



Original article

Investigating Iraqi EFL Learners' Use of Prosodic indicators for structural ambiguity Resolution

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ABSTRACT

Prosody plays a critical role in resolving structural ambiguities in speech. This study investigates Iraqi EFL learners' sentence processing mechanisms by determining whether or to what degree sensitivity to prosody might influence how relative clause attachment ambiguity is resolved. In order to do this, 42 undergraduate Iraqi EFL learners completed two tasks: a silent-reading task to identify the learners' default preference for relative clause attachment, and a listening task to examine the effect of different types of prosodic information, such as prosodic boundary and focal prominence on relative clause attachment ambiguity resolution. A mixed method research design, where the data is analyzed both quantitatively and qualitatively, is adopted in this study. The findings reveal low attachment preference is the default preference. Moreover, the study showed that the learners are not sensitive to different types of prosodic information during relative clause attachment ambiguity resolution; they always preferred low attachment interpretation.

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Keywords: prosody, relative clause attachment, structural ambiguity resolution

استقصاء توظيف الطلبة العراقيين المؤشرات التنغيمية لفك الغموض البنيوي

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المديرية العامة للتربية واسط

المُستخلص

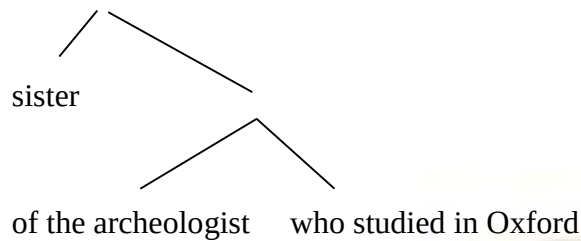
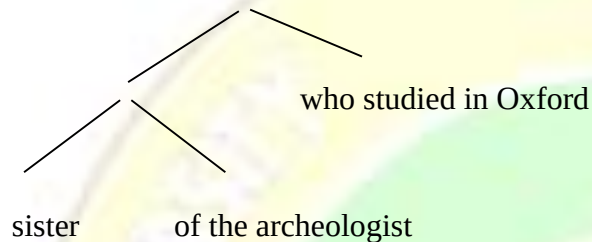
تلعب التَّنْغِيمِيَّة دوراً مهماً في حل الغموض البنيوي في الكلام. تبحث هذه الدراسة في اليات معالجة الجمل لدى متعلمي اللغة الانجليزية كلغة اجنبية في العراق من خلال تحديد ما اذا كانت الحساسية التَّنْغِيمِيَّة قد تؤثر في كيفية حل غموض ارتباط الجمل الوصلية والى اي درجة. ومن اجل القيام بذلك، اكمل 42 طالبا جامعيًا عراقيا يدرسون اللغة الانجليزية كلغة اجنبية مهمتين: مهمة القراءة الصامتة لتحديد تفضيل المتعلمين الافتراضي لربط الجمل الوصلية، ومهمة استماع لفحص تأثير انواع مختلفة من المعلومات التَّنْغِيمِيَّة مثل الحدود التنغيم والبروز البؤري في حل غموض ارتباط الجمل الوصلية. تعتمد الدراسة منهجاً بحثاً مختلطاً حيث يتم تحليل البيانات كمياً ونوعياً. اظهرت النتائج انه ، في غياب المعلومات التَّنْغِيمِيَّة، كان تفضيل التعلق المنخفض هو التفضيل الافتراضي لمتعلمي اللغة الانجليزية كلغة اجنبية في العراق. علاوة على ذلك، اظهرت الدراسة ان المتعلمين ليسوا لأنواع مختلفة من المعلومات التَّنْغِيمِيَّة اثناء حلهم لغموض ارتباط الجملة الوصلية، فهم دائماً يفضلوا تفسير الارتباط المنخفض.

