Grammaticality Judgment of Garden Path Sentences in Persian*

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Garden path sentences have been shown to predict difficulty in language processing, but no study has been conducted on Persian language. This study tested the prediction for Persian ambiguous sentences having two DPs in which the second DP functions as either the modifier of the first DP or the subject/object of the next clause. No significant effects were obtained for grammaticality judgment times but results of the analysis of accuracy of judgments for garden path sentences from 41 Persian native speakers by the use of RSVP technique revealed that there is a garden path effect in such sentences in Persian, and the distance of the critical word from the verb as the disambiguating word affects the comprehension of Persian garden path sentences. Moreover, the results showed that the location of the disambiguating word has an influential impact on processing garden path sentences. The results are discussed in the framework of the late closure principle.

Keywords: Persian garden path sentences, length of ambiguous region, disambiguating word, late closure principle

1. Introduction

Constructing and activating the appropriate syntactic structure is an important part of understanding a sentence and human cognitive system has a great capacity for rapid and efficient conflict detection and resolution. For most sentences this is straightforward and does not result in noticeable processing difficulty. But garden path sentences are not rapidly and efficiently processed. Garden path sentences lead the human sentence processor to construct an initial syntactic structure, which turns out to be incorrect, and thus requires

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syntactic (and semantic) reanalysis. Several studies have provided evidence that readers experience difficulty when they read the garden path sentences (e.g. Frazier & Rayner, 1982; Ferreira & Henderson, 1991a; Pickering, Traxler, & Crocker, 2000). Different aspects of processing garden path sentences including models of sentence processing, strategies adopted, parsing design, theories of initial choice, and reanalysis have been elaborately considered so far.

2. Brief review of studies on garden path sentences

Examining the processing of sentences with syntactic ambiguity, i.e., garden path sentences, has proved to be useful in gaining insight into the underlying mechanisms of human sentence comprehension. In garden path sentences, the syntactic structure assigned to the initial portion of a sentence is syntactically inconsistent with the following words (Meseguer, Carreiras, & Clifton, 2002). Encountering an ambiguous segment, the comprehension system adopts a strategy to resolve the ambiguity. If the information obtained from the rest of the sentence disconfirms the initial analysis then reanalysis of the sentence will occur.

Generally, finding the characteristics of garden path sentences that affect their difficulty, and the nature of the reanalysis process have been the main focus of theoretical and empirical research (Meseguer et al., 2002). With regard to characteristics of garden path sentences, a variety of factors that affect processing difficulty such as plausibility (Sturt, Pickering, & Crocker, 1999), prosodic information (Bader, 1998), length of the ambiguous region (Ferreira & Henderson, 1991a), and argument structure frequency (Ferreira & Henderson, 1991b) have been studied.

Furthermore, there are some controversies over the reason why the garden path effect occurs. Frazier and Rayner (1982) claimed that this happens because structural simplicity guides all initial analyses, that is, the direct object analysis is adopted because it is structurally simpler than the other possible analysis. For example in *The actor learnt the text amused the audience*, the tendency is to interpret *the text* as the object of *learnt* rather than the subject of the next clause. So the parser has to go back to assign a different interpretation. But others, like Altman (1989) and Tanenhaus, Carlson, and Trueswell (1989),
saw the multiple sources of information available to the parser (e.g., the absence of comma and the transitivity bias of the verb) as the main reason.

2.1. Parsing

Parsing or syntactic analysis is a process by which the mind structures incoming words into a hierarchical representation according to the grammar of the language (Boland & Blodgett, 2001). A model of the human parser must account for both the initial attachment preferences of people in the analysis of sentences, and their ability or inability to later revise an incorrect attachment (Stevenson, 1993).

2.2. Reanalysis

Reanalysis, which has been defined in various ways (e.g., Lewis, 1998; Sturt et al., 1999). Reanalysis, which plays an essential role in modular models. It happens once the processor discovers that the initial analysis is inconsistent with subsequently processed disambiguating information and has to construct an alternative analysis. It is due to this detection of the misanalysis and the subsequent reanalysis of the initial structure that difficulty occurs (Van Gompel & Pickering, in press).

