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Examining the Relation between Reading Time and Comprehension of Garden-Path Sentences by Saudi EFL Learners

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Abstract

The current study investigates the real-time processing and comprehension of syntactic ambiguity in Garden-Path sentences by EFL learners with L1 Arabic. The aim is to examine a possible correlation between these two measures, assuming that longer reading times are associated with better comprehension. To do so, fifty female Saudi upper-intermediate EFL students from a Saudi university completed a self-paced reading experiment in which they read Garden-Path and non-Garden-Path sentences and answered comprehension questions. Generalized estimating equations revealed that participants' comprehension of Garden-Path sentences is generally lower than that of non-Garden-Path sentences, but improves with more time spent reading them. The results suggest that initial misinterpretations of Garden-Path sentences are common among female Saudi upper-intermediate EFL learners, replicating previous studies on lingering misinterpretations and the good-enough approach. The study concludes that female Saudi upper-intermediate EFL learners' processing constraints in Garden-Path sentences are likely due to reduced sensitivity to disambiguating cues, as they did not spend enough time reanalyzing the initial misinterpretations of ambiguous sentences. Garden-Path sentences remain a valuable tool for future studies investigating how the human parsing system handles structural ambiguity.

1. Introduction

Sentence processing is a vital part of psycholinguistics. The parser (i.e., the human communication system) typically relies on minimal effort during sentence processing and adopts a single syntactic interpretation (Christianson et al., 2001; Ferreira & Patson, 2007). However, this can come at a cost when processing ambiguous sentences, such as "Garden-Path" sentences. Garden-Path sentences are syntactically ambiguous sentences that lead readers to form initial misinterpretations that need to be reanalyzed for proper understanding (Frazier, 1987). Investigating how the human parser handles these ambiguous sentences helps us understand the mechanisms of real-time processing and the limitations of the human parser. Garden-Path sentences are an important tool for revealing the parser's ability to detect disambiguating cues and processing errors, as well as its capacity for reanalysis after initial misinterpretations. It can also help reveal the parser's cognitive limitations in processing and memory, and why some misinterpretations linger. Moreover, it helps in understanding the difficulties learners face and the differences in their parsing abilities, to improve teaching methods.

Not all ambiguous sentences are Garden-Path sentences, because Garden-Paths have only one correct interpretation. Example (1) below represents reduced relative Garden-Path

sentences (see Christianson et al., 2017; Yoshida et al., 2005), and example (2) below represents NP/Z Garden-Paths or direct object/subject ambiguity (see Christianson et al., 2001; 2024; Qian et al., 2018).

1. The man sent flowers was very pleased.
2. After the mother dressed the baby laughed very happily.

Example 1 is ambiguous because the relative clause is reduced to (sent) instead of (which was sent), so the word (sent) is initially classified as a past tense. Then, the reader is confused when reaching the second verb (was), and the initial interpretation must be revised as (the man who was sent flowers [by someone] was very pleased). In example 2, the phrase (the baby) is initially perceived as the direct object of (dressed), but difficulty arises when reaching the verb (laughed), which lacks a subject. To resolve this ambiguity, the sentence needs to be reanalyzed by adding a comma or pause between the first verb (dressed) and the main subject (the baby) (e.g., after the mother dressed, the baby laughed very happily). Unlike the reduced relative clauses, there are no omitted words in this example.

Previous studies have found that initial misinterpretations of Garden-Path sentences usually persist and are difficult to abandon (e.g., Christianson et al., 2001; Chromý, 2022; Jacob & Felser, 2016; Slattery et al., 2013). To explain the reasons behind this persistence, the "good enough" theory suggests that readers do not always engage in reanalysis and instead rely on "good-enough" structural representations (Christianson et al, 2001; Ferreira & Patson, 2007). Although the processing of Garden-Path sentences has been widely studied, the reanalysis processes of English Garden-Path sentences by Arabic-speaking EFL learners have received little attention. The limited studies that have investigated how this population handles structural ambiguity have used only offline measures and did not examine reanalysis of Garden-Path sentences (e.g., Khan & Al-Namer, 2017). Their online (real-time) language processes and whether they recover from misinterpretations are not well known. Unlike English, which relies on a canonical SVO word order, Standard Arabic has a relatively free word order and is highly inflectional (see Bidaoui et al., 2016 for the differences between English and Arabic). These differences could affect how Arab EFL learners process Garden-Path sentences. Thus, this study is part of a broader project that aims to understand how they process English Garden-Path sentences and any issues they may face. In addition, limited studies have measured the effect of reading time for Garden-Path sentences on comprehension accuracy (e.g., Christianson et al., 2024; Qian et al., 2018), and although these studies have assumed that longer reading times in the Garden-Path condition indicate reanalysis efforts and should lead to higher accuracy, their results revealed that longer reading times were associated with lower accuracy. So, this study will also explore whether this result applies to Arab EFL learners.

