

PROSODIC PHRASING AND MODIFIER ATTACHMENT IN
STANDARD ARABIC SENTENCE PROCESSING

by

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ABSTRACT

PROSODIC PHRASING AND MODIFIER ATTACHMENT IN STANDARD ARABIC SENTENCE PROCESSING

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This dissertation investigates the syntax-prosody interface in Standard Arabic, focusing on the ambiguity of a modifier (relative clause or adjective phrase) in relation to the two nouns in a complex noun phrase. Ambiguity resolution tendencies for this construction differ across languages, contrary to otherwise universal parsing tendencies. One explanation proposed is Fodor's (2000) Implicit Prosody Hypothesis: that readers mentally project onto a text a default prosodic phrasing (possibly different between languages), which then influences their syntactic ambiguity resolution.

Since implicit (silent) prosody cannot be directly observed, previous research has had to infer it by analogy with overt prosody. But the phonology and orthography of SA permit use of novel methods for tapping into the silent prosody of readers. Liaison phenomena sensitive to prosodic boundaries make phonological phrasing in SA very easy to detect. Also, liaison is indicated by diacritics in the 'vowelized' version of SA orthography. Thus, clear data on prosodic phrasing patterns in SA complex nominals can be related to their preferred syntactic/semantic interpretations.

Six experiments are reported: three production experiments and three perception experiments. Participants in Experiment 4 silently read sentences in unvowelized orthography, and added diacritics as they thought appropriate. The inserted diacritics gave evidence of their implicit prosodic phrasing of the sentence. Experiments 5 and 6 investigated Arabic speakers' preferred overt prosodic phrasing when the modifier was forced to attach to either the lower or the higher noun, providing standards for comparison with the prosodic phrasing preferences in silent reading in Experiment 4.

The orthography was put to a different use in assessing modifier interpretation under varying prosodic conditions. In Experiments 2 and 3, vowelized text was presented, establishing one or other of two relevant prosodic patterns. Participants read aloud, and then indicated their interpretation of the sentence. This provided standards for comparison with modifier interpretation (attachment preferences) in silent reading of unvowelized texts (lacking prosodic disambiguation) in Experiment 1.

Results obtained from these experiments provide new information concerning the constraints that apply at the syntax-prosody interface in SA, and also support the hypothesis of an effect of implicit prosody on syntactic interpretation during silent reading.

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CHAPTER 1

INTRODUCTION AND OVERVIEW

1.1 Prosody and Sentence Processing in Standard Arabic

This dissertation investigates the phrasing function of prosody in sentence processing with specific reference to Standard Arabic. This function is studied in close relation to a particular modifier attachment ambiguity which, in recent years, has been a focus of attention within psycholinguistics.

In recent years researchers have documented the important role of prosody in sentence processing. Various studies have shown that prosody influences parsing decisions (Pynte & Prieur, 1996, Shafer, Speer, Warren & White, 2000, Watson & Gibson, 2001, 2003, Clifton, Carlson and Frazier, 2002 and Jun, 2003.)

Prosodic phrasing or the chunking of speech into prosodic groups, which is an important part of sentence prosody, has proven to be constrained by a number of different factors such as constituent length, metrical balance requirements, speech rate and syntactic branching, among others. However, the effects these factors have on phrasing are not the same across languages.

Variation across languages has been an important area of research in many recent studies of prosody in psycholinguistics. Within this plethora of studies, Arabic is a language that has received very little attention and has been very rarely researched from

the point of view of prosody and sentence processing. This dissertation thus breaks new ground with regards to findings about the relationship between prosody and the processing of sentences in Standard Arabic.

1.2 Modifier Attachment in Standard Arabic

This dissertation investigates Arabic speakers' comprehension of sentences containing a complex noun phrase which contains two nouns followed by a modifying element (Relative Clause (RC) or Adjective Phrase (AP)). An example of the Arabic sentence type (containing an RC) is shown in (1) below:

- (1) zaara al-muhaafith maktabat almadrasah ?allatii gudiddat
visit the-mayor library the-school that was renovated
‘the mayor visited the library of the school that was renovated.

Sentences like (1) are ambiguous, since the relative clause (RC) can be understood to modify either the first noun N1 *maktabah* (library) (high attachment) or the second noun N2 *al-madrasah* (the school) (low attachment) (see syntactic representations in Chapter 9, §9.7).

This ambiguous construction has gained a great deal of interest in psycholinguistic research because experiments have shown that speakers of different languages show different patterns of ambiguity resolution for these types of sentences. In Abdelghany & Fodor's (1999) questionnaire study of RC-attachment preferences in Arabic (similar to findings for English), there was an overall 63% low attachment

preference (37% high attachment) whereas in other languages, that will be mentioned later in this study, there is a greater tendency to attach the RC high. This cross-linguistic variation is of theoretical concern because it presents apparent counterevidence to the universality hypothesis which claims that the human sentence processing mechanisms are universal and innate (Frazier & Fodor 1978).

Within the psycholinguistic literature on sentence processing, one of the explanations offering an account for cross-linguistic variation in RC attachment preferences is a prosodic account. Fodor (1998, 2000) has proposed what is termed the Implicit Prosody Hypothesis (IPH). In this dissertation, we will look at Arabic as a testing ground for the predictions of the IPH.

The syntactic, prosodic and orthographic properties of Standard Arabic are such that questions about the syntax-prosody interface in parsing can be asked and clearly answered. Specifically the unique properties of the genitive construction in Arabic with its phonological properties of prosodic cohesion (see Chapter 4, §4.6) as well as Arabic orthography offer an interesting testing ground for theories that deal with the role of prosody in parsing.

1.3 Prosodic Phrasing and Boundary Placement

Considerable evidence shows that speakers organize their speech with reference to an internal notion of cohesion between segments of an utterance. Previous research (Maynell, 1999, Lovrić et al, 2000, 2001) has shown that hearers interpret a prosodic break before a modifier as a marker of a syntactic boundary which blocks local

attachment and prompts high attachment, whereas the absence of a break signals a prosodic grouping effect of cohesion and promotes local attachment. Boundary demarcation is generally measured in current research by acoustic cues such as pitch movements (boundary tones; post-boundary F0 reset), and pre-boundary lengthening of the final stressed syllable.

1.4 Prosodic Phrasing and Phonological Processes in Standard Arabic

This dissertation will look at language-specific phonological processes of phrase-level re-syllabification such as liaison, enchainement¹ or what is termed in the literature external *sandhi* processes that apply across word boundaries, as well as their phonological realization as cues for prosodic phrasing patterns. Sandhi or the joining of word boundaries involves various phonological mechanisms of deletion, insertion and assimilation (see Anderson, 1986).

An example of these processes is the sandhi phenomenon of consonant liaison in French as shown in the phonetic realization of a [t] consonant in example (2) which consists of a phonological alteration whose conditioning environment is across a word boundary (Bybee, 2001, Féry, 2003, Tseng, 2002):

(2) Le climat est [t] également très différent.

“The climate is also very different.”

[From Féry (2003)]

¹ This term is used to describe the phenomenon whereby a word-final consonant sound is realized as the onset of the following syllable. Liaison is the appearance (pronunciation) of a word final consonant which is generally silent. Liaison is normally produced with enchainement but there are cases where there is liaison without enchainement.

Example (3) shows enchainement in French: the realization of a word final consonant at the onset of the following syllable (Tseng, 2002).

- (3) [nwa-re-blanc] for “noir et blanc” (white and black)

Syllabification across word boundaries in the sandhi phenomenon is where edges of words re-syllabify with the following syllable onset. This is a phenomenon that can be exploited in an experiment as a means of investigating degrees of prosodic cohesion and their effect on syntactic attachment decisions in parsing Arabic sentences.

In Standard Arabic, this liaison phenomenon can be shown in the feminine suffix called “*taaʔ marbuutah*”, referred to in this dissertation as the *t-consonant* liaison. This feminine suffix is pronounced as a glottal fricative “*h*”, when the word is followed by a pause or prosodic boundary and that final *h* cannot prosodically carry or be followed by a case vowel marker¹. This is illustrated in (4), where # signifies a boundary:

- (4) tabiib al- ʔamiira**h** # ʔallati kaanat mariidha
physician the-princess who was sick
“the physician of the princess who was sick”

¹ One instance of this is that the “*h*” sound cannot carry the genitive marker “*i*” in Arabic phonology. It is relevant here to mention that case endings in Arabic are short vowels that are realized at the ends of words. Short vowel case endings are only realized phonetically in connected speech where there is no prosodic phrase boundary. The case endings are muted at the edges of phonological phrase boundaries or pause because of the phonological constraint in Arabic that there cannot be an open syllable at a phrase boundary.

However, when this same word “ʔal-ʔamiirah” (princess) is joined in connected speech with the following word, the glottal fricative ‘h’ becomes an alveolar plosive “t” sound that can carry the genitive marker, which is a short “i” vowel sound (usually shown in vowelized text, orthographically, as a diacritic above the last letter of the word). This liaison consonant “t” together with the short vowel “i” case marker then syllabify with the syllable onset of the following word and a process of assimilation takes place.

- (5) tabiib al-ʔa.mii.ra.til.la.tii kaanat mariidha
 physician the-princess who was sick
 “the physician of the princess who was sick”

In the context in (5), where the following word which is the relative marker that begins with the definite article “ʔal” as its onset, the “h” on N2 becomes a “t” which then projects the genitive marker “i”. Then when the t-consonant liaison joins with the definite article onset sound, it deletes or assimilates the “ʔa” and joins with the lateral sound “l” of the definite article and then the whole inter-word juncture becomes “til”.

Therefore, Arabic phonology happens to provide phonological cues with which an experimenter can clearly diagnose prosodic boundaries between N1 and N2 as well as between N2 and a following modifier. This is an interesting and convenient supplement to the use of pre-boundary lengthening or pitch movements as used in other experiments to date in order to detect boundaries between phonological phrases.

Another aspect of Arabic that makes it well-suited to research on prosody and that lends itself well to silent prosody experimentation is the orthography and reading routines

of Arabic speaking readers. It is important to note here that the written Arabic of newspapers, novels and other literary texts mostly does not show short vowels.

As the Arabic reader is acquainted with both the vowelised and unvowelised types of written texts, the control of graphemic display in experimentation is possible.

A standard task given to students in Arabic schools is to add the vowel diacritics onto unvowelized Arabic texts, a task called “*tashkeel*” in the Arabic language classroom. This means endowing a word with diacritic marks to clarify its case and functional role in the sentence. This task can therefore be employed in a psycholinguistic experiment with ambiguous sentences where the target diacritic is the short vowel genitive case marker “i” on N2. If this is marked, then it is assumed to be an orthographic indication that the reader has silently read the word containing a consonant liaison “t” and therefore that there was no boundary at that point in the mental representation of the sentence. If not then the word was silently read with an “h” and there was a boundary at that point. It is the goal of the present study to lend evidence to this hypothesis of a mental representation of prosody in silent reading.

1.5. Overview

Chapter 2 of this dissertation reviews studies on the role of prosodic phrasing in sentence processing. It will also discuss research pertaining to the intricate relationship between prosodic structure and syntactic structure. In addition, the chapter will review studies that investigate cross-linguistic differences in prosodic phrasing patterns.

Chapter 3 discusses the Implicit Prosody Hypothesis as a prosodic account of cross-linguistic variation in ambiguity resolution in reading. Chapter 4 will further explain in detail why Arabic, a language which has hardly been studied from a psycholinguistic point of view, is particularly interesting from the point of view of modifier attachment studies and why Arabic offers a good testing ground for the Implicit Prosody Hypothesis.

Chapter 5 presents a summary of the findings of three corpus studies in Arabic that show the distribution of the complex noun phrase structure under investigation.