Fodor and Inoue (1994) pose a very influential proposal. They believe that reanalysis is the process of revising or repairing an already constructed analysis rather than starting over again. Furthermore, reanalysis is not merely revising the first conceived structure. According to Bornkessel, McElree, Schlesewsky, and Friederici (2004), reanalysis includes two subcomponents: phrase structure revision (the instances mentioned so far) and case marking revision (in initial analysis the parser assigns a case to a noun, say nominative and in reanalysis the case is revised). Although reanalysis may be conceived of as a totally subconscious process, it may be associated with conscious processing. In the case of difficult garden path sentences, the reader or listener may be conscious of the effort required to perform reanalysis (Christianson, Hollingworth, Halliwell, & Ferreira, 2001).

Unlike most researchers who hold that the reanalysis of garden path sentences is an all-or-nothing proposition (e.g. Ferreira & Henderson, 1991a), Ferreira, Christianson and Hollingworth (2001) and Christianson et al. (2001) came to the conclusion that garden path is not an all-or-nothing process.
Christianson et al. (2001, p. 368) state that “the goal of language processing is not always to create an idealized structure, but rather to create a representation that is good enough”, i.e., the reader thinks that he could obtain the meaning of the sentence to a satisfactory degree and no other operation is needed, though his interpretation may not be entirely consistent with the input (see Ferreira & Patson, 2007; Christianson, Williams, Zacks, & Ferreira, 2006).

There has been an intuition from the earliest days of parsing research that the longer a misanalysis is retained, the harder the reanalysis will be (Frazier & Rayner, 1982; Warner & Glass, 1987). For example, The actor learnt the text amused the audience, though a garden path sentence, is parsed more easily than The actor learnt the text that was extracted from a classic literary work amused the audience. In the former sentence, the reader interprets the text as the object of learnt, but immediately when he gets to the verb amused, he reanalyzes the sentence and interprets it as the subject of amused. But in the latter sentence, the reader gives the role of object to the text that was extracted from a classic literary work; and when he comes across the verb amuse, he regresses to reanalyze. But this time the reanalysis is more difficult because he had retained the object role for the text that was extracted from a classic literary work for a longer time. So in this syntactic hypothesis, the addition of new words indirectly makes the reanalysis difficult, because adding more words necessitates having extra syntactic nodes. To explain this, Frazier and Rayner (1982) proposed a semantic hypothesis. When a longer part of a sentence is interpreted in a certain way, it takes longer to give it up and start assigning a new interpretation. Ferreira and Henderson (1991a) replicated Warner and Glass’s (1987) experiment and found that there are factors other than the length of the critical region and syntactic complexity that affect the ease of reanalysis, i.e., the location of the head. They found that the longer the distance between the head of the misanalysed phrase and the disambiguating word, the harder it would be for the parser to reanalyze the sentence.

2.3. Models of sentence processing

2.3.1. Garden-path model

Frazier (1978, 1987) propose Garden-path model which is the most influential model with regard to using decision rules. In this modular model (which assumes that sentence comprehension is not influenced by semantic or
pragmatic factors), the initial parsing decisions are made solely on the basis of syntactic factors (Filik, Paterson, & Liversedge, 2005) and nonstructural information, like semantic plausibility or preceding context, have no influence on the choice of an initial analysis (Traxler, Pickering, & Clifton, 1998). The prediction of Garden-path model about the relative difficulty of comprehension of garden path sentences is that sentences that require revision of the initial structurally simplest analysis will need longer reading times, longer eye fixations, and more regressive eye movements.

According to Garden-path model a sentence is processed in two stages. At first, the parser applies the minimal attachment and late closure principles. Based on minimal attachment, the parser has a tendency to build the simplest syntactic structures, one which has the fewest phrase structure nodes. And according to late closure, the parser will wait as long as possible to attach new items to the current clause. Then, at a second stage, for evaluating the structure, the parser gets help from the information contained in a specialized device called thematic processor which will help the parser in the construction of a new syntactic structure.