الكلمات المفتاحية: التنغيم ، ارتباط الجمل الوصلية ، فك الغموض البنيوي

1. Introduction

Structural ambiguity, in which the same word sequence can be connected to many syntactic structures, is one form of ambiguity in language. The focus of this study is on the syntactic structure which contains a complex noun phrase (NP). The complex NP is of the type N1-of-N2, and a relative clause (RC) follows the complex NP, as stated in the sentence *Oliver fell in love with the sister of the archeologist who studied in Oxford*. This structure is ambiguous because there are two potential parses associated with it. Specifically, the (RC) who *studied in Oxford* can be interpreted as a modifier of the first noun (*sister*) in the complex NP, (i.e., the sister studied in Oxford), or a modifier of the second noun (archeologist) in the complex NP (i.e., the archeologist studied in Oxford). Based on the assumption that the first site is situated at a higher node in the syntactic tree, traditionally, the first type of interpretation is known as N1 attachment (sometimes known as high attachment or early closure). Whereas, the second kind of interpretation is labeled as N2 attachment (sometimes known as late closure or low attachment). These variations are shown in terms of where in the syntactic tree the RC attaches: either to the larger NP itself (the high attachment interpretation) or to the noun contained within a larger NP (the low attachment interpretation).

Oliver fell in love with the sister N1 of the archeologist N2 [who studied in Oxford] RC.

a. Low attachment reading:**b. High attachment reading:**

Communicators frequently utilize variations in prosodic realization to avoid potential miscommunication which results from structural ambiguity. Many studies have investigated the effect of prosodic information in the interpretation of relative clause attachment ambiguities. It was reported that in the absence of prosody, native English speakers favour low attachment reading (Fodor, 2002; Dussias, 2003). On the other hand, it was found that prosodic indicators that highlight the relative strength of prosodic boundaries after N1 and after N2 (Clifton, Carlson, and Frazier, 2002; Jun, 2003) and the relative prominence of the two nouns (Schafer et al., 1996; Lee and Watson, 2011; Jun and Bishop, 2015) have an impact on how native speakers process RC attachment. It was also found that for a sentence like ***Oliver fell in love with the sister of the archeologist who studied in Oxford.*** the likelihood of low attachment interpretation is increased if there is an intonational boundary after N1, whereas the likelihood of high attachment interpretation is increased if there is an intonational boundary after N2 (Fernandez 2007; Teira and Igoa 2007).

No previous studies have tackled the Iraqi EFL learners' use of prosodic indicators in their processing of relative clause attachment ambiguities. Thus, this study tries to fill this gap. The aim of this study is of two folds. First, the study is an attempt to identify whether Iraqi EFL learners prefer, without prosodic information, low attachment reading or high attachment reading. Second, it investigates the Iraqi EFL learners' use of prosodic indicators in their processing of relative clause attachment ambiguities. To attain the purposes of the study, the following questions are raised:

1. In the absence of prosody, do the Iraqi EFL learners opt to low attachment reading or high attachment reading?

2. Do the Iraqi EFL learners make use of prosodic cues in their processing of relative clause attachment ambiguities?

2. Literature Review

2.1 Relative clauses

Relative clauses are subordinate clauses that modify nouns, phrases or sentences by providing more information about them (Ali, 2025: 1190). they perform exactly the same work as adjectives, for example:

1. **Crowded** holiday resorts are not very pleasant.
2. Holiday resorts **which are crowded** are not very pleasant.

Both the adjective **crowded** in 1 and the relative clause **which are crowded** in 2 describe the noun holiday resorts. Thus, a relative clause can be called an adjectival clause, but more usually called a relative clause because it relates to a noun by means of a relative pronoun (like who, that, which, whose) or a relative adverb (like where, when). A relative clause cannot function as a complete sentence on its own (Alexander, 1988; Colovic-Markovic, 2018; Richards and Schmidt, 2013).