The experimental component of this research consists of six experiments designed to investigate modifier attachment in Standard Arabic as well as test the Implicit Prosody Hypothesis. Chapter 6 describes and discusses the methodology and design of the experiments. There are two silent reading experiments: one examining Arabic speakers' preferred interpretation of Arabic sentences similar to (1), and another examining Arabic speakers' preferred prosodic phrasing patterning of the same sentences. There are also two overt-prosody production experiments that examine preferences in the prosodic phrasing of disambiguated sentences, and two overt prosody perception experiments designed to evaluate the perception of prosodic phrasing.

Chapter 7 presents the results of the perception experiments 1, 2 and 3 in detail. Similarly Chapter 8 presents the results of the production experiments 4, 5 and 6 in detail.

Finally, Chapter 9 presents an extensive cross-experimental analysis that compares the results of the different experiments in order to evaluate the claim that silent prosody to a great extent influences sentence processing in the reading of Arabic. Moreover the findings

of the six experiments are evaluated as a whole, and we examine how the evidence presented in this dissertation contributes to the current understanding of the human parsing mechanism and points to future investigations.

CHAPTER 2

PROSODIC PHRASING AND THE SYNTAX-PROSODY INTERFACE

2.1 Introduction

The aim of this chapter is to define the dissertation's working constructs of "*prosody*", "*prosodic phrasing*" and "*the syntax-prosody interface*". Attention will then be given to the phrasing function of prosody in relation to syntax. This chapter also provides a brief overview of the relevant research on prosody that has informed and guided this study.

Topics addressed in this chapter include important issues in the prosodic phonology literature as well as in the research area that investigates the role of prosody in sentence processing. Different models that have been proposed for the syntax-prosody interface are also presented. The chapter concludes with an overview of crosslinguistic studies of prosodic phrasing preferences conducted on a number of different languages including Arabic.

2.2 Defining Prosody

Shattuck-Hufnagel and Turk (1996) state that a satisfactory definition of prosody must include both a description of the relevant acoustic patterns as well as the higher-level constituents that account for these patterns.

Keating (2003) defines prosody as “the organization of speech into a hierarchy of units and domains of definite size and structure, some of which are more prominent than others.” Keating points out that prosody serves both a “grouping” function and a “prominence marking” (contrasting) function in speech.

Grouping includes:

- The various “size groupings of smaller domains into larger ones, such as segments into syllables, syllables into words, or words into phrases” (Keating (2003));

Contrasting includes:

- Stress, which refers to prominence of syllables at the word level;
- Accent, which refers to prominence at the phrase level;
- The distribution of tones (pitch events) such as lexical tones associated with syllables; or intonational tones associated with phrases or accents.

These various aspects of prosody taken in conjunction are seen as characterizing the prosodic structure of an utterance.

2.3 The Phrasing Function of Prosody

There are two main ideas within the sentence processing literature on prosodic phrasing. There is the idea that prosodic boundaries cause a break between constituents during the parsing process. There are also theories in the literature that claim that the primary role of intonational phrasing in comprehension is to group relevant constituents together (Pynte & Prieur, 1996; Speer, Kjelgaard, & Dobroth, 1996; Schafer, 1997; Kjelgaard and Speer, 1999; Frazier & Clifton, 1998). A point worth considering in this regard is that the norm or origin of speech is continuity or what has been termed a “speech flow”, a “stream” or a word “string”. Therefore, the hypothesis is that cohesion is the baseline or default in speech, while inserting a break or boundary or demarcation is a process that is employed by users of a language to facilitate comprehension (as well as production). As pointed out by Selkirk (2000), as far as the syntax-phonology interface is concerned, languages must opt for a dominant cohesional strategy or a dominant demarcative structure, as represented in the relative rankings of the constraints Wrap-XP and Align-XP,R (these constraints will be discussed later on in this chapter in §2.11):

“It is in characterizing the interface between prosodic structure and other grammatical representations - morphosyntactic or informational - that the cohesional and demarcative functions come into conflict and where a language must apparently 'decide', through constraint ranking, which of the functions will predominate.” (Selkirk 2000:240)

It is relevant to distinguish here between competence-based theories of prosodic phrasing and performance-based theories. The former maintain that the grouping of words into intonational phrases influences sentence acceptability. Selkirk (1984), for example, argues for semantic well-formedness conditions that require intonational

phrases to correspond to semantic units called *Sense Units*. Sense Units are defined as groups of words that engage in a semantic relationship with each other.

In contrast, performance-based theories such as Watson & Gibson's (2003) Anti-Attachment Hypothesis, which will be discussed below, is based on the notion that intonational boundaries are useful to listeners in so far as they signal a break between syntactic units. Watson and Gibson (2001) claim that their performance-based theory of prosodic phrasing accounts for a large amount of the English data in their production experiments. They propose that speakers tend to produce an intonational boundary when an incoming word does not attach locally to the pre-boundary word but must be integrated with a head mentioned earlier in the utterance. Data presented by Watson & Gibson are consistent with the hypothesis that intonational boundaries are a function of the size of the most recently completed constituent as well as the size of the upcoming syntactic constituent if it is not an argument of the most recent head.

2.4 Influences on Prosodic Phrasing

Various studies in psycholinguistics have pointed out that the phrasing function of prosody in speech can be impacted by an array of factors including morphosyntax, constituent length (size or weight), tempo, and metrical balance (see Fig.1). Therefore, prosodic structure is the locus for integrating morphosyntactic influences with non-grammatical influences.

Research in prosodic phonology has extensively investigated the distribution of prosodic phrases due to syntactic alignment constraints.

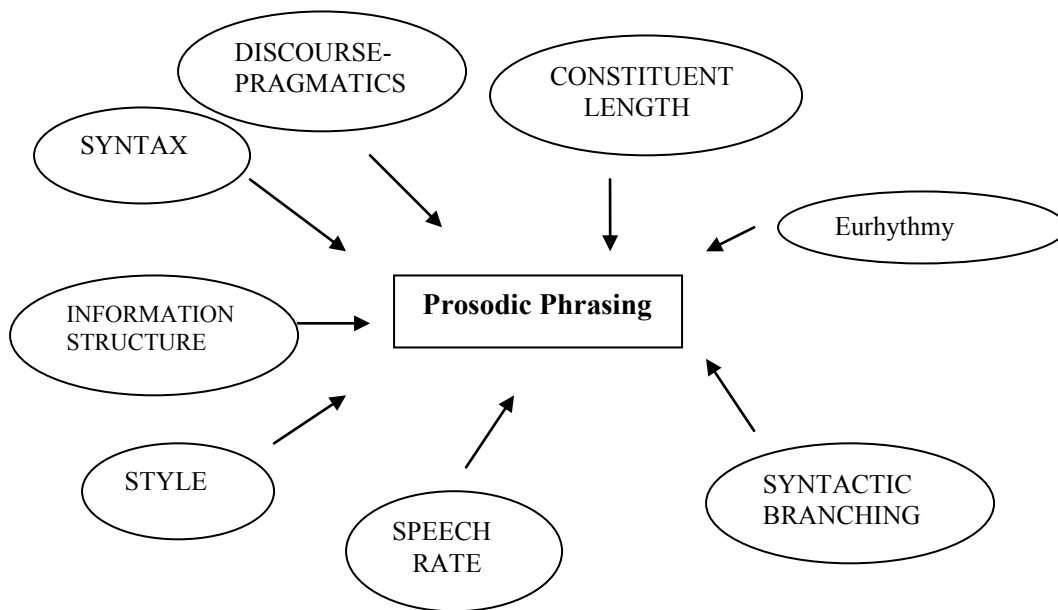


Figure 1: Factors that can influence Prosodic Phrasing.

2.5 Model of the Grammar and Interface Interaction

There are a number of different views concerning the interface between syntax and phonology. A standard modular architecture of generative grammar is organized into components or *modules*. These multiple modules are viewed as working independently of one another, although input-output relations are defined between them. The model below adapted from Kager & Zonneveld (1999) displays the assumed *serial* interactions of the Lexicon-Morphological Component, Syntax, and Post-Lexical Phonology (where phrasal prosody is observed).

Serial modular organization of the grammar:

Morphology $\Rightarrow$ Syntax $\Rightarrow$ Post-Lexical Phonology

[From Kager & Zonneveld, 1999:1]

The main hypothesis of the modular model is that the various aspects of grammatical structure are autonomous. Information flow between grammatical components is limited. If this serial model is rightly motivated, interface issues arise, *i.e.*, intermodular information or *mappings* must be defined by which information leaving one module as an output is ‘repackaged’ so as to become the suitable input to another module (Kager & Zonneveld, 1999:1). The following is a summary from Kager & Zonneveld’s (1999) outline of the main issues discussed in the literature on the syntax-phonology interface:

- **DIRECT VS. INDIRECT REFERENCE.** Is there only indirect reference by phonology to syntax (to the syntactic information after mapping), or is direct reference possible as well (to syntactic information present prior to mapping)?
- **TYPE OF SYNTACTIC INFORMATION.** Not all sorts of syntactic information are relevant to phonology. The theory must define the relevant information.
- **THE DIRECTION OF MAPPING.** This is also known as the issue of Phonology-free Syntax. In the serial organization of the grammar, the syntax feeds into the phonology. However, there are examples in the literature which support consideration of a bidirectional relation between syntax and phonology (Kager & Zonneveld, 1999: 2).

- **THE DIVISION OF LABOUR BETWEEN COMPETENCE AND PERFORMANCE.** The question of which aspects of phrasal phonology should be accounted for by the grammar, and which lie outside it has been investigated in the literature? E.g., rate of speech.

2.6 The Syntax-Phonology Interface: *A brief literature review*

In the early literature on the syntax and phonology interface, the syntax feeds into phonology but the relation between the two is indirect: a mapping procedure is needed to change the former's output into the latter's input. Discrepancies between the domains which follow directly from the syntax and the actually observed ones were covered by processes of so-called "boundary deletion". In Chomsky & Halle's *The Sound Pattern of English* (1968), the authors consider two issues concerning the "discrepancy between the syntactically motivated surface structure and what is apparently required as an input to the phonological component". First, the authors consider the observation that in the example below "the intonational structure of the utterance does not correspond to the surface structure".

(1) [This is [the cat that caught [the rat that stole [the cheese]]]]

The authors observe that the syntactic structure is as in (1) but "the sentence is spoken as the three-part structure *this is the cat-that caught the rat-that stole the cheese*". A *readjustment rule* was proposed which adjusts the structure of (1) to one corresponding to the three-part structure required by the phrasal phonology. Chomsky & Halle were unsure about the status *vis-à-vis* the grammar of such a solution, however they state that "it can certainly be argued plausibly that this 'flattening' of the structure is simply a performance

factor, related to the difficulty of producing right-branching structures.” Second, they note that it “is clear that the rules of the phonological component do not apply to strings that exceed a certain level of complexity or a certain length, and that therefore certain readjustment rules must apply to the syntactically generated surface structure to demarcate the strings to which the rules are limited, that is, the [...] ‘phonological phrases’.” (Chomsky & Halle, 1968: 371-372).