2.3.2. Constraint-based /lexicalist/interactive models

In spite of Garden-path’s dominance as a two-stage account, there have been some other accounts which state that initial decisions are based on some sources of information. In this class of models, every grammatically licensed analysis will be activated and it is the amount of available evidence that makes one analysis stronger or weaker. The specific point of comparison between Garden-path and Constraint-based model is in the use of lexical information, that is, information stored with verbs about the types of phrases with which they co-occur (Ferreira & McClure, 1997; Abney, 1989; Crocker, 1995; Pritchett, 1992). Based on Constraint-based models, verb information influences the initial parsing of the sentence and processing is largely based on lexical rather than phrase structural information (Keller & Zechner, 1995). In this model, the cognitive processing system is made up of processing modules that can interact and share information across levels (Marslen-Wilson & Tyler, 1980; McClelland & Rumelhart, 1981; McClelland, 1987) and competition among the interpretations eventually results in the dominance of a single one. Therefore, with regard to reading times, if one analysis receives more support
than its alternatives, reading times will be short and if there are more than one analysis receiving equal support, reading times will be long (Pickering & Van Gompel, in press).

A lot of research has been conducted on the comprehension of garden path sentences in other languages especially English (e.g., Warner & Glass, 1987; Ferreira & Henderson, 1991a), but to the best of the researchers’ knowledge, no research has been conducted in Persian language. Let’s take a look at the structure of garden path sentences in Persian.

2.4. Persian garden path sentences

In Persian which is an SOV language\(^1\) dependent nouns (functioning as modifiers) follow the head nouns and are connected by unstressed –e (which is not written but read), e.g., deræxt-e si:b (apple tree), in which deræxt is the head and si:b is the dependent noun. This construction is called ezafe ‘addition’ and its general function is to identify class and item of a noun phrase. The first noun is called mozaf and the second dependent one mozafon elœyh (Moein, 1962). As mentioned above the first DP is the head and the DP after -e is the dependent DP.

Below an example of a Persian garden path sentence is provided (sentence 1). In this sentence an ezafe construction has led to a garden path effect while this is not the case with sentence (2). In spoken Persian -e between two nouns indicates that the second noun modifies the first one. In this sentence si:b (apple) modifies deræxt (tree) which is read as deræxt(-e) si:b. Note that -e is pronounced in the spoken form but it is not transcribed into the written form.

1) ta residaem be deræxt si:b ofiad
   When approach, PAST, 1SG to tree apple fall, PAST, 3SG
   ‘When I approached the tree the apple fell.’

\(^1\) Unlike English whose written language is read from left to right, Persian written texts are read from right to left.
2)

ta residœm be derœxt si:b bargio oftad
When approach, PAST, 1SG to tree apple a leaf fall, PAST, 3SG
‘When I approached the apple tree a leaf fell.’

Let’s see what the source of this garden path is. According to the principle of late closure, based on which the parser prefers not to close the currently open clause than to open a new constituent, in sentence (1) above, the parser would adopt si:b (apple) as the modifier of derœxt (tree). The disambiguating word oftad (fell) indicates that si:b (apple) is the subject of the next clause and not the modifier of derœxt (tree), so the parser reanalyzes the sentence. Sentence (1) that requires the first clause be closed early is an early closure sentence and requires reanalysis (because the parser has a tendency to apply late closure as a first attempt, but it fails); it is called garden path. Sentence (2) which does not need reanalysis and is consistent with late closure principle is an example of a late closure sentence.

2.5. Length of critical region

Theories of sentence comprehension have addressed both initial parsing processes and mechanisms responsible for reanalysis and what is important is not the source of the garden path, but the factors involved in the ease of reanalysis. To make the point with regard to Persian language clear, look at example (1) above. In this example, the ambiguous region, i.e., si:b is short. The parser starts attaching si:b to derœxt. But immediately he comes to know that oftad needs a subject. So in the reanalysis the parser closes the node for derœxt and attaches si:b to oftad. Now look at the following example:

3)
ta residœm be derœxt si:b tu bagh hœmsaye oftad
When approach, PAST1SG to tree apple in garden neighbor fall, PAS, 3SG
‘When I approached the tree the apple fell in neighbor’s garden.’

In this sentence, the ambiguous region, i.e., si:b tu bagh hœmsaye which is read as si:b(-e) tu(-e) bagh(-e) hœmsaye is long. The tendency is to attach si:b to derœxt and there is a prepositional phrase after si:b (tu bagh hœmsaye (in
neighbor’s garden)) which modifies it. Now, when the parser gets to the verb oftad, it comes to know that it has to go back and extract si:b and its modifier from the previous node and insert it as the subject of the coming node. But the difference between this example and the previous one is that there is a long distance between the disambiguating word oftad and the ambiguous one, si:b, because of the intervening prepositional phrase, i.e., tu bagh haemsaye (in neighbor’s garden).