Therefore, the significance of this study is to bridge gaps in the literature, contribute to the field of EFL sentence processing, and explore whether previous sentence-processing theories apply to these learners. The present study aims to investigate the following research question:

(1) Is there a relationship between Saudi EFL learners' reading time and comprehension of English Garden-Path sentences?

2. Literature Review

2.1.Sentence-Processing Theories

Various sentence-processing theories have attempted to explain the effects of ambiguity and syntactic complexity on sentence interpretation. First, early theories of language processing, such as Structure-based Approaches (Frazier, 1987) and constraint-based approaches (MacDonald et al., 1994; Trueswell et al., 1993) have assumed that the parser can create accurate sentence representations and completely abandon initial misinterpretations. However, later studies have provided evidence that initial misinterpretations of Garden-Path sentences often persist. One of the first studies was conducted by Christianson et al. (2001),

who explored the interpretation of Garden-Path sentences through five experiments. Native English speakers were asked to read Garden-Path sentences and answer comprehension questions. The results show that participants had difficulty processing Garden-Path sentences and provided more incorrect responses to the comprehension questions. Therefore, Christianson et al. (2001) concluded that the readers' reanalysis was incomplete. This has led to the development of the Good-Enough Theory, which suggests that the parser builds "good enough" representations rather than idealized sentence structures to minimize processing costs and keep up with later material (Christianson et al., 2001; Ferreira & Patson, 2007; Slattery et al., 2013). Several studies on this theory have attempted to explain why misinterpretations persist. While some of these studies support the explanation provided by Christianson et al. (2001) that the reason for "good-enough" interpretations is that readers conduct only a partial reanalysis (e.g., Blott et al., 2021; Chromý, 2022), others suggest it is due to lingering misinterpretations in memory rather than incomplete reanalysis (e.g., Fujita & Cunnings, 2021; Qian et. al., 2018; Slattery et al., 2013).

2.2.Studies on Good-Enough Processing

First, several recent studies that support the findings of Christianson et al. (2001) have incorporated online processing measures, such as self-paced reading or eye-tracking, in addition to comprehension questions (e.g., Blott et al., 2021; Christianson et al., 2024; Chromý, 2022; Jacob & Felser, 2016). Many of these studies reported longer reading times and lower comprehension accuracy for the Garden-Path condition as evidence of processing costs and ongoing reanalysis of initial misinterpretations. For example, a study by Chromý (2022) investigated how native Czech speakers process Garden-Path sentences in their L1 and found that some Garden-Path sentences were not reanalyzed, resulting in inaccurate and incoherent structural representations. The study concluded that the initial misanalysis can linger due to partial reanalysis. Another recent study by Christianson et al. (2024) used eye-tracking and comprehension questions to examine rereading patterns in Garden-Path sentences and whether these patterns affect comprehension accuracy. The results show that sentences were frequently misinterpreted and that comprehension accuracy did not improve with longer rereading time, supporting the Good-Enough Processing Approach. Moreover, Blott et al. (2021) used an eye-tracking experiment to examine how lexical ambiguity in Garden-Path sentences affects the comprehension of L1 English speakers. The results showed that readers often relied on good-enough interpretations and that their reanalysis was often incomplete. In addition, a study by Jacob and Felser (2016) utilized an eye-tracking experiment to investigate how L1 and L2 speakers process syntactic ambiguity in Garden-Path sentences. The results revealed that both groups frequently misinterpreted the sentences, but L2 learners showed lower comprehension accuracy due to incomplete reanalysis and greater reliance on good-enough representations.