2.6.1 French Liaison

One of the main sources of data in theorizing about the phonology-syntax interface is French liaison, which is an example of ‘external sandhi’, that is, phonological alternations whose conditioning environment is across a word boundary. This is particularly relevant to the present study of Arabic, as noted in §1.4 and which will be discussed in more detail in Chapter 4, §4.11.4. A recurrent problem in this area is the fact that it is usually impossible to motivate a purely syntactic account of such alternations. This has led to the widespread view that the relation between syntax and phonology is indirect. French liaison is a phenomenon of external sandhi in which the juncture of two words is observed, when the second word begins with a vowel¹, e.g. *petit* [pəti] + *ami* [ami] → [pətitami] “little friend”. Liaison consonants are usually *enchaînées*, i.e. realized as syllable-onset consonants, although they can also appear in coda position, compare

¹ The basic phonological condition given for liaison- that the following word must be V-initial- is only an approximation, because there is a class of V-initial words in French that do not trigger liaison to the left. To account for these, Gaatone (1978) rejects abstract manipulations of the phonological representations and assumes that the words in question, in contrast to the vast majority of V-initial words, bear a feature [-SANDHI] that blocks word-boundary phenomena like liaison. Tseng (2002) assumes that the left edge of a word is lexically specified as [+LIAISON] if it can trigger liaison in the preceding context, and [-LIAISON] otherwise.

[pə.ti.ta.mi] (with *enchaînement*) and [pə.tit.a.mi] (without *enchaînement*, see Encrevé, 1988).

Numerous approaches to French liaison have been proposed in the literature over the past thirty years or so (see Côté, 2005 for a review). In various phonological approaches, liaison is viewed as being affected by prosodic, morphological and syntactic as well as stylistic factors. The phonological approach dates back to early generative studies on French phonology, in which liaison was seen as an exception to a general process of final consonant deletion, referred to as the “French Truncation Rule” by Schane (1968). By contrast, according to another proposal made later in the same general framework (e.g. Klausenburger, 1974, 1977), liaison consonants were inserted in the course of the derivation. More recent studies of liaison in nonlinear phonology have reanalyzed the deletion/insertion dichotomy, as pointed out by Tranel (1995). Thus, in the auto-segmental account proposed by Encrevé (1988) and Encrevé and Scheer (2005), liaison consonants are viewed as floating segments, with respect to both the segmental and syllabic tiers. Such consonants must be associated with both tiers to be phonetically realized, and this association takes place only under certain conditions.

As noted earlier, liaison consonants when realized are usually syllabified into onset position. This results in a mismatch between word and syllable boundaries. Specifically, the syllable, whose onset position the liaison consonant comes to occupy, is said to *straddle* the boundary between the first word and the second word (e.g. [pə.ti.ta.mi], where the word boundary is between [t] and the following [a]). Recent psycholinguistic studies (Wauquier-Gravelines, 1996; Gaskell et al., 2002; Spinelli et al.,

2003) have shown that this mismatch does not necessarily make it more difficult for listeners to identify the second word, but may in fact facilitate the recognition of that word with respect to a baseline condition. This has consequently raised questions for models of speech perception in which the syllable is viewed as a primary unit of segmentation in lexical access in French (see Content et al., 2001, for a recent discussion in that domain). A related issue concerns the way in which liaison consonants are processed in speech perception. One line of investigation examines which perceptual mechanisms allow a *liaison enchainement* to be distinguished from word-initial as well as word-final consonants, and to which of the two words the liaison consonant is associated by the listener. Another line of study investigates whether in speech comprehension liaison consonants are processed and represented in a way that is different from fixed consonants. In Nguyen et al. (2007), a series of perception experiments are reported which suggest that liaison consonants do have a distinct perceptual status in the speaker-listener's grammar.

Studies in intonational phonology have tried to define the domain in which liaison applies. Some researchers have analyzed liaison as applying within a phonological phrase (PhP) which is a prosodic domain indirectly defined in syntactic terms. However, empirical studies by Morin and Kaye (1982), de Jong (1994) and Post (2000) have found data that cannot be accounted for by this analysis. Brown & Jun (2002) examined liaison data to investigate whether the domain of liaison matches a prosodic unit defined by intonation under the framework of intonational phonology. Their results show that the

domain of liaison matches an accentual phrase. They show better fitting results for an Accentual Phrase domain than for that predicted by the Phonological Phrase analysis.

2.6.2 Italian Raddoppiamento Sintattico

Another phenomenon that has influenced the discussion about the syntax-phonology interface is a phonological process found in Italian. Napoli and Nespors (1979) discuss the phenomenon of RADDOPPIAMENTO SINTATTICO (RS) in a range of Italian dialects. In RS, word-initial consonants are lengthened in certain configurations, as in the example *fa caldo* ‘it’s hot’ [fá k:áldo]. In Tuscan, the phonological context of this lengthening requires a stressed vowel immediately to the left of the target, and a sonorant immediately after the target; in Sicilian, the former requirement is obsolete. Nespors and Vogel examine the syntactic environments for RS. In example (2) from Nespors and Vogel (1979), it is shown that syntax plays a role in the phonological process of vowel lengthening:

- (2) a. Perché [k:]arło non é ancora arrivato? ‘Why has Carlo not arrived yet?’
Che c’è un perché [k]arło lo sa. ‘That there is a reason is known to Carlo’
- b. Devi comprare delle mappe di città [v:]ecchie
‘You must buy some maps of old cities’
- Devi comprare delle mappe di città [v]ecchie
‘You must buy some old maps of cities’

The syntactic condition on the RS rule is different from the conditions on French liaison. One important characteristic of the proposed analysis is that it lacks (readjustment) rules manipulating boundaries. RS is proposed to work as follows:

RS can apply between a word *a* and a following word *b* (where *a* is immediately dominated by *A*, and *b* is dominated (not necessarily immediately) by *B*, only if *A* is a left branch of the first node that dominates both *A* and *B*. (Nespor and Vogel (1979))

This means that “RS applies to a word if its immediate left-hand neighbor is a left branch constituent” (Kager & Zonneveld 1999:8). This analysis presupposes that phonological rules can have access to syntactic structure. Thus “the phonological and syntactic components of the grammar cannot be perfectly discrete” (Napoli & Nespor 1979: 839). The RS analysis “provides support for the direct dependence of phonology on syntax, since the intermediary role of the readjustment component is not present” (Kager & Zonneveld, 1999:9).

2.6.3 Prosodic Hierarchies and Constituents

Phrase-level phonology has developed as a theory of the interaction between syntax and phonology, and one of this theory’s main characteristics was the claim of the relative autonomy of phonological structure from syntactic structure. The asymmetry¹ between syntax and phonology supported such a view. The crucial step towards a separate phonological theory of prosodic phenomena was taken in work by Selkirk in the late 1970’s and early 1980’s (see Selkirk 1980, 1981). The two essential aspects of this theory are: the use of phonological hierarchical structure and the introduction of so called prosodic categories.² Arranged in their hierarchical order, these prosodic categories are those below:

¹ The term “asymmetry” here refers to an observed mismatch between syntax and phonology (see §2.6).

² The reader is referred to Shattuck-Hufnagel and Turk (1996) for a comparison of the full constituent hierarchies posited by various prosodic theories. However, Cambier-Langelveld (2000) rightly points out that “there is no general agreement within the field of prosodic phonology on issues such as the number and types of constituents that need to be distinguished, or how different levels should be analyzed. Terminology is also inconsistent: the same phenomenon may be referred to with different terms by different researchers, and a single term may be used across researchers to refer to different phenomena.”

U = Utterance

I = Intonation Phrase

Φ = Phonological Phrase

ω = Word

F = Foot

σ = Syllable

μ = Mora

(C,V) = (Consonantal or Vocalic) Root Node (= ‘segment’)

Modern prosodic phonology deals with prosodic categories from the Word upward. Since the Word is the maximal unit of the Lexicon, an alternative term for Phrasal Phonology is ‘Post-Lexical Phonology’. It is relevant here to mention the motivation for positing prosodic categories starting with the Word.

2.6.3.1 Prosodic Categories

Rules of syntax-phonology mapping are theorized to exist which are similar to the readjustment rules posited in the original liaison analysis mentioned above. These mapping rules now turn syntactic surface structures into phonological ones, containing phrasal prosodic categories. The term *phonological phrase* introduced by Selkirk (1981) is one of the prosodic categories used in this framework. The main mapping rule singles out phrasal heads in a given structure, and then requires that all material to the left of that head and the head itself be assembled in a right-branching structure. Thus, the sentence in (3) from Abney (1992) below

contains four consecutive *phonological phrases*, as indicated, although its syntactic structure is a [[NP] [VP]] sequence, with the major syntactic break between *professor* and *has*.

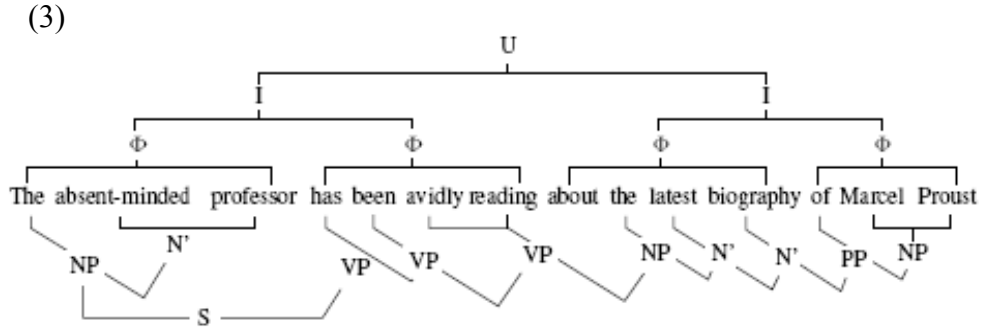


Figure 2: Asymmetry between syntactic structure and prosodic structure. [From Abney (1992)].

Selkirk (1980) presents a discussion of a large range of phonological rules of Sanskrit, and their possible prosodic domains. Its main contribution is the insight that “prosodic phrasal phonology is not just a theory of the discrepancy between syntactic and phonological *structure*, but motivates the need for phonological analyses using boundary markers.” (Kager & Zonneveld, 1999:12).

The empirical core of the literature on ‘phrasal phonology’ is that segmental phonological rules¹ can be conditioned by prosodic domains, in the sense that they apply only within particular domains, or only across particular boundaries. Post-lexical, phrasal

¹ Phonological rules are defined as those which change the value of a distinctive feature, adjust stress or insert/delete a segment, resulting in a different word form; in contrast, processes which change the timing or shape of articulatory configurations that implement the distinctive features of phonological segments are viewed as phonetic.

phonological processes include such phenomena as syllabification of coda consonants; French liaison; assimilatory rules of Bengali described by Hayes and Lahiri (1991) that apply within Phonological Phrases; and other examples provided by Selkirk (1986) of phonological rules that are part of the “sentence phonology”.

2.6.4 Prosody-Free Syntax

One of the main issues in the literature on the syntax-phonology interface is the output-input relation between syntax and phonology. In phonology-free syntax (Zwicky 1969, Zwicky and Pullum, 1986; see also Kager and Zonneveld, 1999), it is claimed that no phonological information is available to the syntax, that is, the syntax-phonology interface is *asymmetrical*. Such a model makes syntactic information accessible to the phonology (mediated by mapping), but it never applies in the opposite direction, encoding phonological information such that it may influence syntax. This asymmetry is part of the hypothesis of the ‘strict autonomy of syntax’ (Chomsky 1965). If syntax is strictly autonomous, then it cannot be sensitive to information represented in other modules.

This model has been strongly defended by Pullum & Zwicky (1988) as they explain away a range of apparent counterexamples to the principle of phonology-free syntax (“No phonological information is available to the syntax”). In the literature on the phonology-syntax interface, a debated phenomenon is Heavy-NP shift:

(4) Heavy-NP-shift (requires prosodic ‘heaviness’ of shifted NP):

a.i he threw [the letter which he had not decoded] into the wastebasket.

- a.ii he threw into the wastebasket [the letter which he had not decoded].
- b.i he threw [the letter] into the wastebasket.
- b.ii *he threw into the wastebasket [the letter]. [Pullum & Zwicky (1988)]

The heaviness condition on shifted NPs is described by Pullum & Zwicky (1988:275-276) not as a syntactic factor, but as a kind of preference related to “processing reasons (crudely, it is easier to complete a lengthy processing chore if there is nothing left on the stack to return to when it is done.”