According to Frazier and Rayner (1982) and Warner and Glass (1987), the ambiguous region with more words, i.e., sentence (3), would be more difficult to process. Why? Frazier and Rayner (1982) proposed a semantic basis to answer this question; when a long phrase is semantically interpreted, it is hard for the parser to reanalyze that phrase. But Warner and Glass (1987) stated that the more syntactic nodes are structured, the harder reanalysis of the ambiguous region would be. In this syntactic hypothesis, extra words affect the ease of reanalysis indirectly, because more words necessitate extra syntactic nodes. So, both the syntactic and the semantic interpretations hold that sentences with long ambiguous regions are harder to process.

3. This study

In this study, attempt is made to examine the effect of both ambiguity and length of the critical region on reaction time and the rate of correctly judged sentences. To find this, a computerized program that recorded both the answers and the reaction time at a time scale of milliseconds was developed.

3.1. Pilot study

A pilot study involved 30 Persian native speakers, 20 of whom were studying at the third grade of high school and the rest were graduate students. The purpose was, firstly, to examine the naturalness of the sentences used in the tests and, secondly, to identify potential pitfalls in the proposed research methodology and the developed software. To this end, a two-month pilot study having a series of mini-pilots was conducted. This included, in the first step, testing the naturalness of the items in the four test versions by 10 Persian native speakers. They were asked to rate the naturalness of the sentences on the basis of a Likert scale from 1 to 5. Almost all the sentences but some garden path
ones (which was quite predictable) were judged natural. The second step included conducting the study in a small scale. At this step, the four versions of tests were submitted to the 20 third grade high school students (each version to 5 students). In the light of the experience gained through the pilot study, some sentences were revised and five sentences were replaced by some new ones. Moreover, decisions as to how long each word should be presented on the monitor were made based on the results of these pilots.

3.2. Participants
A total of 41 third grade high school monolingual male students aged 17, with Persian as their mother tongue participated in this study. They were randomly selected from a pool of 120 high school students in Gorgan, a northern city in Iran. They came from the same pool as those in the pilot study. By choosing high school students one could be sure that they have already mastered their first language and would not have problems with vocabulary or sentence structure of test sentences; and they do not master a second language which could affect their judgments. All the participants had normal vision and were naive with respect to the aims of the study.

3.3. Materials
Materials used in this study were of three types: warm up sentences, test sentences, and filler items. The language of the test was Persian, the native language of the participants.

3.3.1. Warm-up sentences
Five grammatical and five ungrammatical sentences were presented to students as warm-up sentences to familiarize them with what they were expected to do. Like the test sentences, participants were required to read the warm-up sentences on the computer screen and then judge the grammaticality of those sentences by pressing certain buttons. The aim was to familiarize the participants with the way to work with the software and to ensure that they know the notion of grammaticality and ungrammaticality. Furthermore, four of the warm-up sentences were included as the first items in the real test so this would prepare students to continue the study. During the warm-up, the participants were free to ask any question they had with regard to the
sentences, software, etc.

3.3.2. Test sentences

Twenty sets of items were developed (i.e., a total of 80 sentences). In each set, the sentences varied along the factorial dimensions of ambiguity (garden path vs. non-garden path) and length of the critical region (short vs. long). In other words, each set involved four conditions: in two of the conditions the sentences were ambiguous (i.e., garden path) and in two other conditions the sentences were unambiguous (i.e., non-garden path). Moreover, for each of the ambiguous and unambiguous sentences, the length of the critical region was once short and once long.