Relative clauses are of two types, namely: defining relative clauses and non-defining relative clauses (Alexander, 1988). Defining relative clauses (sometimes called identifying or restrictive) offer crucial information about the nouns they modify, for example:

3. A doctor examined the astronauts **who returned from space today**.

Whereas non-defining relative clauses (also known as non-restrictive or non-identifying) offer non-essential, additional information about the nouns they modify, for example:

4. The Thames, **which is now clean enough to swim in**, was polluted for over a hundred years.

Sometimes a relative clause follows a complex NP with the structure N1-of-N2 as in the sentence **Oliver fell in love with the sister of the archeologist who studied in Oxford**. This sentence is ambiguous because the (RC) who **studied in Oxford** could modify the first noun (**sister**), (in this case it is the sister who studied in Oxford), or the second noun (archeologist), (in this case it is the archeologist who studied in Oxford) in the complex NP. This issue will be the focus of this study.

2.2 Parsing models in the relative clause attachment ambiguity

Researchers categorized the models of parsing pertinent to the ambiguous relative clause attachment into accounts based on experience (i.e., the Tuning Hypothesis) and universalist accounts (i.e., the Implicit Prosody Hypothesis, the Construal Hypothesis,

and the Regency/ Predicate Proximity model) (Fernández, 2003). Experience-based accounts assert that the parser favours structures that have frequently and successfully used in previous experience. As a result, some syntactic processing techniques unique to a language must be acquired via experience (Cuetos et al., 1996). According to Experience-based accounts, readers' and speakers' preferences for relative clause attachment can be attributed to their familiarity with comparable linguistic structures. Conversely, the universalist accounts of the cross-linguistic differences in relative clause attachment assume that the attachment preferences arise from various parameters that are applied in post-syntactic phrases of language processing rather than from different routines used by the parser (Frazier, 1978; Hemforth et al., 2015). It is reported that the preference for low attachment is consistent with a general syntactic reflex to minimize structure during processing, which was discovered early in sentence processing research (viz. Kimball's (1973) Right Association and Frazier's (1978) Minimal Attachment strategy).

Furthermore, Fodor (1998, 2002) proposes that low attachment during the processing of relative clauses in English is also characterized by a prosodic inclination to incorporate the relative clause within the same prosodic unit as the head noun in English. Under the universalist accounts, Fodor puts forth the Implicit Prosody Hypothesis (IPH) as one of the key models of parsing. According to this Hypothesis, the resolution of ambiguity is affected by "the default prosodic contour projected during silent reading. Other things being equal, the parser will prefer the analysis associated with the most natural prosodic contour for the construction" (Fodor, 2002: 112).

This hypothesis postulates that even in silent reading where the analysis of prosody is supposed to be performed implicitly, not explicitly, as in speaking and listening, a prosodic analysis is projected. Fodor (1998) has suggested that prosodic variations between languages could be the cause of cross-linguistic heterogeneity in the structural analysis of ambiguous relative clauses attachment. Prosodic phonology (Nespor and Vogel, 1986) suggests that different languages have different mappings between syntactic and prosodic structures. The prosodic processor is influenced differently by the prosodic patterns of different languages (Fodor, 2002; Jun, 2003). Thus, prosody is an essential element that needs to be considered in investigating relative clause attachment disambiguation.

2.3 The role of prosodic information in disambiguating RC attachment

In spoken language, parsing could be guided by information carried by prosody (Clifton and Duffy, 2001). Communicators usually depend on variations in prosodic realization to avoid potential miscommunication which results from structural ambiguity. It has been demonstrated by research on the processing of auditory

sentences that ambiguity resolution in L1 processing can be biased by prosodic information (Schafer et al., 1996; Kjelgaard and Speer, 1999; Frazier et al., 2006).

The role that Prosody can play in interpreting relative clause attachment ambiguities has been the subject of numerous studies. It was reported that in the absence of prosody, native English speakers show preference for low attachment reading (Fodor, 2002; Dussias, 2003). Whereas their processing of relative clause attachment is affected by prosodic information which signals the relative strength of prosodic boundaries following N1 and N2 (Clifton, Carlson, and Frazier, 2002; Jun, 2003) as well as the relative prominence of N1 and N2 (Schafer et al., 1996; Lee and Watson, 2011; Jun and Bishop, 2015). It was found that prosodic choice is affected by factors such as phrase boundary, the phrases length, prominence marking, and speech rate (Clifton et al., 2002). The prosodic boundary effect has been one of the prosodic factors that has mostly been studied by researchers. In spoken language, the interpretations of many constituent structure ambiguities can be clarified by using prosodic boundary (Clifton et al., 2002). It was reported that for a sentence like ***Oliver fell in love with the sister of the archeologist who studied in Oxford***, the likelihood of low attachment interpretation is increased if there is an intonational boundary after N1 (the sister), whereas the likelihood of high attachment interpretation is increased if there is an intonational boundary after N2 (the archeologist) (Fernandez 2007; Teira and Igoa 2007).