On the other hand, some studies on good-enough processing suggest that the persistence of misinterpretations is not due to incomplete reanalysis but due to the inability to discard them from memory (e.g., Fujita & Cunnings, 2021; Qian et. al., 2018; Slattery et al., 2013). Slattery et al. (2013) used an eye-tracking experiment to test this hypothesis, and their results suggested that syntactic reanalysis can lead to complete and accurate representations. They argued that what is good enough is the interpretation of the sentence due to the interference of the memory trace with the new syntactic representation. However, this study did not involve any comprehension questions and just assumed that the Garden-Path sentences were misinterpreted. Therefore, a recent study by Fujita and Cunnings (2021) replicated the study using both offline and online comprehension measures to examine how L1 and L2 learners process Garden-Path sentences. Their study suggested that L2 learners performed weakly in reanalysis compared to L1 speakers due to an inability to discard the initial misinterpretations from memory. Moreover, another study by Qian et. al. (2018) has also argued against Christianson et al.'s (2001) view that incomplete reanalysis is responsible for persistent misinterpretations. Their study

investigated the relationship between reanalysis effort and comprehension accuracy using ERP and self-paced reading experiments. They argued that if incomplete reanalysis is responsible for good-enough interpretations, then higher reading times, which suggest reanalysis effort, would lead to better accuracy. However, the results of the self-paced reading experiment revealed that the relationship was significant in the opposite direction because spending more time led to poorer comprehension.

In sum, the debate over what causes lingering misinterpretations and how Garden-Paths are processed continues. Choosing a single explanation might be overly simplistic, as multiple factors could be at play. A recent study by Cehákova and Chromý (2023), which examined how L1 speakers of Czech interpret Garden-Path sentences, revealed that both Christianson et al. (2001) and Slattery et al.'s (2013) views of good-enough interpretations could be applied to the same participants. The learners in the study either failed to complete the reanalysis or had diverse representations of Garden-Path sentences. To conclude, recent studies confirm that Garden-Path sentences remain a relevant tool for understanding the difficulties of sentence processing. Although many studies have explored L1 and L2 sentence processing, limited studies have investigated Arabic-speaking EFL learners' processing of structurally ambiguous English sentences, and these studies have used only offline tasks (e.g., Khan & Al-Namer, 2017). Because populations differ in how they process sentences, it is important to explore how EFL learners with L1 Arabic process Garden-Path sentences and whether they utilize the good-enough approach. Thus, the current study contributes to the L2 sentence processing literature by investigating how this understudied population processes syntactic ambiguity. In addition, it utilizes both online and offline measures to gain a deeper understanding of their L2 processing.

3. Methodology

The current study adopted a quantitative paradigm, employing a self-paced reading experiment and comprehension questions to measure the final interpretation and real-time processing of Garden-Path sentences by Saudi EFL learners. The self-paced reading technique has been used effectively by previous studies to measure readers' online cognitive processes during reading Garden-Path sentences, such as reading time and processing difficulty (e.g., Alseraye, 2022; Blott et. al., 2021; Cehákova & Chromý, 2023; Fujita & Cunnings, 2021). Measuring reading speed for ambiguous sentences could reflect participants' sensitivity to ambiguity, as longer reading times reflect greater processing difficulty. Adding an offline comprehension task was necessary for this study to measure outcomes of interpretation and determine the extent to which the initial misinterpretations persist among participants. A quantitative analysis examined a possible correlation between reading time and comprehension accuracy for Garden-Path sentences, assuming that longer reading time is associated with greater accuracy.

3.1. Research Materials and Experimental Design

The self-paced reading experiment of the current study was designed using Gorilla.sc, an online experiment builder (see Anwyl-Irvine et al., 2020). The experiment consisted of a background questionnaire, an online reading task, and an offline comprehension task. The stimuli for the study consisted of twenty-four sentences and twenty-four comprehension questions. First, the background questionnaire was used to collect some demographic information about the participants. After that, the respondents proceeded to the self-paced reading task, in which they were instructed to read sentences at a normal pace. This task measured their reading times of the sentences. Of the twenty-four sentences, sixteen were experimental items adapted from previous studies (Christianson et al., 2001; Yoshida et. al., 2005) to ensure validity and reliability. They consisted of Garden-Path sentences and well-matched, unambiguous items with similar lengths and vocabulary difficulty. The Garden-Path

sentences involved the two structures mentioned in the introduction (see examples 1 and 2). In the first structure, the ambiguity was manipulated by either reducing the relative clause or using 'that' without reduction. In the second structure, the presence of the comma was manipulated by either omitting the comma or adding it to help disambiguate. The remaining eight sentences were filler items that were unambiguous and varied in structure to avoid systematic responses and distract attention from the study's purpose. All the sentences were presented in a randomized order for each participant, so the participants had to use their cognitive control when encountering Garden-Path sentences to form a correct judgment. Each sentence was divided into five regions as follows:

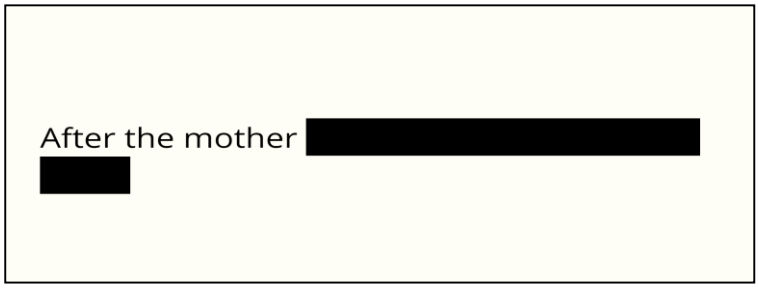
1 2 3 4 5

After the mother / washed,/ the baby/ went/ to sleep.

The sentences were presented in chunks using phrase-by-phrase presentation techniques to record reading times and collect real-time processing data. They appeared in a linear format, from left to right, one region at a time, as each participant controlled their reading pace and moved from one segment to the next (see Figure 1 below). To measure initial reading times and locate processing difficulties in real time, re-reading or backtracking was not allowed.

Figure 1

Example of How Sentences Appeared in the Online Task



Third, off-line comprehension questions followed each sentence. For example, the sentence: *"After the mother washed, the baby went to sleep"* is followed by the question "*Did the mother wash the child?"* and the choices 1. Yes 2. No 3. I don't know. All Garden-Path items required the participants to recover from the initial misinterpretation, so a successful reanalysis of the example above would be "the mother washed herself", not the baby. The correct answer to all ambiguous items was "no". If participants chose "yes" more often for Garden-Path items, it means their initially assigned misinterpretations have persisted. The choice "I don't know" was added to prevent participants from relying on guesses. Finally, the same process of reading a sentence and answering a comprehension question continued to the end of the self-paced reading task.

3.2.Participants and Data Collection

The participants of the study were undergraduate EFL students at a Saudi university in Riyadh, Saudi Arabia. They are all Saudi females with Arabic as their L1. They had normal vision and their ages ranged from 18 to 24 years. Only upper-intermediate EFL users were recruited from the English Department because the stimuli included structurally complex sentences. The reason for selecting participants with the same English proficiency level, gender, and age group was to have better control over variables that might affect their responses to the experimental items. Before conducting the experiment, ethical approval was obtained from the university, and the participants completed the consent forms. Moreover, a number of actions were taken to ensure the overall reliability and validity of the study, such as conducting a pilot study to assess the reliability of the materials and experimental design, carefully selecting participants, controlling the experimental conditions, and controlling the testing

environment. Due to time limitations, all available subjects for the main study were included. The final sample included 50 participants. Twenty other participants were excluded from the analysis due to low accuracy on filler items or inability to complete the tasks. The data size included 1200 reading times and 1200 accuracy responses to comprehension questions. The experiment was conducted over several sessions in computer labs with the researcher present to explain the nature of the self-paced reading task. Each session lasted about 30 minutes and included 10 to 20 students to reduce disruptions that might affect the results. The data was collected in three months in 2024.

3.3.Analysis Methods

The analysis investigated a possible correlation between reading time and comprehension of Garden-Path and non-Garden-Path sentences, assuming that longer reading time is associated with better comprehension. For the analysis, comprehension accuracy was the dependent variable, and reading time and sentence type were the independent variables. The models also included an interaction term between the two independent variables to determine whether the relationship between reading time and comprehension accuracy varied by sentence type. SPSS version 23 for Windows (IBM Corp., Armonk, NY) was used to analyze the data. Reading time was measured in milliseconds (ms), and its normality was assessed using skewness and kurtosis, a histogram, and a quantile-quantile plot (Fidell & Tabachnick, 2003; Kim, 2013; Mishra et al., 2019; West et al., 1995). For those that were not normally distributed, data transformation was conducted (Lee, 2020). The comprehension accuracy data consisted of 'yes', 'no', and 'I don't know'. Correct answers were given a 1, and incorrect answers received a 0. To focus on a more accurate representation of their comprehension, the "I don't know" responses, in which participants were unsure of their answers, were excluded from the analyses.