These test sentences were divided into four versions. These versions were balanced so that each condition in each set appeared only once in each version and all conditions were present in each version. In this way, each participant received ten garden path sentences five of which had a short critical region (si:b) (see below) and five of which had a long critical region (si:b tu bagh hemsaye) and ten non-garden path sentences with short and long critical regions. Examples of each condition in each set are provided below:

a. Non-garden path sentence (short critical region):

4) ta residœm be derœxt si:b bœrgi oftad
   When approach, PAST, 1SG to tree apple a leaf fall, PAST, 3SG
   ‘When I approached the apple tree, a leaf fell.’

b. Non-garden path sentence (long critical region):

5) ta residœm be derœx si:b tu bagh hemsaye bœrgi oftad
   When approach, to tree apple in garden neighbor a leaf fall,
   PAST, 1SG PAST, 3SG
   ‘When I approached the apple tree in the neighbor’s garden, a leaf fell.’

c. Garden path sentence (short critical region):

6) 
\[ \text{ta \ residœm be derœxt si:b oftad} \]

When approach, PAST, 1SG to tree apple fall, PAST, 3SG

‘When I approached the tree, apple fell.’

d. garden path sentence (long critical region):

7) 
\[ \text{ta \ residœm be derœxt si:b tuj bagh hämsaye oftad} \]

When approach, PAST, 1SG to tree apple in garden neighbor fall, PAST, 3SG

‘When I approached the tree, the apple in neighbor’s garden fell.’

Table 1. The Distribution of the Different Test Sentences in each Version

<table>
<thead>
<tr>
<th></th>
<th>Garden path sentences</th>
<th>Non-garden path sentences</th>
</tr>
</thead>
<tbody>
<tr>
<td>Short critical region</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>Long critical region</td>
<td>5</td>
<td>5</td>
</tr>
</tbody>
</table>

Table 1 provides an overview of the different test sentences in each version.

Later on, the test sentences were given to 10 Persian native speakers to check for the naturalness of the items and as mentioned earlier, almost all the sentences except some garden path ones (which is quite predictable and natural to happen) were judged natural. The researchers assume that ambiguity of the sentences will affect the analysis of sentences, so that garden path sentences will take more time to be analyzed and the rate of the accurate judgments will be low. Furthermore, the longer the critical region, the harder the analysis is predicted to be.

3.3.3. Filler items

To obscure the regularities in test items, twenty filler items (ten grammatical and ten ungrammatical sentences) were used in this study. These sentences were selected from newspaper articles to maintain authenticity. Examples are provided below:
8) *Cinema-of Iran can a place special among people Find, PAST, 3SG
“Iran’s cinema can find a special place among people.”

9) *Having seen the book the mayor lent for the library.

Sentence (9) is grammatically wrong, because shahrdar ba raye ketabkhane omanet dad has no object while the verb is transitive.

Another function the filler items had was to ensure that the participants did attend to the sentences they read on the monitor. If a participant’s correct answers to these 20 items were lower than 85%, he would not be included in the data analysis.

In this way, each version included 50 items: 10 warm-up sentences, 20 test sentences, and 20 fillers. The warm-up and filler items were the same across the four versions of the test but the test sentences varied.

3.4. Procedure

The participants were tested individually. Each participant sat in front of the monitor of a laptop. The test sentences were presented in a non-cumulative way, using Rapid Serial Visual Processing (RSVP). They were taught that by pressing the space button on the keyboard a sentence would appear in the following manner: at first a fixation cross appeared for 1500 ms, blinking three times and then disappeared. Thereafter, at the same location, the first word appeared for 250 ms and then disappeared. This process continued until the last word of the sentence. Up to this point, the words appeared automatically and the participants had no control over it. The timing for the presentation of the words was based on the findings of the pilot study. Then two boxes would appear, one for (dorost) which means correct/grammatical and the other one for (ghalæt) meaning false/ungrammatical. The participants were instructed to select one of them and make their grammaticality judgments by pushing a certain 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 time, 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. Based on the participants’ questions in the pilot study, it was emphasized in the instructions that sentences appeared on the monitor only once and they were only required to judge the sentences on the basis of their grammaticality and not, for example, their being real or unrealistic.

3.5. Design and data analysis

The design of this study was a $2 \times 2$ one. The first variable was the ambiguity of the sentence (garden path vs. non-garden path) and the second one was the characteristic of critical region, i.e., its length (short vs. long). The dependent variables included reaction time and the rate of correctly judged sentences. A repeated measures ANOVA was conducted to answer the research questions.

4. Results

4.1. Results for reaction time

The 41 participants’ reaction times for short/long garden path and short/long non-garden path sentences that had been correctly judged were calculated. Table 2 below shows the descriptive statistics for the four conditions.