Some researchers have carried out some studies to identify prosodic indicators other than prosodic boundary, even though the majority of prosody research has concentrated on prosodic boundary effects. Schafer et al. (1996), for instance, examined how syntactic attachment of complex NPs is influenced by focal prominence, a pitch-accent. They postulated a hypothesis known as the ‘focus attraction hypothesis’. This hypothesis assumes that “an adjunct will be taken to modify a phrase P if P is focused than if it is not, grammatical and pragmatic constraints permitting” (136). In order to verify the focus attraction hypothesis’ predictions, Schafer et al. (1996) investigated the preferred interpretation of English native speakers’ when NP1 or NP2 is accented in the stimuli, as in the following examples:

- a. The sun sparkled on the PROPELLER of the plane that the mechanic was so carefully examining.
- b. The sun sparkled on the propeller of the PLANE that the mechanic was so carefully examining.

The result of their study was that NPs with accents were more probable to be interpreted as the RC head. The participants in their study tended to interpret the RC as a modifier of NP2 when it is pronounced with accent more than when NP1 is pronounced with accent. This implies that even after accent manipulation, the default preference persists. Schafer et al. (1996), also found that applying a contrastive accent

(L+H*) to the head had a greater impact. Thus, the results of their study showed conformance with their hypothesis predictions when they are implemented to relative clause attachment structures. The findings of Schafer et al.'s study indicate that the most significant information is thought to have received the most elaboration. Thus, decisions on the semantic structure may be the basis for syntactic attachment. Their research lends credence to the idea that prosody is a structure that is intimately linked to information structure and syntax.

Baek (2019) reports that in Low attachment readings, English native speakers pause after N1, and they pronounce N2 (the head of the second prosodic phrase) with higher pitch and greater intensity. Whereas, they pronounce N1 (the head of the first prosodic phrase) with higher pitch and greater intensity, and they pause after N2. In other words, pauses are used by native English speakers to indicate boundaries between prosodic phrases. Along with the marking boundary, it was demonstrated that English speakers pronounce a word, when it was the head of (modified by) the relative clause, with more acoustic prominence.

3. Research Methodology

3.1 Participants

To investigate the Iraqi EFL learners' processing and preference of relative clause attachment ambiguity in English, 42 undergraduate Iraqi EFL learners are recruited from English department in the faculty of Education, Wasit University. The students are in grade four of the academic year 2024- 2025. The participants were selected from fourth grade because they are well acquainted with such syntactic matters.

3.2 Experimental materials

Twelve English sentences with relative clause attachment ambiguity are used as stimuli to examine how Iraqi EFL learners process this type of ambiguity. Each sentence includes a complex NP with the structure NP1 of NP2 followed by a RC. The RC can be a modifier of either NP1 or NP2 in the complex NP in direct object position. The English sentences are adopted from (Jun and Bishop, 2015). The sentences are listed in appendix (1).

For each base sentence, four utterances are produced: one with a prosodic boundary after NP1; a second utterance with a prosodic boundary after NP2; a third one with contrastive focus on NP1; and a fourth utterance with contrastive focus on NP2. The prosodic manipulation suggested in Jun (2003) is adopted to be the base for the aural stimuli for this study. The prosodic manipulation contains four conditions. The conditions have the labels: "Pause 1 Condition (IPh boundary, noted as [IPh (L-H%)], after NP1), Pause 2 Condition (IPh boundary after NP2 before RC), Focus 1 Condition (contrastive focus on NP1), and Focus 2 Condition (contrastive focus on NP2)" (Jun, 2003; cited in Kim, 2021: 122). The utterances were recorded by a trained linguist who is specialist in phonetics and phonology. Table 1 presents a sample set of stimuli with four experimental conditions.