First, the study variables were summarized using descriptive statistics. Then, inferential analysis was conducted to answer the research question using the generalized estimating equations (GEE) for binary responses with a logit link (Agresti, 2002; Fitzmaurice et al., 2004; Liang & Zeger, 1986). The GEE was chosen because it is commonly used for analyzing correlated repeated measures collected from the same subject over time. The main assumptions of the GEE analyses were examined and satisfied, including independence between subjects, a suitable link function that depends on the nature of the data, and an appropriately specified correlation structure. In this study, a binomial distribution and a logit link for the binary data were used because the dependent variable (response accuracy) had binary outcomes. Various structures (exchangeable, AR(1), independent, and unstructured) were considered to model the working correlation matrix. The quasi-likelihood information criterion by Pan (2001) was used to choose the best correlation structure for the data (IBM Documentation Help, 2025).

4. Results and Discussion

This study examined how EFL learners with Arabic as their L1 process Garden-Path sentences in English. The study employs both online and offline processing measures to investigate whether reading time is related to comprehension of these sentences. First, the descriptive statistics of each of the offline and online comprehension measures are briefly discussed, and then the correlation between them is examined. Table 1 below presents comprehension accuracy for the comprehension questions, with only about 30% of the valid responses to the Garden-Path sentences answered correctly, compared to 72.1% for the non-Garden-Path sentences. Table 2 shows the initial reading times by sentence type. The mean reading time was very similar for Garden-Paths (M = 6013.10, SD = 2787.63) and Non-Garden-Paths (M = 6010.91, SD = 1954.23). A logarithmic transformation was used to ensure normality of the reading time data, which was assessed using skewness and kurtosis.

Table 1

Comprehension Accuracy

	Total *N*	Valid *N*	Correct (*N* (%))	Incorrect (*N* (%))	I don't know (*N* (%))
Garden-Path	400	371	122 (32.9)	249 (67.1)	29 (7.2)
Non-Garden-Path	400	387	279 (72.1)	108 (27.9)	13 (3.3)
Filler	400	396	386 (97.5)	10 (2.5)	4 (1.0)

Note. *N* = number of observations; total *N* = total number of observations of "correct", "incorrect", and "I don't know" responses; valid N = number of observations for "correct" and "incorrect" responses. % for "correct" and "incorrect" responses was computed using the valid *N*. % for "I don't know" responses was computed using total *N*.

Table 2

Reading Time by Type of Sentence

	Original scale				After log transformation			
	M	*SD*	*s*	*k*	*M*	*SD*	*s*	*k*
Garden-Path	6013.10	2787.63	2.07	6.09	8.62	0.40	0.46	0.53
Non-Garden-Path	6010.91	1954.23	0.59	-0.24	8.65	0.33	-0.13	-0.39
Filler	4543.31	1569.24	0.92	0.76	8.36	0.34	0.05	-0.24

Note. *M* = mean; *SD* = standard deviation; *s* = skewness; *k* = kurtosis.

Before discussing the results of the inferential statistics, some inferences can be drawn from the data above. The lower comprehension results for Garden-Path sentences suggest that initial misinterpretations of these sentences persisted, thereby replicating the findings of previous studies (e.g., Christianson et al., 2001, 2024; Chromý, 2022; Jacob & Felser, 2016; Slattery et al., 2013). Moreover, the lack of a difference in reading time between Garden-Path and non-Garden-Path sentences suggests that the Saudi EFL participants made quick responses without fully reanalyzing the syntactic structure. A similar processing effort was used to parse both sentence types. Thus, it is not surprising that the results of the offline task revealed lower comprehension for Garden-Path sentences because recent L1 and L2 studies (e.g., Blott et. al., 2021; Schütt et al., 2023; Xie et al., 2022) have found that readers who successfully resolve ambiguous structures usually utilize additional neural resources and spend more time reading Garden-Path sentences. These findings challenge the predictions of traditional sentence-processing theories (e.g., Frazier, 1987; MacDonald et al., 1994; Trueswell et al., 1993), which hold that complete syntactic reanalysis in ambiguous contexts is the parser's default mechanism. On the contrary, these results support the Good Enough Approach to language processing (Christianson, 2016; Christianson et al., 2001; Ferreira & Patson, 2007), which suggests that readers often settle for "good-enough" interpretations rather than deep analysis to keep up with later material and minimize processing costs.