In order to test the first null hypothesis of the study, i.e., to see whether ambiguity and length of the critical region had any effect on reaction time of different versions, a repeated measures ANOVA was conducted.

There were two within factors: ambiguity with two levels, including garden path and non-garden path sentences, and length, including short and long critical regions. With regard to reaction time, the results showed no significant effect for ambiguity ($F_{(1, 40)} = .989, p > .05$) nor for length of the critical region ($F_{(1, 40)} = .271, p > .05$). Furthermore, the results of the analysis showed no significant interaction between ambiguity of the sentence and the length of the
4.2. Results for accuracy of judgments

This time the second null hypothesis of the study was addressed to see whether ambiguity and length have any effect on the accuracy of judgments or not. The 41 subjects’ correctly judged sentences for different sentence types were calculated. Descriptive statistics for the answers are shown in Table 3 below. The maximum possible score for each condition was 5 as there were five sentences in each condition.

A quick glance at the data gives the impression that both ambiguity and length of the critical region have an effect on the rate of grammatically judged sentences. Looking at Table 3, we see that the mean for garden path sentences \(((2.634 + 2.243)/2 = 2.483)\) is less than the mean for non-garden path sentences \(((3.853 + 3.365)/2 = 3.609)\). In other words, performance on non-garden path is much better than that on garden path ones. We see a garden path effect in Persian because the rate of accurate responses for them is very low. To see if the difference is significant or not, a repeated measures ANOVA was conducted. The results showed a significant effect for sentence ambiguity \((F_{(1, 40)} = 8.880, p < .05)\). So the prediction that garden path sentences are problematic for Persian learners is supported. The length of the critical region also showed a significant effect \((F_{(1, 40)} = 63.668, p < .05)\). Going back to Table 3, we see that the mean for sentences with short critical regions \(((2.634 + 3.853)/2 = 3.243)\) is higher than that for sentences with long critical regions \(((2.243 + 3.365)/2 = 2.804)\). In other words, the shorter the critical region, the
better and more accurately the sentences are processed.

But the results of the analysis showed no significant interaction between sentence ambiguity and length ($F(1, 40) = .073, p > .05$). In other words, when the critical region was short, there was a significant difference between garden path and non-garden path sentences, which was verified by a t-test as well ($t_{40} = 5.86, p < .05$). And when the critical region was long, again a significant difference was obtained between garden path and non-garden path sentences ($t_{40} = 4.405, p < .05$).

The finding that there is no interaction between length and ambiguity shows that length is affecting both sentence types, i.e., garden path and non-garden path sentences, in the same way. A better performance in short sentences in comparison with long ones seems a natural finding (as the significant effect of length shows) but one would also expect length to be more costly in garden path sentences which would be the case if the interaction were significant. Because when the ambiguous region is long, reanalysis requires the parser to extract some items that have been assigned to a certain node and insert them in a new one. While this restructuring does not occur in non-garden path sentences. The question that raises here is why both garden path and non-garden path sentences are affected to the same degree. This point is elaborated below.

### 4.3. Further analysis of the data

One point which emerged after the test sentences were developed is worth mentioning here. In some Persian ambiguous sentences, the disambiguating word (the word that signals the ongoing analysis of the sentence is not correct) is object indicator *ra* (see sentence 10 below). In others, it is the verb itself which is disambiguating (sentence 11). In the former case, ambiguity is expected to be resolved earlier, while in the latter, ambiguity is resolved only
once the parser gets to the end of the sentence (in Persian, the verb comes at the end of the sentence). For example, in sentence (10) below, the parser takes Tehran bozorg ve por terafic as the modifier of Šæhrdar. But coming across the object indicator ra, the parser reanalyzes the previous section. So he faces no problem with the rest of the sentence. In this example, the location of the disambiguating word is in the middle of the sentence not at the end. But in sentence (11) below, the parser takes tu bagh haemsaye as the modifier of si:b. But coming across the verb oftad, he has to reanalyze the whole sentence. In this example, the disambiguating word is at the end of the sentence.

10) Šæhrdar Tehran bozorg ve por terafic ra aludeterin Šæhr namid
    ‘The mayor called the big and crowded Tehran as the most polluted city (of the country).’