The standard explanation of apparent phonological influences on syntax is known as the ‘filtering’ model (Ross 1967). Syntax works by giving as output syntactically well-formed structures that are then the input to the phonology. The phonological component functions as a filter on the output of syntax defining its own range of constraints. In example (4) of Heavy-NP shift¹, both word orders (with and without shift) are syntactically well-formed, and therefore both are inputs to the phonology. Unacceptability will result as in (4bii) and the phonology will judge it as unacceptable, whenever a syntactic output cannot be parsed into well-formed prosodic structures. For example, the phonology assigns a prosodic phrase structure to the output *he threw the letter in the wastebasket*; but it would reject *he threw in the wastebasket the letter*, since this would include a non-branching phrase at the end of the utterance. In sum, it is proposed that what appears as an impact of phonology on syntax is apparent only as each component functions independently. Kager & Zonneveld (2002:18) note, however, that

¹ For further important work on Heavy NP Shift the reader is referred to Inkelas & Zec (1990), Wasow (1997) as well as Selkirk (2001).

“while the filter model formally preserves the properties of serialism and modularity, it raises the urgent question of what actual interactions of syntax and phonology it actually excludes.”

2.6.5 Relevant Syntactic information for Prosodic Phrasing

Research on the syntax-phonology interface has focused on the nature of the syntactic information that is relevant to prosodic phrasing. In earlier research a considerable amount of agreement had been reached on the assumption that the mapping accesses surface syntactic structure only (Lehiste, 1973, Selkirk 1984, Kaisse 1985, Pullum & Zwicky 1988). It has also been widely assumed that prosodic phrasing is mostly insensitive to information about lexical categories, an assumption which supported generalizations in terms of X-bar structure (e.g. Selkirk 1981, 1986; Nespor & Vogel 1986).

Kager & Zonneveld point out that theories of the syntax-phonology interface differ mainly in whether they associate a key role to grammatical relations (*relation-based* mapping, Nespor & Vogel 1986), to phrasal rank (*end-based* mapping, Selkirk 1986), or to branchingness (which has been called *arboreal* mapping, Zec & Inkelas 1990). The following section will give a brief summary of the main ideas within each approach.

2.6.5.1 End-based mapping

The theory of end-based mapping is based on the idea that edges of prosodic domains align with edges of syntactic constituents (Chen 1985, Selkirk 1986, Selkirk & Shen 1990). The mapping process accesses only one type of syntactic information: edges of X-bar constituents. Differences in mapping between languages are suggested to be due to parametric variation with respect to X-bar level and the relevant edge of syntactic constituents or, as Selkirk & Shen (1990:319) state it: “For each category C^n of prosodic structure of a language there is a two-part parameter of the form”:

“ C^n : {Right/Left; X^m } where X^m is a category type in the X-bar hierarchy.”

“A syntactic structure-prosodic structure pair satisfies the set of syntax phonology parameters for a language if and only if the Right (or Left) end of each constituent of type X^m in syntactic structure coincides with the edge of constituent(s) of type C^n in prosodic structure.”

In this theory of the syntax-phonology mapping, all that is relevant to mapping is the X-bar level of constituents and the location of edges. That is, information about syntactic relations (e.g., head/complement, dominance and sisterhood as well as lexical category) is not visible to the phonology. End-based theory thereby delimits the type of syntactic information which is accessible to mapping: constituent edges plus X-bar type, rather than functionally related information involving argument structure, such as head-complement.

Chen (1990) criticizes end-based theory for imposing too strong limits on the types of syntactic structure referred to by mapping. He argues that, in addition to syntactic

edges, there is still a major role in mapping for *syntactic relations* (head complement, but also argument-adjunct). Evidence for his claims comes from data of Xiamen Chinese tone sandhi. Both end-based and relation-based mapping principles, according to Chen, serve essential functions in the organization of speech “[...] demarcation highlights the endpoints of grammatically important constituents, e.g. word, phrase, clause. [...]”. Chen goes on to suggest that “phonological processes serving a demarcative function tend to operate within end-based derived prosodic relations, while co-articulation effects typically occur within a relation-based unit of processing.”

2.6.5.2 Branching-based mapping

Zec & Inkelas (1990) claim that branchingness is an important aspect in the syntax-phonology interface. To support their claim that branchingness directly affects prosodic phrasing, Zec & Inkelas discuss the following example in (6) from Hausa. Hausa has a particle *fa* that is used to emphasize the immediately preceding material. What is relevant here is the distribution of *fa*, which is interpreted in terms of the prosodic structure rather than syntactic structure.

Consider the following examples in (6) from Zec & Inkelas (1990):

- (5) a. *Ya [sayi **fa** teburin]_φ
 he bought table-def.
 ‘he bought the table’
- b. Ya [sayi]_φ **fa** [babban tebur]_φ
 he bought big table
 ‘he bought a big table’

- c. *Ya [sayi **fa** teburin]_φ [jiya]_φ
 he bought table-def. yesterday
 ‘he bought the table yesterday’

Zec & Inkelas (1990) note that the distribution of *fa* is mediated prosodically, that is, it is “a clitic subcategorized to occur at the right edge of a ϕ -phrase”.

fa: [[]_φ ____]_φ

This prosodic requirement is said to be satisfied in (6b), where the verb and the branching object NP belong to different ϕ -phrases, but it is not so in (6a) and (6c) where the verb is grouped in a ϕ -phrase together with a non-branching object; therefore they are judged as ungrammatical. The mapping rule is stated in the following:

Phonological Phrase Algorithm (Zec & Inkelas, 1999)

- a. Prominent phrases are mapped into their own phonological phrases.
- b. From the bottom up, *branching nodes* are mapped into phonological phrases.
- c. No two phonological words on opposite sides of an XP boundary may be phrased together to the exclusion of any material in either XP.

Provision (b) refers to branchingness, giving preference to syntactic sister nodes in forming prosodic phrases. Provision (c) rules out the mapping of the string /sayi fa babban/ in (6b) as a single phonological phrase, as that would strand *tebur*, which is part of the same NP as *babban*, in a phrase of its own.

In sum, Zec & Inkelas argue that the distribution of Hausa *fa* cannot be accounted for without reference to the notion ‘branching node’. Furthermore, since branchingness co-determines grammatical distribution, it must be part of the mapping itself and not

merely a low-level effect of restructuring. Inkelas & Zec argue that the grammar must allow for the copresence of syntax and phonology (Inkelas 1989), which is mediated through prosody:

Copresence Hypothesis [Inkelas & Zec (1990)]

Prosodic and syntactic structures are autonomous and co-present.

2.6.6 Direct Reference

In ‘indirect reference’ models, phrasal phonology is sensitive to syntactic information indirectly, by means of an interface mapping that makes only a limited kind of syntactic information (relations, or edges) accessible for defining prosodic phrases. It is theorized that phrase-level phonology cannot be sensitive to any other syntactic information than what is provided in the mapping. However, there are counterexamples that challenge this strong hypothesis: certain phrase-level phonological rules have been claimed to be *directly* sensitive to syntactic information. Such rules refer to syntactic information which according to relation-based or end-based theories should be inaccessible as a result of the mapping. An example of this is illustrated in the following example from Hausa (Kraft & Kirk-Green 1973, as cited in Hayes 1990). In Hausa, final long vowels of verbs appear as short when the verb precedes a full NP direct object, as in (6c):

(6)	a.	ná: ká:mà: ‘	‘I have caught (it)’
	b.	ná: ká:mà: ší	‘I have caught it’
	c.	ná: ká:mà kǐ:fǐ:	‘I have caught a fish’

d. ná: ká:mà: wà Mú:sá: kí:fí: 'I have caught Musa a fish'

Notice that (6a-b) have no full object (none in 6a, a pronominal one in 6b).

Nonapplication in (6d) shows that a full direct object must directly follow for shortening to take effect. In its reference to morpho-syntactic categories like 'verb' and 'direct object', the shortening rule is sensitive to information that should be inaccessible, at least under the strong restrictive viewpoint that mapping is blind to lexical category (see work by Kaisse (1985, 1990) and Odden (1990) for different proposals and further explanation).

2.6.7 Optimality Theory and End-based Mapping

Optimality Theory (Prince & Smolensky 1993, McCarthy & Prince 1993) produced a shift in perspective on the syntax-phonology mapping. This shift has become manifest in the contributions of McCarthy (1993), Selkirk (1995), Helsloot (1995), Truckenbrodt (1995), Bao (1996), Golston (1996) and Peperkamp (1996) among others. The innovation is that the syntax-phonology mapping is modeled as a set of universal but violable constraints functioning to align edges of syntactic and prosodic categories, and interacting with domain-specific constraints (of morpho-syntactic or prosodic well-formedness). The following are the basic principles of OT as summarized by Kager & Zonneveld (1999):

Violability. Constraints are violable.

Parallelism. Constraints of different types compete within a single hierarchy.

The aspect of violability implies that the syntax-phonology interface is modeled by interactions of “soft” constraints. Parallelism implies that the mapping is co-determined by constraints of different domains. For example, end-based constraints interact with prosodic well-formedness constraints. In OT, phrase-level phonology is defined as the locus of interaction of universal yet violable constraints belonging to different functional domains.

Within optimality theory, linguistic phenomena such as prosodic phrasing are described through the specific interaction of universal constraints (McCarthy and Prince, 1993). An optimal output form for a given input is selected from among a number of competing potential surface forms. The form that best satisfies the highest-ranking constraint on which the candidates conflict is considered to be optimal. Constraints can be violated but only in order to satisfy a higher ranked constraint. The constraints are universal, but languages may differ with respect to each other in the ranking order of the constraints. The constraints on prosodic phrasing have been discussed for a number of different languages: Delais-Roussarie’s (1996) constraints on French phrasing, Selkirk’s (2000) constraints on English phrasing, and Truckenbrodt’s (1999) constraints on phrasing in two Bantu languages (Kimatuumbi and Chichewa) among others.

Within the prosodic phonology literature, Selkirk (2000) outlines an important perspective on the syntax - prosody interface, which is relevant in the discussion of prosodic phrasing. Selkirk puts forward some preliminary hypotheses about the hierarchy of constraints on prosodic phrasing in English within an optimality theory framework. The constraints suggested to play a role are constraints on the syntax-phonology interface

(Align-XP,R and Wrap-XP), constraints on the focus-phonology interface (Align Focus, R) and constraints on the size and accentual content of prosodic phrases (BinMax, BinMin and MiPAccent) as shown below.

Constraints on the Syntax-Phonology Interface.

Align XP: “The edge of each lexical XP coincides with the edge of a major prosodic phrase.”

Wrap-XP (Truckenbrodt, 1995): “The elements of an input morphosyntactic constituent of type XP must be contained within a prosodic constituent of type MaP in output representation.”

Constraints on Size and Accentual Content

BinMax: “A major phrase must consist of at most two minor phrases.”

BinMin: “A major phrase must consist of at least two minor phrases.”

MiP Accent: “A minor phonological phrase (MiP) contains at least one accent.”

Constraint on the Focus-Phonology Interface.

Align R Focus: “Align the right edge of a Focus constituent in informational or syntactic structure with the right edge of a major phrase in the phonological structure.”

In Selkirk’s presentation, examples are given to support the hypothesis that the constraints Align-XP, R, Wrap-XP and Align Focus, R, which interact with the phonological

constraints on the size and tonal content of prosodic phrases, capture fundamental facts of English phrasing.

