, Traxler& Van Gompel, 2001).

Garden Path (syntax-first) Model

Syntax-first or garden-path model of sentence processing, provided by Frazier and Rayner (1982), was an answer to the question of how people process language. This is a serial, modular view of language processing. It is serial because the parser initially considers only one syntactic structure regarding minimal attachment and late closure. And it is modular since the initial stages of word and sentence comprehension are not influenced by higher levels of knowledge like context. Pickering et al., (2001) asserts that in this model, the syntactic analyses are computed by the processor, in two stages serially. In the first stage, an initial analysis is constructed by drawing on a limited range of information sources. However, access to lexically specific information, including structural information associated with specific words, detailed lexical semantics, discourse, and world knowledge, is assumed not to be available at this stage (Elman, Hare & MacRae, 2004). In the second stage, other sources of information will be available to the comprehender, which may sometimes lead to abandoning its initial analysis and revision of the initial parsing (Pickering et al., 2001).

As the other name of this model 'syntax-first' suggests, the initial parsing decisions are based only on knowledge about permissible grammatical structures (Filik, Paterson, & Liversedge, as cited in Arabmofrad, 2006). In this model, the human sentence parsing mechanism initially pursues just a single analysis when encountering the temporary ambiguities of natural language. However, then the chosen analysis turns out to be incorrect if there is more than one possible analysis for some parts of the sentence and consequently the parser is led down to garden-path (Frazier & Rayner, 1982). In the Garden path model, the construction of syntactic analysis is based on two principles i.e., minimal attachment and late closure.

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> *Late closure: "*When possible, attach incoming lexical items into the clause or phrase currently being processed i.e., the lowest possible nonterminal node dominating the last item analyzed" (Frazier & Rayner, 1982, p. 180).
>
> *Minimal Attachment: "*Attach incoming material into the phrase-marker being constructed using the fewest nodes consistent with the well-formedness rules of the language" (Frazier &Rayner, 1982, p. 180).

Since it is assumed that the principle of Minimal Attachment applies before the principle of Late Closure, Minimal Attachment has priority when conflicts between the two arise (Gibson, 1991). The principles of Minimal Attachment and Late Closure inside a serial processing model correctly predict a large array of garden-path effects and preferred readings of the ambiguous input.

Constraint-based (Lexicalist) Theories

The term "constraint" refers to any pattern from human's language experience that becomes part of the linguistic knowledge; constraints can be based on frequency, plausibility, grammaticality, and so forth (Boland & Blodgett, 2001). In respect of the wide variety of constraints that seem to affect sentence comprehension, Multiple constraint-based (lexicalist) theories of sentence comprehension have been developed (Green & Mitchell, 2006; MacDonald, Pearlmutter, & Seidenberg, 1994). The influence of specific lexical information, context, verb category, and many other constraints in comprehending a sentence are crucial in such theories. Constraint-based models are also referred as parallel models of processing since in these models all possible analyses at the choice point are considered at once (Green & Mitchell, 2006), that is, the processor can activate multiple analyses in parallel (Pickering et al.,2001). Both syntactic and nonsyntactic information are employed in a single stage to foreground one analysis, but other analyses remain activated.

These theories consider language comprehension as an interactive process whereby all possible syntactic representations are simultaneously partially active and competing for more activation across time Cargill et al. (2007). Unlike the syntax-first models, multiple syntactic or non-syntactic sources of information are immediately integrated to determine the amount of activation provided to each of the competing alternatives.

Clifton, Meyer, Treiman and Wurm (2003) state that constraint-based theories correctly predict that a variety of factors like specific lexical information, context, verb category, and many other factors can reduce or eliminate garden-path effects when a temporarily-ambiguous sentence is resolved in favor of an analysis that is not normally preferred. However, as predicted by the constraint-based theories, such factors will be a source of creating garden paths when the sentence is resolved in favor of its normally-preferred analysis. That is, situational and discourse context have been emphasized as major constraints on sentence comprehension by constraint-based theories. MacDonald and Pearlmutter (1995) argue that in constraint-based models, ambiguity resolution is a function of two kinds of probabilistic constraints, frequency and context.