11) ta residœm be derœxt si:b tu bagh haemsaye oftad
    ‘When I approached the tree, the apple in neighbor’s garden fell.’

The prediction is that those garden path sentences with long ambiguous regions which contain ra as the disambiguating word will be parsed earlier than those containing verb as the disambiguating word. So attempt was made to see if there is any difference in the analysis of these two types of sentences with regard to reaction time and the rate of correctly judged sentences. Perhaps the reason why length did not affect garden path sentences in the aforementioned analysis is that the garden path sentences including ra were reanalyzed so quickly and this reduced the reaction time and increased accuracy rate of judgments to an extent comparable to non-garden path sentences.

Regarding reaction time, the results showed that the mean of those 13 ambiguous sentences having the main verb as the disambiguating word (2.50) was higher than the 7 sentences with ra as the disambiguating word (1.91). To see whether this difference is significant or not, a paired sample t-test was conducted. The results showed the difference was significant ($t_{40} = 2.572$,
p < .05). Hence, it can be concluded that the sooner the disambiguating word appears in the sentence, the easier the reanalysis becomes.

Similar results were obtained with regard to accuracy of judgments; that is, the mean of accurately judged sentences containing *ra* (.60) as the disambiguating word was higher than those having the main verb as the disambiguating word (.41). The difference, using paired sample t-test, came out to be significant (*t*\(_{40}\) = 3.576, *p* < .05).

Thus, garden path sentences containing *ra* were significantly easier than those containing verb. And that is why no significant difference has been found between long garden path and long non-garden path sentences. Of course, as one reviewer noted, it is not obvious whether the ease of reanalysis is due to the location of the disambiguating word in the sentence or it is because one of the disambiguating words (*ra*) functions as a better cue than the other one (verb). But this could be checked only if the two words could occupy the same position in the sentence. As far as Persian is concerned, verbs come at final position but *ra* never comes at that position.

This time sentences containing *ra* were excluded from the analysis and the data were submitted to a repeated measures ANOVA. Table 4 below shows descriptive statistics for this data.

| Table 4. The Mean and SD for Accuracy of Judgments of Sentences Containing Verb as the Disambiguating Word |
|---|---|---|---|
| | Ambiguous region | N | Mean | Std. Deviation |
| Garden path sentences | Short | 41 | 1.41 | .948 |
| | Long | 41 | .902 | .969 |
| Non-garden path sentences | Short | 41 | 1.902 | 1.067 |
| | Long | 41 | 2.048 | 1.071 |

As can be seen in the table, the mean for the rate of correctly judged garden path sentences is less than that for the non-garden path ones. In other words, length is shown to be costly for the garden path sentences. And this is also evidenced by the results of a repeated measures ANOVA where interaction is significant (*F*\(_{1,40}\) = 5.183, *p* < .05), indicating that length is costly for garden path sentences and not for the non-garden path ones.
Based on this reanalysis of the data coming from sentences containing verb as the disambiguating word, one can safely claim that length is costly for garden-path sentences.

5. Discussion

The purpose of the present study was, on the one hand, to investigate if garden path effect is observed in Persian. Moreover, attempt was made to see if length of the critical region affects ease of reanalysis in Persian garden path sentences. That is, when the parser is being garden pathed, whether the length of the critical region has any effect on the ease of reanalysis or not. The results showed that while there is no significant difference in the reaction time for short/long garden path and non-garden path sentences, there is a significant effect in the accuracy of judgments of short and long garden path and non-garden path sentences, while in neither case was a significant interaction observed between sentence ambiguity and length. Moreover, in sentences containing verb (which comes at the end of a sentence in Persian) as the disambiguating word, the results also showed a significant effect of the distance between critical word and the disambiguating word, that is, the longer the distance, the harder the reanalysis of garden path sentences was. Of course, this was true only verb was the disambiguating word (not ra). Furthermore, the results can be fully explained in the framework of late closure principle, that is, participants preferred not to start a new node and attach the incoming words to the already open node.

At the end, it should be noted that since the present study is the first one studying Persian garden path sentences and factors affecting their comprehension, needless to say, the implications should be drawn with caution.

References

In J. Fodor & F. Ferreira (Eds.), Reanalysis in sentence processing (pp. 1-46). Dordrecht: Kluwer Academic Publishers.