Thus the Optimality Theory framework of the syntax-phonology interface proposed in Selkirk (1995) abandons a parametric approach in favor of the interaction of ranked and violable constraints. Selkirk's theory is composed of functionally diverse types of constraints that interact within a single hierarchy, where they obey general Optimality-Theoretic principles which will be described in detail in Chapter 9, such as strict domination and minimal violation.

2.6.8 Eurhythmy and Prosodic Phrasing

Ghini (1993), analyzing Italian, suggests that the branching conditions proposed by Nespor & Vogel (1986) for Italian can be reformulated in terms of a set of principles that make reference to notions of phonological weight, balance and symmetry, which contribute to the eurythmicity of the utterance¹. He proposes a eurhythmic constraint of *Uniformity* on prosodic phrasing; the following from Ghini (1993) describe this constraint:

- a. "A string is ideally parsed into same length units; the average weight of the phonological phrases depends on tempo: at an average rate of speech (moderato), a phonological phrase contains two phonological words; the number of words within a phonological phrase increases or decreases by one by speeding up or slowing down the rate of speech."

¹ Metrical balance or the idea that speakers tend to prefer phrases of equal size has been proposed by a number of studies. In psycholinguistic literature experiments with spoken English sentences, Gee & Grosjean (1983), observed a strong tendency for breaks to divide sentences into symmetrical or balanced units. See also the "Same Size Sister" principle of Fodor (1998).

- b. “Strings are symmetrically parsed.”
- c. “If strings with an odd number of primitive phonological phrases are not symmetrically parsed according to (b), phonological phrases on the recursive side are heavier than phonological phrases on the non-recursive side.”

Ghini’s (1993) constraints have been employed in work on English (Selkirk 2000:45) as well as on Brazilian Portuguese (Sandalo and Truckenbrodt 2002). Sandalo and Truckenbrodt adopt a MAX-BIN constraint on the phonological phrase, similar to Ghini for binarity, by requiring that the average phonological phrase, at normal speech rate, consist of two prosodic words.

MAX-BIN (Sandalo and Truckenbrodt 2002)

P-phrases consist of maximally two prosodic words.

Sandalo & Truckenbrodt also show that the eurhythmic factor of *Uniformity*, which prefers phonological phrases of equal length, interacts with Max-Bin and the right-alignment of syntactic and phonological phrases in Brazilian Portuguese to determine phonological phrasing.

2.7 Modeling the Process of Prosodic Phrasing

One question that has received increasing attention within the literature on prosody in sentence processing is when grammatical and non-grammatical effects influence prosodic phrasing and which prosodic constituents they influence. For

completeness, an investigation of prosodic phrasing should include a model that characterizes the stages and mechanisms that generate prosodic phrasing during on-line (incremental) sentence processing. Three approaches that try to depict various aspects of such a model will be discussed here: Keating and Shattuck-Hufnagel's (2002) account of phonetic encoding for speech production, Fodor's (2002) hypothesis of the structural interpretation of prosody in sentence perception as well as Clifton, Carlson & Frazier (2002, 2006) "informative boundary hypothesis" and "rational speaker hypothesis" accounts of the effects of perceived prosody and the recognition of prosodic structure in listening comprehension. The various processes characterized in these approaches will be drawn upon when accounting for the prosodic phrasing patterns of Arabic in the present study.

2.7.1 A Model of Prosody in Sentence Production.

In incremental models of sentence production, the planning that precedes speech production is said to take place in incremental fragments (Kempen and Hoenkamp, 1987). Phonological encoding refers to "the process of generating the representation which will support an articulatory plan for an utterance, on the basis of the morpho-syntactic specification of its underlying sentence and other kinds of information" (Levelt 1989). A key feature of this process is incrementalitiy which refers to the generation of the syntactic structure of a sentence in left-to right increments with limited look ahead. It also entails that what the processor is doing with a particular increment of an utterance should not be dependent on information in later increments and as soon as enough

information is available from one type of processing for an initial portion of the utterance, the next level of processing can begin for that portion and “as a result, the articulatory plan for the beginning of an utterance can be generated before the entire syntactic plan for the utterance is in place..” (Keating & Shattuck-Hufnagel 2002:116)

Keating and Shattuck-Hufnagel have discussed the problems associated with Levelt's (1989) incremental single PWd – model of speech production which relies on the phonological word as the building block for higher level structure. Keating & Shattuck-Hufnagel criticize the view that word-form encoding is separable from phrase-level processing and support an approach where segmental and suprasegmental characteristics need to be integrated in production planning. They propose a “prosody first” model in which higher-level prosodic structure of an utterance becomes available as needed during word-encoding. They propose a model that accommodates a “look-ahead” mechanism to later parts of the utterance, a “look-up” to higher level prosodic constituent structure as well as a “look inside” the syllable of the current word.

Keating and Shattuck-Hufnagel point out that there are many observations which indicate that speakers make use of information about upcoming words in order to determine the surface form of the current word. They state that “the possibility of a variable-sized buffer for phonological encoding could solve this problem, but this represents a potentially serious retreat from strict incrementality.” (K&S 2002:)

Keating and Shattuck-Hufnagel present numerous examples as evidence that speech production is set up to employ a look-ahead mechanism. K& S also offers further evidence that speakers look up to higher levels of prosodic constituent structure in speech

production. It is beyond the scope of the present study to review all the examples of this evidence. However, it is particularly important to present, in the next section, one relevant evidence which will be drawn upon in the discussion in Chapter 4 of the segmental phonological processes as well as in Chapter 9 in reference to the break indices which will be proposed for Standard Arabic.

2.7.1.1 Edge effects and Prosodic domains.

Phonetic effects at the edges of words or what Keating and Shattuck refer to as “edge effects” show that phonetic prosodic structure reflects the hierarchy of prosodic constituents. “The phonetic shape of a segment depends not only on its position in its syllable, but also on its position in the foot, PWd and larger phrasal constituents” (Keating 2000:131). Fougeron (1999) provides a review of studies of the effects of position in prosodic domains and the realization of individual segments or features. For example, Pierrehumbert & Talkin (1992) show that /h/ is more consonant-like when it is phrase-initial than when it is phrase-medial, that word-initial vowels are more likely to be laryngealized when they are Intonational-Phrase-initial (and/or pitch-accented), and that the Voice Onset Time (VOT) of /t/ is longer phrase-initially. Similarly, Keating, Cho, Fougeron and Hsu (2003) present results from four languages (English, Korean, French and Tiawanaese) showing that the articulation of a stop consonant’s oral constriction is stronger when the consonant occupies the initial position in higher-level prosodic domains.

Such findings provide support for the view that speakers need knowledge of the prosodic organization of the utterance above the level of the PWd. Reduction processes that operate differently at the edges of prosodic constituents also support this claim. For example, a particle can be reduced when it occurs in the middle of a phrase, as for *up* in e.g. *Look up the word*, but not when it occurs at the end, as in *Look the word up* even when unaccented (Selkirk 1995). This means that the speaker must know whether there is a boundary after this word, in order to determine the quality of the vowel.

Final lengthening (see Fougeron (1999) for a review and Cambier-Langeveld (2000)) is perhaps the best-known edge effect. A final example of edge effects is the pattern of constituent-edge glottalization. For left edges, Dilley et al. (1996) report that reduced word-initial vowels are significantly more likely to be glottalized at the onset of a Full Intonational Phrase than an Intermediate Intonational Phrase. For right edges, Epstein (2002) showed that breathy and creaky voice quality is associated with Low boundary tones, but not with low phonetic pitch in general. Redi and Shattuck-Hufnagel (2001) report that final creak is more likely at the end of a Full Intonational Phrase than at the end of an Intermediate Intonational Phrase, a constituent which is lower on the hierarchy. “If the creak is a planned variation in voice quality, rather than an automatic consequence of another planned event such as lowered F0 or reduced air flow in these locations, then this pattern provides evidence for the speaker's need to know something about the higher-level prosodic structure of the utterance.” (Redi and Shattuck –Hufnagel 2001).

Keating (2002) examines what she terms “domain-initial articulatory strengthening”, that is, segment phonetic strengthening associated with the beginnings of prosodic domains. Keating puts forward a claim about how this strengthening works through the whole of prosodic structure: that it is cumulative, in the sense that the higher in the prosodic tree an initial position is the stronger that position and the segment in it.

The prosodic positions that Keating compared are generally edges of domains. A domain-initial segment (or syllable) is at the beginning of some prosodic domain. A domain-final segment (or syllable) is at the end of some prosodic domain. Furthermore, because prosodic domains are hierarchically organized, a given segment (or syllable) is usually initial or final in multiple (nested) domains.

Keating considers two functional implications of domain-initial strengthening. First, because it depends on phrasing, segment strength may convey information about the local coherence vs. disjuncture in connected speech. A strengthened segment indicates a break and the start of a new domain, while domain-internal spans of segments are not interrupted by strengthening. On this view, speakers manipulate strength to indicate the degree of break/cohesion between words in connected speech. Keating indicates that “while stronger segments may consume more calories of a speaker’s articulatory energy than do weaker ones, weaker segments do not reflect laziness or inattention on the part of the speaker. Rather, we should think of the speaker’s energy as constantly directed to control of the modulation of articulation, because all levels of strength carry information.” Second, strengthening may increase information about segment identity, and in just those positions where such information is most important.

Glottalization of word-initial vowels at the beginnings of prosodic domains (Dilley et al. 1996), which gives them a more consonantal quality, is seen as a strengthening enhancing the perceptual clarity of the following vowel by providing a psychoacoustically salient spectral edge (Pierrehumbert and Talkin 1992; Pierrehumbert 1994; Pierrehumbert and Frisch 1996; Pierrehumbert 2000).¹

In sum, it is suggested that prosodic structure organizes the treatment of feature in segments, and the interactions of segments. One aspect of this dependence is the relation between the strength of a prosodic position, and the phonetic strength of a segment in that position. Since phonetic encoding of segments is highly sensitive to prosodic structure, prosody needs to be computed first, not last.

2.7.1.2 Keating and Shattuck-Hufnagel's Model

Keating and Shattuck-Hufnagel (2002) outline an alternative model to the local, incremental construction of prosody mentioned in §2.13.1. This model involves the initial construction of a higher-level prosodic representation of the entire utterance, with subsequent integration of word-form information into this larger structure. That is, the speaker may construct at least some higher-level prosodic representation without reference to word forms, providing aspects of prosodic processing that do not require word-form information. As more information about both word forms and non-grammatical factors becomes available, restructuring of this initial default representation may then occur.

¹ See §4.11.4, Chapter 4 on “glottalization” in post-pausal position in Arabic. This phenomenon will be utilized in the experimental section of the dissertation as a segmental cue for prosodic phrasing in Arabic.

This hypothesis notes that not all of the information about the words¹ of an utterance is required at the same time; as a result, various kinds of information can be retrieved separately, as needed for further processing. This view of 'build prosody first, and then retrieve segments' contrasts with the view that words and segments are retrieved first and then organized into prosodic constituents. According to the former model, prosodic representation develops in phases. The first default prosodic representation is based only on the syntax and is closely related to it. The prosodic constituents produced by the first pass of prosody-building are tested in a second pass against form-based constraints, which may trigger restructuring of the constituents. As a result of restructuring, they become less closely tied to the syntax, and therefore appear more prosodic.

Two presuppositions characterize the above model, first, that all of syntax is already available, and thus the default prosodic structure can be built all at once rather than incrementally; and second, that there is a series of restructurings moving gradually closer to the surface form.² This proposal suggests the possibility that at least some of the phenomena usually assigned to the syntactic component of the grammar may be better viewed as the result of restructuring of the default prosody derived from surface syntax.