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Parsing

Readers or listeners use their linguistic knowledge (e.g., morphology, syntax, semantics, and phonology) for interpretation of the language they encounter. A parser, by using the grammar of a language which contains the general syntactic principles and constraints of a language, assigns different syntactic structure to a sentence (Arabmofrad, 2006). In other words, a syntactic description of a sentence is produced from its surface form by parsing (Rohde, 2002). Boland and Blodgett (2001) define parsing or syntactic analysis of sentences as the means by which people structure incoming words into a hierarchical representation according to the grammar of their language. In this respect, a two-stage model of parsing has been presented by Kimball (1973) in the first stage of which, the surface structure of a sentence is computed on the basis of surface grammar rules. The deep structure is then derived from the surface structure in the second stage. Boland and Blodgett (2001) also state that this process can be broken down into at least three components: (1) generation of syntactic structure, including the identification of alternative structures at points of ambiguity; (2) selection of a single structure; and (3) reanalysis if the structure initially selected turns out to be incorrect.

Reanalysis

Lewis (1998) defines reanalysis as "the function of revising the interpretation of previously perceived linguistic material based on information that follows later" (p. 249). Carreiras, Clifton and Meseguer, (2002) define reanalysis as the following: "at some points in comprehending a sentence, a reader may assign a unique structural analysis to the sentence up to the point in question. If later information forces the reader to attempt to revise that analysis, reanalysis occurs" (p. 4). They mention some factors affecting processing difficulty, including plausibility, prosodic information, and length of the ambiguous region, among others.

Parsing Preferences in Different Languages

In studying the parsing of structurally ambiguous sentences, most researchers have focused on embedded relative clause ambiguous sentences because this kind of ambiguity occurs in numerous languages. In the following example, which could be interpreted as implying that either the servant or the actress was the person who was on the balcony, if the parser attaches the RC to NP1, this is called NP1 attachment, early attachment or high attachment, and if it attaches RC to NP2, it is called NP2 attachment, late closure or low attachment (Cuteos, Mitchell & Corely, 1996).

Someone shot the servant (NP1) of the actress (NP2) [who was on the balcony]

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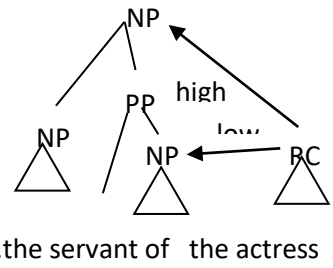


Fig. 1. ***Low Attachment &High Attachment Preference***

Comparison between parsing preferences of different languages has shown that in French, Italian, German, Dutch and several other Indo-European languages eventual high attachment preferences have been found (Kamide & Mitchell, 1997). Also, in Spanish high attachment strategy is used (Cuteos et al., 1996). However, in English (Carrerias & Clifton, 1999) and Arabic low attachment strategy is used. In Persian, Marefat and Arabmofrad (2008) and Marefat and Meraji (2005) investigated processing ambiguous sentences with embedded relative clauses and concluded that Persian speakers prefer to attach the verb to the first noun phrase and so they use high attachment strategy. Such an analysis can also be done for transformational ambiguous sentences. In such sentences, there are two noun phrases that the main verb refers to either the first noun phrase or second noun phrase. If the verb refers to the first noun phrase, this is called NP1or high attachment and if the verb refers to the second noun phrase, it is called NP2 attachment or low attachment. So, by studying the preferences of Persian native speakers in reading transformational ambiguous sentences, the attachment preferences of Persian speakers can be determined.

3. Research Questions

1- Do Persian speakers prefer the first noun phrase or the second noun phrase in transformational ambiguous sentences?

2- Is there any difference between ambiguity status (ambiguous vs. unambiguous) as far as the accuracy of judgments is concerned?

3- Is there any difference between ambiguity status (ambiguous vs. unambiguous) as far as reaction time is concerned?

4. Method

Participants

The initial sample consisted of 80 students of whom eight participants did not completely answer the needed questions. So, results of accuracy of judgment and reaction times of 72 Persian speakers, 37 males and 35 females, aged between 17 and 21 were analyzed in this study. All of them were selected randomly from a total of 250 students of two high schools in Kalale town, in Golestan Province, Iran. The first language of all of them was Persian and all of them have mastered their mother tongue completely, so they didn't have problems with vocabulary or sentence structure of

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test sentences. Moreover, they had not yet mastered a second language which could affect their judgments about test sentences. All of them were able to work with computer and have practiced working with the software to answer the questions.

Instruments & Materials

The materials used in this experiment were of three types of computer-based sentences: warm-up sentences, test sentences, and filler items. The language of the test items was Persian, the native language of the participants.