Next, the correlation between comprehension accuracy and reading time was explored using a statistical analysis of the data. Based on previous studies (Blott et al., 2021; Schütt et al., 2023; Xie et al., 2022), it was assumed that longer reading times in the Garden-Path condition may indicate reanalysis efforts and thus lead to higher comprehension scores. First, the GEE results revealed that the interaction between reading time and sentence type was not statistically significant ($\chi^2(1) = 0.070$, $p = 0.791$; Table 3). This implies that the effect of reading time on response accuracy did not depend on type of sentence, so the variable type of sentence was removed from the GEE model. Thus, to determine the relationship between reading time and comprehension accuracy, a GEE model was conducted with reading time as

the only independent variable (Table 4). There was a statistically significant association between reading time and comprehension accuracy ($\chi^2(1) = 4.589$, $p = 0.032$; Table 4), regardless of the type of sentence. Figure 2 shows a plot of log(reading time) versus the probability of an accurate response. The GEE model also revealed a 75.9% increase in the probability of an accurate response for a one-unit increase in reading time after log transformation (*OR* = 1.759, 95% *CI* = [1.049, 2.948]). So, subjects who spent more time reading were more likely to provide correct answers than those who spent less time reading. This result enhances the study's reliability, as it suggests that the subjects took the experiment seriously. It also indicates that when EFL Saudi participants spend more time reading and exert more processing effort on either Garden-Path or non-Garden-Path sentences, their accuracy improves. This implies that their lingering misinterpretations of Garden-Path sentences are due to incomplete reanalysis and to insufficient time spent on the online task to utilize implicit knowledge. The theoretical implication of this finding is that it supports Christianson et al.'s (2001) reasoning for the persistence of misinterpretations and good-enough interpretations of Garden-Path sentences, which is partial reanalysis and the inability to repair the underlying syntactic representation. It is also consistent with Chromý's (2022) recent findings, who suggests that some Garden-Path sentences may never be reanalyzed by readers.

Table 3

Results of GEE for Comprehension Accuracy – With Interaction Effect

			95% *CI*		Hypothesis test			95% *CI* for Exp(*B*)		
Parameter	*B*	*SE*	Lower	Upper	χ^2	*df*	*p*	Exp(*B*)	Lower	Upper
Intercept	-3.889	3.513	-10.775	2.996	1.226	1	0.219			
Type of sentence										
Garden-Path	-2.593	3.446	-9.347	4.161	0.566	1	0.452	0.075	0	64.143
Non-Garden-Path	Ref									
Log(reading time)	0.559	0.407	-0.239	1.357	1.885	1	0.170	1.749	0.787	3.884
Type of sentence * Log(reading time)	0.107	0.402	-0.681	0.894	0.070	1	0.791	1.113	0.506	2.445

Note. Number of observations = 758. Ref = reference category; *B* = parameter estimate; *SE* = standard error; *CI* = confidence interval; lower = lower bound; upper = upper bound; χ^2 = Wald chi-square test statistic; *df* = degrees of freedom; *p* = *p*-value; Exp(*B*) = odds ratio.

Table 4

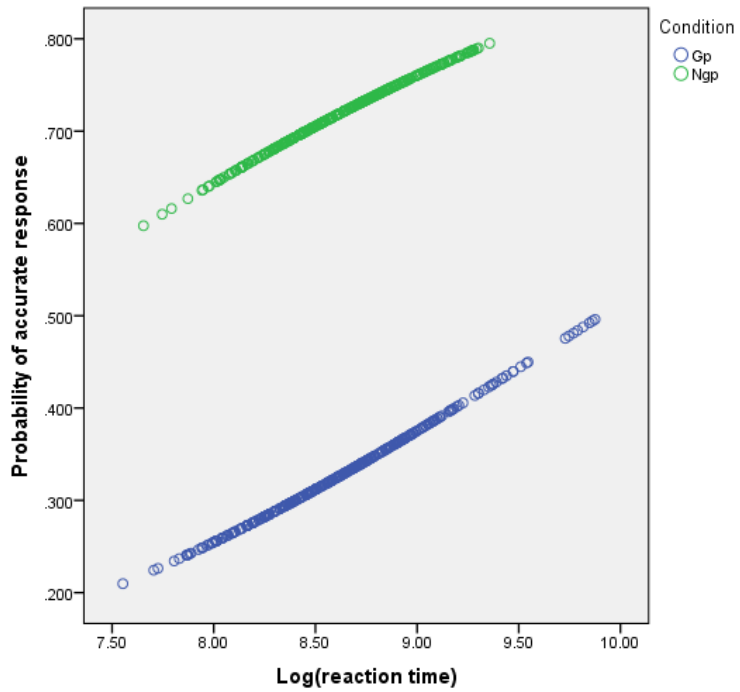
Results of GEE for Comprehension Accuracy – Without Interaction Effect