Condition	Stimuli example
Pause 1	Jennifer blackmailed the boss [Ipoh (L-H%)] of the clerk who was dishonest.
Pause 2	Jennifer blackmailed the boss of the clerk [IPh (L-H%)] who was dishonest
Focus 1	Jennifer blackmailed the BOSS [L+H*] of the clerk who was dishonest
Focus 2	Jennifer blackmailed the boss of the CLERK [L+H*] who was dishonest.

Table (1) A Sample Set

3.3 Procedures

To identify the default preferences of the Iraqi EFL learners for low attachment reading or high attachment reading, the participants were asked to engage in a silent reading task without any explicit prosody. In this task, the participants were presented with the experimental sentences and for each target sentence there are two sentences. Each one paraphrases one of the two readings of the RC attachment ambiguities; in one sentence the RC modifies the N1 while in the other, the RC modifies N2 as shown in Figure (1).

Sara met **the sister of the actress who was pregnant**

- (a) **It was the sister who was pregnant.**
 (b) **It was the actress who was pregnant.**

Figure (1) the two forms of resolving the RC attachment ambiguities

The participants were asked to read the sentences silently and then select what they think is the intended reading.

For the main listening task, 48 aural utterances were presented randomly to the participants. For each target utterance, two short sentences were presented on a sheet of paper. Each one paraphrases one of the two readings of the RC attachment ambiguities. The task is to listen to the target utterance twice and then decide which reading is intended by the speaker. For the two tasks, participants must quickly determine which reading is intended, relying on their immediate intuitions, without

reviewing their choices. The sequence in which NP1 and NP2 are presented in the sheet answer was assigned randomly for each item, ensuring that the participants do not simply select their choices based on the order in which they appear.

4 Results and Discussion

4.1 Silent reading task

The outcomes of this task established the default Iraqi EFL learners' preferences in the present study regarding the interpretation of RC ambiguity in the absence of prosody. It is found that 96% of the participated students in the task show a NP2 attachment preference (the low attachment), whereas only 4% of the students prefer NP1 attachment (the high attachment). Table (2) presents the outcomes of the silent reading task.

	Silent reading
NP 1	4
NP 2	96

Table (2) Percentages of NP1 and NP 2 Responses of Silent Reading

The study finds that in the absence of prosody, Iraqi EFL learners tend to prefer low attachment while processing ambiguities associated with RC attachment. In other words, they choose NP2 as the head of the RC. The students' strong tendency toward NP2 responses can be ascribed to two factors: first, in their preference for low attachment, Iraqi EFL learners follow the locality principle in English grammar. According to this concept, linguistic dependencies and processes are generally restricted to sentence parts that are close to one another. It indicates that rules of syntax, like movement or agreement typically function over short distance, which facilitates the processing of sentences. This principle explains why Iraqi EFL learners prefer low attachment where NP2 is closer to the relative clause than NP1 in the target sentences. Second, Iraqi EFL learners in processing such sentences, make use of a structure building strategy called Late Closure. A Late Closure strategy can be used to resolve some ambiguities whose alternative structures are equally syntactically complex. This strategy provokes the parser to incorporate newly received words from the lexical processor into the syntactic constituent under processing. In other words, the parser prefers to append new elements to more recent constituents rather than further-reaching constituents, because this is a simpler computational option.

When processing relative clause attachment ambiguity in the absence of prosodic cues, Iraqi EFL learners' preference is consistent with that of English native speakers (Fodor, 1998, 2002; Kim, 2021; Marina and Mikhael, 2023).

4.2 Listening task

This section presents the findings of the main experimental task conducted in the present study. The listening task findings show how Iraqi EFL learners react to prosodic adjustment when they resolve sentences that are syntactically ambiguous. Table (3) shows the percentages of NP1 and NP2 responses by Iraqi EFL learners for each of the four different experimental conditions.