Warm-up Sentences

Seven grammatical and seven ungrammatical sentences were presented to students as warm-up sentences. They read the sentences on the computer screen and then judged the grammaticality of those sentences by pressing certain buttons. The reason for presenting these sentences from the beginning was to help participants to get familiar with the task they are supposed to do in the main study and also practice how to work with the software.

Test Sentences

Test sentences were 12 sets of sentences. In each set, there were three sentences (i.e., a total of 36 sentences). In the first sentence of each set, the verb referred to first noun phrase (NP1). In the second sentence, the verb referred to the second noun phrase (NP2). And in the third sentence of each set which was a transformational ambiguous one; the verb referred to either the first or second noun phrase (NP1/NP2). These test sentences were divided into three groups (i.e. each group involved 12 sentences) (see appendix 4). The three groups were balanced so that each condition in each set appears only once in each set and all conditions were presented in each set. In this way, each participant received four sentences in which the verb refers to NP1; four refers to NP2 and four ambiguous ones (referring to both NP1 and NP2). The following is an example of test sentences:

1. Verb referring to NP1

Xānom doctor	*be Ali*	*goft*	*Ke*	*bārdār æts*
The doctor$_{NP1}$ (female)	to Ali $_{NP2}$ (male)	told	that	She is pregnant

The doctor (female) told Ali that she is pregnant. In this sentence the verb can only refer to NP1, therefore the sentence is unambiguous.

2. Verb referring to NP2

Āghāje doctor	*be Fāteme*	*goft*	*Ke*	*bārdār æst*

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The doctor$_{NP1}$ (male)	to Fateme$_{NP2}$ (female)	told	that	She is pregnant

The doctor told Fateme that she is pregnant. In this sentence, the verb can only refer to NP2, so this sentence is also unambiguous.

3. Verb referring to NP1/ NP2

Fœribā	*be Sārāh*	*goft*	*ke*	*bārdār œst*
Fariba$_{NP1}$ (female)	to Sarah $_{NP2}$ (female)	told	that	she is pregnant

Fariba told Sarah that she is pregnant. In this sentence (3), more than one parse is possible. The verb can refer to either of the preceding NPs. So, this sentence can be interpreted in more than one way and is ambiguous.

Filler Items

These filler items consisted of a total of 14 sentences, seven grammatical and seven ungrammatical sentences (see Appendix 2). The sentences were selected from newspaper articles and TV programs to maintain authenticity. The reason for using such filler sentences was to obscure regular and repetitive pattern of test sentences; that is, putting grammatical and ungrammatical filler sentences among test sentences keeps the participants alert in answering test sentences. So, we can be sure that the participants pay attention to all the sentences they read on the monitor. Examples of grammatical and ungrammatical sentences are provided in the following.

An example of a grammatical sentence:

4. پسر همسایه مهندس ساختمان خواهد شد

The neighbor's boy will be a civil engineer.

An example of an ungrammatical sentence:

5. ❋ برادر بزرگم به دانشگاه راه یافته شد

My older brother is entered university❋.

Table 1. *Distribution of Different Sentences in each Test Version*

	Grammatical sentences	***Ungrammatical sentences***
Verb referring to NP1	12	--
Verb referring to NP2	12	--
Verb referring to NP1/NP2	12	--
Warm-up sentences	5	5
Filler items	7	7

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Procedures

The participants sat in front of the laptop and were tested individually. Before going through test sentences, they worked on warm-up sentences to get familiar with the procedure and the software. After warm-up sentences, the test sentences were presented in a non-cumulative way, using Rapid Serial Visual Processing (RSVP). The participants were taught that by pressing the space button on the keyboard a sentence appears in the following manner: at first, a fixation cross appears for 1500 ms, blinking three times and then disappears. Thereafter, at the same location, the first word appears for 750 ms and then disappears. This process continues until the last word of the sentence. Up to this point, the words appear automatically and the participants have no control over it. Then two boxes appear one for درست (*dorost*) which means correct/grammatical and the other one for غلط (*ghalæt)* meaning false/ungrammatical. The participants were instructed to select one of them and make their grammaticality judgments by pushing a response key if it was grammatical and another one if the sentence was ungrammatical. The two keys chosen for this step were the right and down arrow keys. Because the two keys are adjacent, participants could click these keys by the same finger and use of the other hand or fingers would not play any role in the results. Decisions and decision times were automatically recorded. Decision or reaction time was estimated as the interval between the disappearance of the last word and the participant's pressing the button to judge the grammatical status of the sentence. Furthermore, they were told that in case of clicking a key mistakenly, they should let the researcher know so that s/he could correct it in the answers recorded by the software. On average, each student reported having clicked the wrong key two times that showed their attention while taking the test.