			95% *CI*		Hypothesis test			95% *CI* for Exp(*B*)		
Parameter	*B*	*SE*	Lower	Upper	χ^2	*df*	*p*	Exp(*B*)	Lower	Upper
Intercept	-3.926	2.291	-8.416	0.564	2.937	1	0.087			
Type of sentence										
Garden-Path	-1.664	0.154	-1.966	-1.362	116.686	1	< 0.001	0.189	0.140	0.256
Non-Garden-Path	Ref									
Log(reading time)	0.565	0.264	0.048	1.081	4.589	1	0.032	1.759	1.049	2.948

Note. Number of observations = 758. Ref = reference category; *B* = parameter estimate; *SE* = standard error; *CI* = confidence interval; lower = lower bound; upper = upper bound; χ^2 = Wald chi-square test statistic; *df* = degrees of freedom; *p* = *p*-value; Exp(*B*) = odds ratio.

Figure 2

Plot of Log(Reading Time) and Probability of an Accurate Response



Note. GP = Garden-Path sentences; NGP = Non-Garden-Paths.

L2 reanalysis difficulty can stem from diverse causes and yield different outcomes, which is why it remains an important direction for future studies. As mentioned in the introduction, little attention has been given to the Arabic-speaking EFL learners' processing of structural ambiguity in English, particularly Garden-Path sentences. One study on this population was conducted by Alseraye (2022), who investigated how Arabic Garden-Path sentences are processed by native Saudi students. His results, however, showed that participants' comprehension accuracy for Garden-Path sentences was not affected, although they spent more time reading them than non-ambiguous sentences. This is contrary to the present study's result, where comprehension was much lower for the Garden-Path sentences. The two studies did not include the same participants or age groups. Nonetheless, this comparison could reflect L1-L2 differences in processing strategies. For example, Alseraye's (2022) results indicate that L1 Arabic readers continued to have efficient processing despite the ambiguity due to the use of morphological processing strategies in L1 Arabic. Ambiguity resolution and reanalysis in Arabic are affected by its morphology, which is based on roots and patterns. The reliance on these morphological roots during processing limited the Garden-Path effect. Moreover, prior L1 linguistic exposure aids comprehension. On the other hand, there are several processing limitations for L2 learners, such as the challenge of managing two languages simultaneously. In addition, the reliance on good-enough comprehension when processing L2 Garden-Path sentences, while balancing reading time with comprehension, results in the persistence of initial misinterpretations and reduced sensitivity to disambiguating cues. This is evidenced by the correlation analysis in the current study, which showed that comprehension accuracy and recovery from misinterpretations improved as participants spent more time reading. In sum, this comparison indicates that sentence-processing strategies can differ across and within populations. Thus, continued research in this area, and examining how Arab EFL learners process English Garden-Path sentences, can offer insights into their language acquisition process and the role of their L1. It can also enhance our knowledge of the difficulties they face in reading comprehension and processing ambiguous L2 structures. This

could help researchers and English teachers improve reading instruction methods to guide learners in overcoming these difficulties.