	Pause 1	Pause 2	Focus 1	Focus 2
NP1	7	11	14	5
NP2	93	89	86	95

Table (3) Percentages of NP1 and NP 2 Responses by Condition

As shown in the table, a pause, whether situated after NP1 or NP2, does not affect the Iraqi EFL learners in their processing of relative clause attachment ambiguities. When a prosodic boundary is placed after NP1, Iraqi EFL learners predominantly choose NP2 as a head noun (93 %). They prefer low attachment. The percentage of NP2 of this condition is similar to that of the silent reading (96 %). On the other hand, when NP2 is followed by a prosodic boundary, Iraqi EFL Learners' preference for low attachment (NP 2) is reduced (89%), but the impact was not significant enough to change their default preference for NP2 as a head of the RC. This means that there is no interaction between the Pause factor and attachment preference.

Concerning focus conditions (Focus 1 and Focus 2), table (3) shows that when NP2 is accented, Iraqi EFL learners predominantly prefer low attachment (96%)- they choose NP2 as a head noun. The percentage of NP2 of this condition is strongly similar to that of the silent reading (95%). The learners also show preference for low attachment (86%) when NP1 is accented, but to a lesser degree than that when NP2 is accented. The learners' responses of Focus 1 and Focus 2 conditions suggest that the focus factor does not have an effect on the learners' attachment preference.

It is found that in all the four conditions (Pause 1, Pause 2, Focus 1, Focus 2), the learners show low attachment preference. To put in other words, Iraqi EFL learners do not respond to the prosodic boundary or the prominence manipulation while processing relative clause attachment ambiguity. No interaction is found between these prosodic indicators and attachment preference.

Iraqi EFL learners' propensity for low attachment can be due to several factors. First, the effect of the Locality principle and Late closure on Iraqi EFL learners is so strong that even with different prosodic boundary and different prominence manipulation they still prefer low attachment. In other words, the effect of prosodic boundary and prominence manipulation is not so great to make the learners change their default preference for low attachment to high attachment. Another factor that stands behind Iraqi EFL learners' non-use of prosodic cues in their processing of relative clause attachment ambiguity can be the fact that the prosodic system of the

English language is different from that of the Arabic language due to distinct features like intonation, stress, and syllable structure. Additionally, it seems that Iraqi EFL learners lack comprehension of the prosodic system of English language. The reason for that can be attributed to the lack of genuine communication with English native speakers in day-to-day situations. In addition to that, such issues, prosodic information, do not receive enough interest in their study.

Regarding the use of prosodic information in resolving RC attachment ambiguity, it is found that Iraqi EFL learners, who always prefer low attachment reading and do not make use of prosodic information, differ from native English speakers. Previous studies demonstrated that native English speakers prefer low attachment reading when there is an into national boundary after N1, whereas they show high attachment reading preference when there is an into national boundary after N2 (Fernandez 2007; Tiera and Iago 2007). It was also found that English native speakers produce a pause after N1, and N2 (the second prosodic phrase head) is pronounced with higher pitch and greater intensity in low attachment readings. On the other hand, they pronounce N1(the head of the first prosodic phrase) with higher pitch and greater intensity, and they produce a pause after N2 in high attachment readings (Beak, 2019).

5. Conclusions

The present study set out to identify whether Iraqi EFL learners, in the absence of prosodic cues, prefer low attachment reading or high attachment reading and to determine whether or not Iraqi EFL learners make use of prosodic cues in their processing of relative clause attachment ambiguity. The obvious findings to emerge from the study are that, in the absence for prosodic cues, Iraqi EFL learners show preference of low attachment interpretation. Even with different prosodic manipulation, they still prefer low attachment interpretation. No interaction is found between the prosodic boundary or the prominence manipulation and attachment preference. Iraqi EFL learners do not respond to such prosodic cues. Thus, they follow experience-based accounts while processing RC clause attachment ambiguity. Future research can be conducted by researchers to identify how interpreters interpret RC clause attachment ambiguity.

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