5. Results

Accuracy of Judgment

Grammatically judgment of participants is one of the important factors in studying the nature of the processing of transformational ambiguous sentences and determining the parsing preferences, so 72 participants' judged sentences were analyzed. Descriptive statistics for the answers are shown in Table 2 below.

Table 2. *Descriptive Statistics of Accuracy of Judgments*

	N	*Mean*	*Std. Deviation*	*Std. Error Mean*
NP1	72	.84	.18	.021
NP2	72	.81	.20	.024
NP1/2	72	.89	.19	.023

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It can be seen from the data in Table 2 that the means of each of sentences demonstrated gain scores of .84 for NP1 attachment sentences, .81 for NP2 attachment sentences, and .89 for NP1/2 attachment sentences. Therefore, the initial look at the mean differences of these three groups of sentences indicates that the sentences with NP1/2 attachment outperformed the other two groups by having more accurate judgments (NP1/2 > NP1 > NP2).

In the next step, a paired samples t-test was conducted to determine whether any significant difference might be observed for the grammatically judgment of participants in each of the three groups. The results of the paired samples t-test, as presented in Table 3, indicated that there is not any significant difference between accuracy of judgments in NP1 and NP1/2 mean scores, t (71) = -1.95, p = .22, p < .05 and no significant difference between accuracy of judgments in NP2 and NP1/2 mean scores t (71) = -3.14, p = .23, p < .05. However, there was a significant difference in NP1 and NP2 mean scores, t (71) = 1.15, p = .25, p < .05. This means that difference between the accuracy of judgments of the participants in pairs of NP1 and NP2 referring sentences were low, but in two other pairs with ambiguous sentences (sentences with reference to NP1/2), the difference was high.

Table 3. *Paired Samples T-test for Accuracy of Judgment*

		Paired Differences					*T*	*Df*	*Sig. (2-tailed)*
		Mean	*Std Deviation*	*Std. Error Mean*	*95% Confidence Interval of the Difference*				
					Lower	*Upper*			
Pair 1	NP1Mean - NP2Mean	.034	.25	.030	-.025	.09494	1.15	71	.254
Pair 2	NP1Mean - NP12Mean	-.052	.22	.026	-.105	.00096	-1.95	71	.054
Pair 3	NP2Mean - NP12Mean	-.086	.23	.027	-.141	-.03177	-3.14	71	.002

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Results for Reaction Time

The results obtained from the preliminary analysis of reaction times are presented in Table 4.

Table 4. *Descriptive Statistics of Reaction Times*

	Mean	*N*	*Std. Deviation*	*Std. Error Mean*
NP1	1.68	72	.929	.109
NP2	1.97	72	1.32	.156
NP1/2	1.61	72	.990	.116

Note: All reaction times are given in milliseconds.

According to Table 4, a comparison of the means of each of the sentences demonstrated a gain score of 1.68 for NP1 sentences, 1.97 for NP2 sentences, and a score of 1.61 for NP1/2 sentences. Therefore, as shown in table 4, the NP2 attachment sentences had the highest reaction time means in comparison to the other two groups (NP2 > NP1 ~ NP1/2). And NP1 and NP1/2 attachment sentences had smaller reaction time means. So, the participants produced shorter reading times to the sentences in which because of a semantic cue, the verb refers to the first noun phrase (NP1). But the reading times for sentences in which the verb is semantically related to the second noun phrase (NP2) is longer. Moreover, the table indicates that the reading time of transformational ambiguous sentences is very close to results of sentences that refer to NP1. This means that the default strategy used to resolve ambiguity is attaching the verb to NP1.

In the next step, paired samples t-test was conducted to determine whether any significant difference might be observed in measuring the reaction times of participants in each of three conditions. The results of the paired samples t-test, as presented in Table 5, indicate that there is not any significant difference between accuracy of judgment in NP1 and NP1/2 mean scores $t(72) = .62$, $p = .907$, $p < .05$ and also NP2 and NP1/2 mean scores $t(72) = 2.75$, $p = 1.11$, $p < .05$. But the difference between performance of NP1 and NP2 mean score, $t(72) = -2.76$, $p = .900$, $p < .05$, is much more.