Although much research has been done on the processing mechanisms of syntactic ambiguity, there is a gap in the literature on how to implement this in teaching learners to resolve ambiguity and reanalyze in real time. When L2 learners process Garden-Path sentences in real time, misinterpretations usually persist due to weak sensitivity to syntactic cues and difficulty with reanalysis. Thus, processing-based instruction should be integrated into language teaching to help improve learners' comprehension. Some practical implications are provided for teaching learners to enhance their L2 sentence-processing strategies, especially when faced with syntactically ambiguous sentences. First, Input Processing Instruction (VanPatten & Cadierno, 1993) suggests providing learners with input-based tasks that force them to connect meaning to form. This should help them shift their focus from relying on semantics to noticing syntactic cues and revise initial interpretations of syntactically ambiguous sentences, such as Garden-Paths. VanPatten and Cadierno (1993) found that Processing Instruction was more effective for real-time processing than traditional instruction, which usually focuses on teaching grammar rules and sentence production. This can be implemented in training learners to process Garden-Path sentences in real time. For example, teachers could repeatedly expose learners to Garden-Path sentences as implicit training to increase their awareness of syntactic ambiguity. Students can be asked to read the sentences as a whole or word by word, as in a self-paced reading task, and reveal their initial interpretations. This can then be followed by ambiguity-resolution tasks to enhance their ability to revise initial interpretations. Xie et al. (2022) suggest that cognitive training should be combined with sentence-processing tasks, rather than relying solely on language input. In their study, they found that learners who perform better at ambiguity resolution have higher monitoring ability and working memory. Thus, learners can be shown the full sentence, for instance, and then be asked to reanalyze it and explain where the interpretation changes. This trains them to detect errors, be sensitive to disambiguating cues, be flexible in processing, and reanalyze.

5. Conclusion

This study investigated female Saudi upper-intermediate EFL learners' offline comprehension of Garden-Path sentences and how it relates to their online processing time using a self-paced reading experiment and comprehension questions. As noted in the literature review, the interpretation of English Garden-Paths by EFL learners with L1 Arabic has received little attention. The few existing studies on this population have exclusively used offline measures (e.g., Khan & Al-Namer, 2017), and online processing has been largely unexplored. So, one significance of this study is that it addresses this gap in the literature. In addition, this study offers several methodological contributions, including the use of both online and offline measures and the exploration of their correlation. The use of the online self-paced reading task and offline comprehension questions provided deeper insight into participants' cognitive processes as they dealt with ambiguity. The results of the offline comprehension task suggested that initial misinterpretations of Garden-Path sentences are common among female Saudi upper-intermediate EFL learners, whose comprehension accuracy was generally lower for these sentences, thus replicating the results of previous studies on lingering misinterpretations and the good-enough approach (e.g., Christianson et al., 2001; Slattery et al., 2013). In terms of reading time, the participants spent a similar amount of time reading both Garden-Path and non-Garden-Path sentences, which could explain why comprehension accuracy was much lower for Garden-Path sentences. Based on the discussion of the results in light of the latest sentence-processing theories, the lower accuracy and processing limitations of the female Saudi upper-intermediate EFL learners may be due to a weaker sensitivity to disambiguating cues, as participants did not spend more time

processing or reanalyzing the ambiguous sentences. This is confirmed by the correlation analysis, which has revealed that spending more time reading allowed the participants to develop better comprehension and more efficiency in recovering from misinterpretations.

Despite this study's significant findings, it has some limitations that could be addressed in further research. The first limitation concerns the research participants, which may, to some extent, affect the study's generalizability. The number of participants was relatively small due to time constraints. Moreover, this study included only Saudi female participants due to social and cultural considerations, which may have led to slightly gender-biased findings. Thus, replicating the study with a larger sample size and including male participants may help confirm the outcomes and determine whether the results differ by gender. In addition, all EFL participants with L1 Arabic were Saudi nationals and at the upper-intermediate level of English. So, this study could be replicated with EFL learners from different Arabic-speaking countries and with various L2 levels. The second limitation of the current study relates to the stimuli and design. In addition to the self-paced experiment, the offline task used only yes/no comprehension questions and avoided including too many tasks that might make the L2 learners reluctant to participate. Future studies should include further measures, such as open-ended questions, to reduce measurement error and gain deeper insight. Moreover, each condition included a relatively small number of examples in the online task, as including many examples could lead participants to adapt to the Garden-Path sentences and become aware of the temporary ambiguity, thereby affecting the results. Furthermore, this study focused only on participants' initial misinterpretations of Garden-Path sentences and did not allow participants to reread the sentences. So, further studies could explore whether reading time and accuracy change after the chance to reread. Another limitation of this study is that it did not investigate individual differences in the processing of Garden-Path sentences, which could be a very interesting topic for further studies. It can broaden our understanding of the differences in processing strategies learners use during the reanalysis of Garden-Path sentences, as some learners demonstrate better comprehension than others. In conclusion, despite the limitations of the current study, it sought to contribute to the good-enough approach of L2 sentence processing by examining how Arabic EFL learners process temporary ambiguity to help them process it more efficiently.

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