¹ Keating and Shattuck-Hufnagel (2002) mention many different types of information about words that are needed for planning the production of an utterance, including such things as their number and serial order, whether or not a word will receive phonological content in the utterance, metrical information such as the number of syllables and stress pattern, the number and serial order of contrastive phonemic segments within a word, and the articulatory instructions for realizing these contrasts.

² If prosodic structure is built incrementally, the claim is that the increments must be large enough to account for the facts of phonological and phonetic segmental sensitivity to prosodic structure.

Ferreira (1993) also considers that the prosodic constituent structure is generated without knowledge of the segmental content. According to this hypothesis, abstract timing intervals are assigned to various sentence locations early on in the speech planning process. Later, “segmental factors are taken into account, but words and pauses are in a trade-off relationship so as to respect the total duration of the allocated intervals”. Discussing the durational structure of speech Ferreira points to two levels of durational control: extrinsic and intrinsic. Units of words are viewed as having a set of intrinsic durations. Ferreira suggests that “as these units are integrated into larger entities (phrases, utterances) they get “stretched” and “squeezed” in accordance to the requirements of larger speech demands”.

It is worth mentioning here that Ferreira (2007) has strongly pointed out that sentence production theories have conflated prosody with the effects of performance and planning. She distinguishes between “the higher prosodic structure of an utterance and the acoustic effects that arise as a speaker tries to manage the psychological processes involved in language production” (Ferreira 2007)). The question put forward by Ferreira is “whether a particular acoustic effect is attributable to performance or to the implementation of a phonological representation.” (2007:1152). The algorithm proposed by Ferreira looks at prosodic constituents to the left of a boundary as well as considering semantic-syntactic constituents to the right of that same boundary and distinguishes between pauses attributable to a prosodic representation from those caused by the need to plan.

2.7.2 Fodor's Model of the Perception of Prosody in Silent Reading

Fodor's (2002) *Structural Interpretation of Prosody Principle* as well as the *Implicit Prosody Hypothesis* propose an intricate interface relationship between the implicit assignment of prosody and the interpretation of structure during silent reading. The idea is that prosodic structure is assigned on the basis of low-level syntactic factors such as lexical category and headedness with the mediation of non-syntactic factors such as phrase length and then this projected prosodic pattern may be interpreted as signaling syntactic structure just as it would if it had been heard in a spoken sentence.. A detailed discussion of this hypothesis will be the main focus in Chapter 3 as well Chapter 9, §9.2.

2.7.3 Clifton, Carlson and Frazier's Model of the Perception of Prosody in Listening

In studying the RC-attachment ambiguity illustrated in (1) in chapter 1, it is important to investigate the perception of boundaries relative to the overall prosodic patterning of the sentence, not just to the region of the complex NP and relative clause. Recent evidence indicates that listeners utilize global prosodic representations during sentence processing, not just local prosodic cues (Shafer, 1997; Shafer et al., 2000).

Clifton & Frazier (2002) present results from experiments that investigate whether different types of intonational boundaries have different effects on syntactic parsing and evaluate the claim that only an "informative" boundary will affect interpretation. They offer a definition of "informative" such that a boundary is informative "if it is phonologically larger than certain structurally-defined earlier boundaries". The experiments test Carlson et al.'s (2001) "informative boundary" hypothesis, which claims

that the identification of a prosodic boundary is affected not by its absolute size but by its size relative to a relevant early boundary. Carlson et al. investigated the interpretation of ambiguous sentences like (7) below:

(7) Susan learned that Bill telephoned after John visited.

The final adjunct phrase “after John visited” may be attached low, modifying “telephoned” in the complement clause or may attach high in the main clause, where it modifies “learned”. Carlson et al. manipulated and introduced different types of prosodic boundaries after “*learned*” and before “*after*”. The prosodic boundary immediately before the ambiguous adjunct in (11) did not reliably trigger more high attachments. What was significant was the relative size of the boundary immediately before the adjunct compared with the earlier boundary after “learned”. More specifically, when the phonological boundary at pre-adjunct position was larger than the earlier boundary, more high attachments of the adjunct were observed. Furthermore, when the pre-adjunct boundary was smaller than the relevant early boundary, more low attachment interpretations were observed. When the two boundaries were of equal size, an intermediate number of high attachments were observed. Carlson et al. explain their findings by positing what they call the “*informative boundary hypothesis*”.

Clifton, Carlson and Frazier (2006) have also recently discussed the “rational speaker hypothesis” which states that “listeners interpret intonation by assuming that the speakers do not make prosodic choices without some reason”. Following Ferriera (2007),

the parser can be said to distinguish between prosody and performance effects and Clifton et al. present evidence suggesting that the boundaries that might be attributed to planning are not as likely to be treated by the comprehension system as cues to syntactic structure compared to those that are more related to prosody.

2.8 Prosody and first-pass parsing

Serial models of human sentence processing assume that the parser computes a single ongoing structural representation (first-pass on-line) which is updated more or less word by word though some models permit look-ahead or delayed decisions (see Marcus, 1980). In the case of an ambiguity, this ongoing representation which has been called the *current partial phrase marker* (CPPM) can be expanded in more than one way. A serial parser opts for one of the possible expansions and pursues only this one. If the current phrase marker computed at the point of ambiguity is compatible with further input, processing proceeds successfully; if not the CPPM has to be revised when the conflict is detected.

The question of whether (overt) prosody is used in first pass parsing and in reanalysis in language comprehension is an important point in considering any theory pertaining to the syntax-prosody interface. Researchers have found that prosody reduces difficulty associated with dispreferred continuations of locally ambiguous structures, suggesting that prosody plays an early role in parsing (Speer, Kjelgaard and Dobroth, 1996 and Cutler et al., 1997, for a review).

Watson & Gibson (2002) addressed this question in a cross-modal lexical decision task. Subjects listened to sentences like (8) up to the end of the direct object “picture”.

(8) The detective gave the picture... OF (NP) / TO (VP)

Then subjects performed a lexical decision task for each of two words in this context, both of them prepositions. One word was of a kind that would introduce a phrase which was unambiguously an argument of the immediately preceding noun (“of” in (8) which would head a PP, argument to “picture”, such as “of the girl”). The other word was of a kind that would introduce a phrase that was an argument of the verb (“to” in (8), which would head a PP, argument of “gave”, such as “to the searchers”). The tone of the word “picture” was manipulated so that it signaled either the presence of a following intonational phrase boundary or the absence of a following intonational boundary. In V-NP-PP constructions, an intonational boundary typically occurs before the preposition in the VP attachment continuation, whereas a boundary is usually absent before the preposition in the NP attachment continuation (Cooper & Paccia-Cooper, 1980; Price et al. 1991; Pynte & Prieur, 1996; Schafer et al. 2001).

Watson and Gibson argue that if prosodic information is used in first-pass syntactic structure-building, lexical decisions should be faster for the locally attached preposition “of” than for the non-locally attached preposition “to” when there is no boundary tone on “picture”. The opposite pattern is predicted when a prosodic boundary is

present: reading times for “to” should be faster than reading times for “of”. The results of this experiment confirmed Watson & Gibson’s predictions, and thus support the hypothesis that prosody is used in first-pass parsing.

2.9 Intonational Boundaries and Sentence Comprehension

The speech signal conveys prosodic information which organizes the utterance hierarchically into syllables, feet, phonological phrases and intonational phrases etc. (Nespor & Vogel, 1982, 1983; Selkirk, 1972, 1984, 1986). One important question is whether this structuring plays any role in comprehension. A great deal of evidence suggests that listeners use intonational boundary information to make decisions in sentence comprehension.

Lieberman (1967) observed that differing syntactic surface constructions of globally ambiguous sentences can be distinguished by listeners using intonational boundaries. Lieberman’s proposals have been supported by research showing that listeners can use this prosodic information to disambiguate globally ambiguous sentences if – but perhaps only if – the where the surface structures of the competing interpretations differ (Lehiste, 1973; Lehiste, Olive, & Streeter, 1976; Wales & Toner, 1978; Cooper & Paccia-Cooper, 1980; Warren, 1985; Price et al., 1991; Shafer, 1997).

Prosody can also be used to disambiguate sentences with temporary ambiguities, suggesting that prosodic information is used during on-line processing (Marslen-Wilson et al, 1992; Warren et al., 1995; Grabe, Warren, & Nolan, 1995; Speer, Kjølgaard, and

Dobroth 1996). Speer, Kjelgaard, and Dobroth (1996) found that listeners used boundaries to disambiguate ambiguities as shown in (9):

- (9) Whenever the guard checks the door [is / it's] locked.

In (9) there is a temporary ambiguity at the point of processing the NP “the door”. This NP can be the direct object of “checks” or the subject of the main clause yet to come. In both on-line and off-line experiments, comprehension was facilitated when an intonational boundary occurred at the corresponding clause boundary for the two interpretations: a boundary after “the door” in the direct object attachment condition and a boundary before “the door” in the main clause subject attachment condition. Understanding was facilitated compared to a baseline condition with neutral prosody; switching the prosodic boundaries for the two interpretations interfered with comprehension relative to the baseline.

Pynte & Prieur (1996), showed that prosody influences the comprehension of V + NP + PP constructions. They conducted a series of word-monitoring experiments in which native speakers of French were presented with utterances of French sentences like the following (where # indicates a prosodic break):

- (10) a. # L'étudiant choisit # un appartement # avec *soin* #
“The student chooses a flat with care.”
b. # L'étudiant choisit # un appartement avec *soin* #
“The student chooses a flat with care.”

- (11) a. # L'étudiant choisit # un appartement # avec *balcon* #
"The student chooses a flat with a balcony."
b. # L'étudiant choisit # un appartement avec *balcon* #
"The student chooses a flat with a balcony."

The presence of a prosodic break in front of the preposition was found to favor the verb-complement interpretation of the PP (response time to the last word was shorter for phrasing (10a) than for phrasing (10b) but it did not hinder the noun-complement interpretation of the PP ((11a) and (11b) were equally easy.

In a preliminary study, Pynte & Prieur had asked trained phoneticians to read silently a series of short texts. Subjects were instructed to indicate, on the written text, the position of prosodic breaks by inserting one, two, or three slashes, depending on the strength of the break. The probability to end a given prosodic unit by inserting a prosodic break was found to increase as the unit became longer, i.e., as more words had been encountered since the last inserted break. Pynte & Prieur's hypothesis that break expectations might interact with syntax was supported by the finding that more prosodic breaks were produced in front of verb-complement PPs than in front of noun-complement PPs. Further experimentation was also consistent with the notion that metrical properties can play a role in sentence comprehension.

It is suggested that intonational boundaries signal syntactic structure because the presence of an intonational boundary serves as a strong cue not to attach the upcoming word to the last potential attachment site before the boundary. A boundary is suggested to

often indicate that a syntactic constituent is complete and no further attachments should be made to it, which could result in a tendency by listeners not to make attachments to a head followed by a boundary (see Shafer, 1997 on the Visibility Hypothesis; also Frazier and Clifton, 1998 and Watson & Gibson, 2003 on the Anti-Attachment Hypothesis).

2.10 Cross-linguistic Differences in Prosodic Phrasing

Research has revealed that different languages favor different prosodic phrasings for similar syntactic constructions (Prieto, 1997, for Catalan; Nibert, 2000, for Castilian Spanish; Frota, 2000, for European Portuguese; D'Imperio, 2002, for the Neapolitan variety of Italian.)

Elordieta, Frota, Prieto & Vigário, (2003) and D' Imperio, Elordieta, Frota, Prieto & Vigário (2003), in studies of a corpus of read utterances from four Romance languages (Catalan, European Portuguese, Italian and Spanish), examined the role of constituent length and syntactic branching in determining prosodic phrasing. The researchers created a database, consisting of SVO sentences with combinations of 2 constituent length variables (short = 3 syllables and long = 5 syllables), which applied to the S and O, as well as 7 syntactic branching conditions (non-branching subject/object, branching subject, branching object, branching subject and object, double-branching subject, double-branching object, and double branching subject and object.)