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Table 5 *Paired Samples T-test for Reaction Time*

		Paired Differences					*T*	*Df*	*Sig.*
		Mean	*Std Deviation*	*Std. Error Mean*	*95% Confidence Interval of the Difference*				*(2-tailed)*
					Lower	*Upper*			
Pair 1	NP1Mean - NP2Mean	.034	.25	.030	-.025	.09494	1.15	71	.254
Pair 2	NP1Mean - NP12Mean	-.052	.22	.026	-.105	.00096	-1.95	71	.054
Pair 3	NP2Mean - NP12Mean	-.086	.23	.027	-.141	-.03177	-3.14	71	.002

These pairwise comparisons showed no significant difference between reaction times of sentences with NP1 antecedents and reaction times of ambiguous sentences. But reaction times of NP2 antecedents were significantly different from reaction times of both NP1 and ambiguous sentences. This means that when the verb refers to NP2, the processing time to make judgments about such sentences is enhanced because the initial attachment has to be revised for the reason that the verb semantically disambiguates towards a structurally non-preferred attachment.

6. Discussion

The purpose of the present study was to investigate the processing of transformational ambiguous sentences in Persian and determine the parsing preference of Persian speakers in these sentences. The research question asked whether Persian speakers prefer the first or the second noun phrase in transformational ambiguous sentences and also to know any difference between ambiguity status (ambiguous vs. unambiguous) as far as the accuracy of judgments and reaction times are concerned. In this way, if the reaction times for both sentences are different and semantic constraints has no role in processing sentences, it can be concluded that Persian speakers are guided by structure-based parsing strategies, but if the reaction times for both sentences referring to either of NP1 and NP2 are the same we can conclude that Persian speakers use constraint-based strategies because the semantic features play a main role in processing.

Comparing the results of grammatically judgment and also reaction times for transformationally ambiguous sentences (sentences in which the verb refers to either NP1 or NP2)

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and unambiguous sentences (sentences in which the verb refers only to NP1 or NP2) indicated that unambiguous sentences were judged more accurately than ambiguous sentences and the verbs with reference to NP1 was processed with shorter reaction times in comparison to sentences with reference to NP2. In addition, the results indicated that reaction times of transformational ambiguous sentences were close to reaction times of sentences referring to NP1. That is, the findings suggest that Persian speakers in transformational ambiguous sentences unconsciously prefer to attach the verb to NP1 to resolve the ambiguity. Therefore, high attachment is the strategy used by Persian speakers to resolve transformational ambiguous sentences. As mentioned above, to the best of the researcher's knowledge no study has investigated processing of this type of ambiguity in Persian, but the results of studying other types of ambiguous sentences like embedded relative clause ambiguous sentences also revealed that native Persian speakers are guided by high attachment strategy in processing structurally ambiguous sentences (Marefat & Arabmofrad, 2008; Marefat & Meraji, 2006). Therefore, the findings of the present study are consistent with results of studying other types of ambiguities in Persian. As mentioned in the literature review, in languages like English (Carrerias & Clifton, 1999) and Arabic (Marefat & Arabmofrad, 2008), native speakers are guided by low attachment strategy in processing structurally ambiguous sentences. However, in languages like Spanish (Cuteos, Mitchell & Corely, 1996), French, Italian, German, Dutch and several other Indo-European languages (Kamide & Mitchell, 1997) eventual high attachment preferences have been found.

Findings of this study and other ambiguity resolution studies in Persian suggest that Persian native speakers are guided by structure-based parsing strategies. This is due to the fact that if semantics were playing a role, we would expect the reaction times to be the same for both sentences in which the verbs semantically refer to NP1 or NP2. Within the constraint-based accounts, semantic constraints are expected to contribute to comprehension. However, in this study, the constraints provided by semantic relatedness of the verb to NP2 could not make the readers immediately recognize that the sentence is grammatical because it was against their expectation that verb must be attached to NP1, a syntactically guided preference.