In the results, Catalan exhibited a high tendency for (S) (VO) phrased utterances. However, when a short subject was followed by a VP containing a long object, speakers in the study tended to group the S with the following V in an (SV) (O) phrasing (as

illustrated in (12). The researchers suggest that there is a tendency in Catalan to balance out the weight of the prosodic constituents (see Ghini, 1993 and Fodor, 1998):

- (12) a. La nena # mirava la noia
“The little girl was watching the girl”
b. La nena mirava # la melmelada meravellosa
“The little girl was watching the wonderful marmalade”

The role of syntactic and prosodic constraints on phonological phrasing in Catalan was also examined by Prieto (2003). The author shows that prosodic constraints regulate the size and eurythmicity of phrasal constituents. Prieto argues that phonological phrasing in Catalan is determined, among other things, by the interaction of right-alignment of syntactic and phonological phrases (ALIGN-R XP, based on Selkirk 1986) with the influence of three eurhythmic conditions that have the role of increasing the eurhythmic properties of the sentence:

- A MAX-BIN requirement that each phonological phrase should contain at least two prosodic words.
- a WEIGHT UNIFORMITY requirement, which prefers phonological phrases of equal length (following Ghini (1993a, 1993b) for Italian.
- a NO-CLASH condition, which does not allow the presence of two immediately adjacent stressed/accented syllables.

Prieto shows that in Catalan, WEIGHT UNIFORMITY overrides ALIGN- R XP in many contexts. The following example (15) shows that speakers prefer to group the subject with the verb and a predicate with an object noun if the resulting phonological phrases are more balanced for phonological weight and length:

- (15) [Vaig menjar pastissos] [plens de xocolata]
 ??[Vaig menjar][pastissos plens de xcocolata]
 “I ate cakes full of chocolate”

Prieto concludes that prosodic structure cannot rely on syntactic structure alone but has to refer to prosodic aspects of stress, phonological weight and balancing.

Returning to the study by Elordieta et al., in European Portuguese (EP), the dominant phrasing was (SVO). No cases of (SV)(O) phrasing were seen, irrespective of object length or balance considerations. The only alternative phrasing to (SVO) was a (S)(VO) pattern, which is favored by the co-presence of a long S (by the length of the S instead of its syntactic complexity) together with an extra-long O. The researchers argue that a break after V would make a more balanced phrasing in this case; the break is, however, always placed after S. Thus, (SV)(O) structure tends to be avoided in EP. This is shown in the study by similar phrasing patterns of long non-branching subjects and short branching subjects, where (SVO) dominates. In the contrast between the phrasing of short branching and long branching subjects, (S)(VO) increases in the latter condition (see example (13)).

- (13) a. *A nora loura memorizava dilemmas*
 “The blond daughter-in-law memorized dilemmas”
 b. *O namorado megalomano da brasileira # mirava morenas*
 “The Brazilian’s megalomaniac boyfriend looked at the dark-haired women”

The results overall indicate that the number of syllables is the major phonological factor contributing to phrasing in EP. It appears, therefore, that in EP, unlike Catalan, phonological length plays a more important role in phrasing than does syntactic complexity.

In European Spanish, on the other hand, the most common phrasing is (S)(VO).

- (14) La nina de Lugo # miraba la mermelada.
“The girl from Lugo looked at the marmalade”

In Italian, it was found that only the syntactic complexity of the Subject that determines phrasing; neither the length nor the syntactic complexity of the object play any substantial role.

In sum, Elordieta et al.’s study shows that languages differ in the preferences they exhibit for prosodic phrasing and that the factors influencing these preferences vary across languages.

Especially pertinent to the present research is a study by Hellmuth (2006) that examines phonological phrasing in the dialect of Arabic spoken in Cairo (Egypt), whose prosody above word-level is largely uninvestigated to date.¹ In Hellmuth’s study, the mapping between syntactic structure and prosodic structure appears to be sensitive to prosodic binarity restrictions which Hellmuth states are best measured in terms of minor phonological phrases (MiPs) (see Chapter 2, §.2.11).

¹ See Chapter 4, §4.5.1 for a discussion of prosodic similarity between SA and CA.

Following Elordieta et al. (2003), Hellmuth created a corpus of SVO sentences in Cairene Arabic (CA) in which both syntactic complexity and prosodic weight were systematically varied as shown in the examples in (16). The corpus was recorded by CA speakers at varying speech rates. An auditory transcription was made of the recordings with reference to the F0 contour, using a proposed autosegmental-metrical analysis (Ladd 1996) of CA intonation building on existing descriptions (Mitchell 1993). The cues to phrasing¹ in Hellmuth's study reveal that, in CA, the majority of sentences are produced within a single MaP, i.e., (SVO) structure. Only when *both* subject and object are prosodically heavy do (S)(VO) phrasings occur (examples (16 a-e) below).

(16) [From Hellmuth (2006)]

(a) [NP [V NP]] → (NP V NP)**MaP**
 il-film biyghum bint amii
 the-film upsets cousin(f)-my

(b) [[N AP] [V NP]] → (N AP V NP)**MaP**
 siyaasi muhimm bighum baladna
 a-politician important cheats country-our

(c) [[N AP] [V NP]] → (N AP V NP)**MaP**
 il-muhandis il-miamaarii l-muhimm biyghum baladnaa
 the-engineer the-architectural the-important cheats country-our

(d) [[N AP PP][V [N AP PP]]] → (N AP PP V NP)**MaP**
 il-mumassil il-muhimm fil-film biyghum bibt ammi
 the-actor the-important in-the-film upsets cousin(f)-my

¹ Evidence for prosodic phrasing comes from a range of postlexical tonal phenomena including local pitch range reset, final lowering, and phrase tones which mark the edges of major phonological phrases (MaPs).

(e) [[N AP PP][V [NP]]] → (N AP PP V NP)**MaP**

il-mughannawaati l-muhimm fi-nihaayat-il-film biyghumm bint-ammii
the-singer the-important in the end-of-the-film upsets cousin(f)-my

f) [[N AP PP][V [N AP PP]]] → (N AP PP V N AP PP)**MaP** or (N AP PP)(V N AP PP)**MaP**

il-mughanawaati l-muhimm fi-nihaayat-il-film biyghum banaat-ammii
the-singer the-important in the end-of-the-film upsets cousins(f)-my

l-ayaaniin min il-ʔiskindariyyah
the-ill from-Alexandria

Hellmuth's constraint-based account of these data proposes that in CA, a preference for branching MaPs outweighs the need to align their edges with the edges of syntactic maximal projections [BINMAP >> ALIGN R XP, MAP]. This binarity is measured in terms of minor phonological phrases (MiP), themselves minimally branching and thus each composed of two prosodic words (PWd) (thus to satisfy BINMAP a phrase must contain 4 prosodic words).

Support for the role of an MiP level of phrasing in CA arises from more frequent instances in Hellmuth's data of alignment outweighing binarity in slower speech; more (S)(VO) occur. Preferred MaPs still consist of two MiPs but an MiP may be composed of a single PWd, if this latter is of sufficient prosodic weight; thus, a MaP can be composed of two or three PWds rather than four under these conditions.

As evident from the above discussion, languages differ with respect to the effects that various constraints have on the possible or preferred phrasing of a given syntactic

construction. Whether this is due to parametric variation in rules, or to differences in ordering of constraints, it is something to take note of in performance models of the role of prosody in syntactic processing.

2.11 Summary

This chapter has presented a description of the various aspects of prosodic phrasing. It has defined some of the different theoretical approaches present in the literature that have focused on the interface of prosodic phrasing and syntactic structure. This chapter has also presented various models describing how prosody is processed in speech production, silent reading and listening comprehension. It has prepared for the discussion of the “implicit prosody hypothesis” in the following chapter which will be the main working hypothesis in accounting for the data in this study. The chapter also looked at differences in prosodic phrasing preferences across various languages which will also be a key aspect in accounting for differences in syntactic parsing preferences across languages.

CHAPTER 3

THE IMPLICIT PROSODY HYPOTHESIS

3.1 The Late Closure Principle and the Universality Hypothesis

Research in sentence perception and comprehension has generated key questions as well as developed working hypotheses about the nature and design of the human sentence processing mechanism. An especially relevant area of investigation concerns the nature of the parser, the machinery that deals with the building of syntactic structure from linguistic input. Researchers have hypothesized that the parser's on-line tendencies reflect the architecture of the processing mechanism.

According to the influential Garden-Path model of human sentence processing (Frazier, 1978; Frazier & Fodor, 1978; Frazier & Clifton, 1996), principles of parsing are universal: this is what gives the theory its simplicity and explanatory power. The theory argues that, when processing linguistic input, the parser utilizes a set of principles which are part of the inherent architecture of the human language processor. Languages differ in their individual grammars but the principles that navigate and deploy the grammar are the same. Variation is attributed to the individual grammar of the particular language, not to the principles.

Kimball (1973) proposed specific parsing principles based on characteristics that he suggested were defining of the nature and functional capacity of human cognition. These principles serve to minimize storage requirements and bypass difficulties related to the limitations of human short-term memory. Frazier & Fodor (1978) refined Kimball's principles in their Sausage Machine Model. Among these principles are Minimal Attachment (Frazier & Fodor, 1978) and Late Closure (Frazier, 1978). These principles have been argued to optimize the speed, efficiency and ease of processing by opting for the analysis which requires the least effort and exerts the least demands on memory load and retention on the part of the structure-building device. These principles are therefore seen to be inherently driven by the general conditions of the human cognitive system. These principles reflect cognitive economy by keeping mental processes as simple and efficient as possible which in turn serves to reduce the burden on working memory during parsing.

A theory of this kind which attributes all parsing strategies to the design characteristics of human cognition entails that these strategies should apply universally in all natural languages and invariantly across all constructions. The Garden -Path theory is based on such a universal account. A serious challenge to the claim of universality would be the discovery of cross-linguistic variation in parsing strategies which cannot be associated with differences in their grammars. Thus, a major challenge facing the universalist approach is the apparent failure of the Late Closure Principle to apply cross-linguistically.

Among the principles of the Garden-Path model is the principle of “Late Closure” which was first formulated for English (Frazier, 1978) and assumed to hold across all languages. Late Closure is similar to Kimball’s (1973) principle of Right Association:

Kimball: *Terminal symbols optimally associate to the lowest non-terminal node.*

Frazier: *When possible, attach incoming material into the clause or phrase currently being parsed.*

The implication for parsing is that when the parser has a choice between a non-local (distant or high) and a local (recent or low) attachment, it will choose to attach to the local attachment site. (Note that the implications differ to some extent in a left-branching language: discussion here is restricted to right-branching languages such as English and SA, except where otherwise noted.)

Closure ambiguity involves a problem connected with determining constituent boundaries in two different ways. A familiar example of this principle is the following from Kimball (1973):

(1) Tom said that Bill left yesterday.

In (1) the parser is faced with a structural ambiguity. The adverb *yesterday* can be interpreted as modifying either the first verb *said* or the second verb *left*. Late Closure correctly predicts the preferred reading: the ambiguously attached constituent *yesterday* is typically interpreted as attaching low.

Research has shown that Late Closure applies in a variety of constructions in English and in other languages as well (see Kimball (1973) and Frazier (1978) for a number of English constructions.) However, the Late Closure principle has since been challenged, initially by researchers working on Spanish (Cuetos & Mitchell, 1988) and subsequently by a number of researchers studying other languages. A certain type of ambiguity has been the focus of this research question: the complex noun phrase construction. For a complex NP with two nouns, such as (2), a relative clause modifier may be associated with the first noun (N1) “the daughter” or the second (N2) “the colonel”.