7. Conclusions & Implications

So far, however, there has been little discussion about the processing of other types of ambiguity in Persian. The results revealed that high attachment is the strategy used by Persian speakers to resolve structurally ambiguous sentences. The main objective of the present study was to investigate the processing of transformational ambiguity in Persian and determine the parsing preference of Persian speakers in these sentences. According to the results of the analysis of reaction time and accuracy of judgments, it is concluded that Persian speakers use high attachment strategy to resolve transformational ambiguous sentences. Findings of this study are compatible with the results of

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studying other types of ambiguity in Persian, for example in relative clause attachment ambiguous sentences Persian speakers use high attachment strategy (Marefat & Arabmofrad, 2008; Marefat & Meraji, 2006). Findings of this study and other ambiguity resolution studies suggest that Persian native speakers are guided by structure-based parsing strategies. Because if semantics were playing a role, we would expect the reaction time to be the same for both sentences in which the verbs semantically refer to NP1 or NP2. Within the constraint-based accounts, semantic constraints are expected to contribute to comprehension. But in this study, the constraints provided by semantic relatedness of the verb to NP2 could not make the readers immediately recognize that the sentence is grammatical because it was against their expectation that verb must be attached to NP1, a syntactically guided preference.

Since the present study is the first one in studying this kind of ambiguity, examining how these kinds of ambiguous sentences are processed provides useful information for linguists and psycholinguistics to analyze how ambiguous Persian sentences are comprehended. Therefore, Persian native speakers' attachment preferences in these kinds of ambiguous sentences can be determined, the results of which can be compared with parsing preferences of other languages. Moreover, the results can be compared by parsing preference of other types of ambiguity in Persian; for example, structurally ambiguous relative clauses.

The findings of this study can have some pedagogical implications for the language teachers and learners in an EFL context. The pedagogical implications for Persian language teachers are that they should attempt to make students recognize the importance of the ambiguity which is rife through the language and their everyday life and help them in implementing ambiguity their learning process (using in writing, and speaking and recognizing it in listening and reading) and real life. It is also useful for learners of Persian to get familiar with another type of ambiguous sentences that may be more difficult for them to comprehend.

These findings have also important implications for curriculum materials developers to include such structures in the Persian textbooks in order to familiarize learners with the nature of ambiguity as an inseparable part of daily language. They should incorporate a variety of real-life activities and learning tasks with regard to ambiguous sentences.

Authors' Contributions

All authors contributed significantly to the research process.

Declaration

We declare that this manuscript is original and has not been submitted to any other journal for publication

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Transparency Statements

The authors affirm that the data supporting the findings of this study are available within the article. Any additional data can be obtained from the corresponding author upon reasonable request.

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Declaration of Interest

The authors report no conflict of interest.

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The authors do not have any financial or non-financial competing interests.

Ethical Consideration

This manuscript adheres to the ethical guidelines provided by the Committee on Publication Ethics (COPE) for ensuring integrity and transparency in the research publication process.

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APPENDICES

Appendix 1. Warm-up sentences

Grammatical sentences:

غزلهای حافظ شیرازی بسیار دل نشین است.

پسر همسایه مهندس ساختمان خواهد شد.

Ungrammatical sentences:

برادربزرگم امسال به دانشگاه راه یافته شد.

زیباترین داستان شاهنامه تعلق به رستم و سهراب هستند.

Appendix 2. Filler items

Grammatical sentences:

شهردار تهران ازعزم جدی خود برای احیای برج آزادی خبر داد.

شهرمکه پرازکوههای سنگی کوچک و بزرگ است.

Ungrammatical sentences:

*انسان باید از زشتیها پرهیز و مبارزه کرد.

*دانش اموزان اعلامیه را به تابلو چسباند.

Appendix 3. Test sentences

NP1or NP2 فریبا به فاطمه گفت که باردار است.

NP2 آقای حمیدی به فریبا اطلاع داد که باردار است.

NP1 فاطمه به همسرش گفت که باردار است.

NP1or NP2 مهسا به آیدا گفت شاگرد اول شده است.

NP2 مدیر به مهسا گفت شاگرد اول شده است. .

NP1 مهسا به مادرش گفت شاگرد اول شده است.

NP1or NP2 مرجان به زهرا گفت کفشش گم شده است.

NP2 مرجان به مسئول جاکفشی اطلاع داد کفشش گم شده است.

NP1 پلیس به زهرا گفت کفشش گم شده است.

NP1or NP2 مجید به محسن خبرداد دوستش تصادف کرده است.

NP2 پلیس به محسن خبر داد دوستش تصادف کرده است.

NP1 مجید به ما گفت دوستش تصادف کرده است.

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