- (2) Someone shot the daughter of the colonel who was on the balcony.

The Late Closure Principle predicts that the relative clause attaches to the NP currently being processed, and thus is interpreted as modifying N2 (low attachment). This prediction holds for English, not dramatically but fairly reliably (Cuetos & Mitchell, 1988). N2 preference (low attachment) holds also in languages including Swedish, Norwegian and Romanian (Ehrlich, Fernández, Fodor, Stenshoel & Vinereanu 1999). But N1 preference (high RC attachment) has been observed in other languages, e.g., *Spanish* (Cuetos & Mitchell, 1988; Carreiras & Clifton, 1993; Gilboy et al., 1995), *German* (Hemforth, Konieczny, Scheepers & Strube, 1988), *Dutch* (Brysbaert & Mitchell, 1996) and *French* (Zagar, Pynte & Rativeau, 1997). Several explanations for this cross-linguistic variation have been proposed. (For a review see Brysbaert & Mitchell (1998), and for a detailed summary of different languages investigated see Lovrić (2003).)

In their ground-breaking study using written sentences in an ambiguity – resolution questionnaire, Cuetos & Mitchell (1988) tested the interpretation preference for sentences like (2) in English and Spanish. Their results revealed that when asked to make a choice between two alternative interpretations, English-speaking subjects preferred the second noun or the lower site interpretation, while Spanish-speaking subjects preferred to attach the RC to the higher site.

Cuetos and Mitchell also conducted a series of self-paced reading experiments examining attachment preference in Spanish. The sentences used were similar to those illustrated in (2) except that the attachment of the RC was disambiguated. N1 and N2 differed in gender and the phrase “con su marido” within the RC was used to disambiguate the sentence toward high attachment (3a) and low attachment (3b). In this experiment, subjects took longer to read the disambiguating part of the sentence when there was a forced low attachment.

(3a) (*Forced high attachment*)

Alguien disparó contra la criada del actor que estaba en al balcón
Someone shot against the maid of-the actor that was on the balcony
con su marido.
with her husband.

(3b) (*Forced low attachment*)

Alguien disparó contra el criada de la actriz que estaba en al balcón
Someone shot against the butler of-the actress that was on the balcony
con su marido.
with her husband.

Fernández (2000, 2003), has reported contrary data for Spanish using number disambiguation. Fernández challenges the initial attachment preference for Spanish

reported to be high by prior studies (Clifton, 1988; Cuetos & Mitchell, 1988; Carreiras & Clifton, 1999; Gibson et al., 1999 and Mitchell et al., 1999). This line of research which addresses experimental procedures and their subsequent variation in experimental results will be further discussed in the following section.

3.2. The Late Closure Controversy and Issues of Experimental Methodology

Variation in the methodology used in studies on the RC attachment ambiguity has yielded controversial results (see Fernández 2003 for a detailed discussion of the methodological variation in experiments on RC-attachment). The methodology and experimental designs used to uncover the attachment preferences across languages have been critically questioned. These include differences in the materials used, differences in the processing stage examined, that is, whether the experimental procedure taps into on-line early, speeded or initial processes as opposed to off-line, un-speeded or late processes. Whether the experimental procedure is influenced by post-syntactic thematic and discourse factors has also been an issue of concern. Closer inspection of the materials and data on attachment preference suggests that experimental outcomes may be sensitive to factors such as the length of the RC (Fodor 1998), the length of the NPs, the animacy and inanimacy of the NPs (Desmet & Mitchell, 1999), the type of preposition in the NP complex, the animacy of the nouns (Fernández, 2000), the definiteness of the NPs (Gilboy et al, 1995), and the position of the complex NP in the sentence (Hemforth et al., 2003). Nevertheless, the conclusions drawn from Cuetos and Mitchell's original study seriously questioned the universality of the parsing principles. There have since been

different interpretations and explanations for the differing experimental findings across languages: the Construal/Gricean account, Attachment-Binding Dualism, Predicate Proximity/Recency account, the Prosodic account and the Tuning Hypothesis. I will not review these approached here; most have lapsed since first being proposed. For a detailed critical evaluation, see Lovrić (2003). This dissertation will focus on a prosodic explanation proposed by Fodor (1998) in the form of the Implicit Prosody Hypothesis.

3.3. The Prosodic Account

The argument proposed by the prosodic account with regards to cross-linguistic variation is that different attachment preferences in sentences containing the relative clause ambiguity are to be explained by differences in the prosodic component of the grammar. The assumption is that it is differences in the characteristic prosodic “packaging” patterns of languages that give rise to cross-linguistic variation in RC-attachment. This account has its roots in the observation made within the “Sausage Machine” framework (Frazier & Fodor, 1978) that packaging, a function of the lengths of constituents, affects parsing decisions. In 1978, the need for packaging was ascribed to short-term memory limitations, but in 1998 the similarity to prosodic packaging became apparent.

In reading, according to Fodor (1998), prosodic packaging is assigned prior to a full syntactic analysis of the word string, hence it cannot show much sensitivity to syntactic alignment principles except where the relevant syntax is quite local. In reading, therefore, prosodic packageing is determined largely by other factor, such as constituent

weight. Prosodic “heaviness” may be counted in terms of length (number of syllables or pitch accents) but also possibly in terms of syntactic branching and/or syntactic category). The central idea is that large constituents tend to attach high, and small ones low (“Anti-gravity”, Frazier and Fodor, 1978). In Fodor (1998), Anti-gravity is expressed in the “Same-Size Sister Principle”, which is a close relative of other principles favoring geometrical tree balance such as the Uniformity Principle and Balance Principle discussed in Chapter 2, §2.6.8.

Same-Size Sister Principle: *Attach a constituent to a sister of its own size.*

Evidence that the length of constituents influences packaging derives from examples such as the following from Fodor, (1998, originally from Frazier & Fodor (1978) :

- (4) a. Mary threw the bat, the ball and the glove down.
- b. Mary threw the bat, the ball and the glove down into the mud.

In (4a), the short constituent “down” tends to attach low and thus be grouped with *glove* inside the *glove*-NP even though that analysis is not a coherent analysis:

- (5) Mary threw [the bat, the ball and [the glove down]]

However, when the attaching constituent is lengthened in (6), the sentence is more easily packaged and parsed correctly.

(6) Mary threw [the bat, the ball and the glove] [down into the mud.]

In relative clause attachment, Fodor's Same Size Sister Principle says that a large relative clause needs to balance itself against a large sister such as the whole of N1 of N2, not just N2 (N2 by itself is too small). Fodor proposes that this principle has its roots in prosody (uniformity of prosodic phrasing). It provides an explanation for the observation (merely intuitive at that date) of a length effect for relative clause attachment which is revealed in a pattern with longer relative clauses attaching higher than shorter ones. The prosodic account supposes that with a long RC, there is a greater tendency for RC to be an independent prosodic unit, with a prosodic break between RC and N2. This phrasing pattern fosters high attachment of the relative clause, i.e., (N1 of N2) (long RC). If the RC is short, it is unlikely to be treated as an independent prosodic phrase so there is a greater tendency for it to be packaged with no prosodic break intervening between it and N2, i.e., (N1 of N2 short RC).

Bradley, Fernandez and Taylor (2003) report a study on American English that constituent lengths throughout a sentence can affect the overall prosodic packaging and thereby influence RC attachment preferences. The authors reason that increased sentence length, even if achieved via expansion of a constituent distant from the RC, raises the likelihood of a sentence-internal phrasing break, which may be located at the beginning of the RC, and thus encourage high RC attachment.

In recent years, there have been several demonstrations that syntactic parsing decisions during reading are affected by mentally projected prosodic patterns (Bader,

1998; Fodor, 1998; Hirose, 1999). While most have manipulated constituent length, an early study by Bader (1998) presents data in support of the influence of stress placement on processing in silent reading, specifically on recovery from garden path sentences in German. Bader suggests that in reanalysis, recovery from the garden path is difficult if, the correct analysis requires a stress pattern different from that assigned on the first-pass syntactic parse. This is expressed in the Prosodic Constraint on Reanalysis:

Prosodic Constraint on Reanalysis

“Revising a syntactic structure is difficult if it necessitates a concomitant reanalysis of the associated prosodic structure” (Bader, 1998:8).

Bader thus claims that reanalysis is prosodically constrained. Like Fodor’s Implicit Prosody Hypothesis, this presupposes that prosody is assigned to sentences during silent reading as part of the process of phonological encoding. Phonological encoding is the process by which written language is paired with mentally projected phonological representations, even when these are not physically realized as in reading aloud. Bader conducted a series of three self-paced reading experiments which support the claim of phonological coding during reanalysis of garden-path sentences in German. Using the German variant of the English *her*-ambiguity (*ihr*-ambiguity), the study manipulated the prosodic structure of sentences by inserting a focus operator (a focus particle, the sentence adverbial *sogar* (even) into locally ambiguous sentences as shown in (7b) and (7d) compared with (7a) and (7c) respectively.

- (7) a. Zu mir hat Maria gesagt, daß man ihr Geld anvertraut hat
to me has Maria said that one her money entrusted has
‘Maria said to me that someone entrusted money to her.’
- b. Zu mir hat Maria gesagt, daß man sogar ihr Geld anvertraut hat
to me has Maria said that one even her money entrusted has
‘Maria said to me that someone entrusted money even to her.’
- c. Zu mir hat Maria gesagt, daß man ihr Geld beschlagnahmt hat
to me has Maria said that one her money confiscated has
‘Maria said to me that someone confiscated her money.’
- d. Zu mir hat Maria gesagt, daß man sogar ihr Geld beschlagnahmt hat
to me has Maria said that one even her money confiscated has
‘Maria said to me that someone confiscated even her money.’

The local ambiguity in the pronoun *ihr* means it can either be a dative pronoun or a possessive pronoun. The verb *anvertrauen* (“to entrust”) obligatory takes a dative object while the verb *beschlagnahmen* (*to confiscate*) cannot be used with a dative. The sentence becomes unambiguous when the lexical verb is encountered near the end of the sentence. The preferred analysis on-line is the possessive interpretation of *ihr*, where *Geld* bears sentence stress by default. When the verb *anvertraut* is processed in (7a), syntactic reanalysis is required to achieve the dispreferred dative reading. No prosodic reanalysis is needed, however: the first computed prosodic representation associated with the preferred possessive analysis is compatible with the correct dative reading. When *sogar* is inserted as in (7b), sentence stress on *Geld* is still the intonation associated with the preferred possessive structure, but this prosody is no longer compatible with the dispreferred dative reading in. When the lexical verb *anvertraut* is encountered in (7b) and demands

reanalysis to the dative reading, the only acceptable prosodic structure is one that has an accent on the pronoun *ihr* to make it the focus of *sogar*. Thus when the verb *anvertraut* is processed, the reanalysis required in (7b), unlike (7a), involves a reanalysis of both syntactic structure and prosodic structure, which explains Bader's experimental finding that (7b) is more difficult to parse than (7a) in which only a revision of syntax is necessary.

Fodor's (1998) Implicit Prosody Hypothesis also involves prosodic influences in silent reading but differs from Bader's in that it posits an influence of prosodic phrasing on first-pass syntactic parsing, not only on reanalysis. Like Bader, Fodor advances the idea that in silent reading a prosodic contour is mentally imposed on the input and that the syntactic parser is sensitive to that prosodic phrasing. In case of a syntactically ambiguous sentence, the hypothesis is that in silent reading the 'prosodic parser' assigns a preferred (default) prosodic contour and then the syntactic/semantic parser is influenced by it.

The Implicit Prosody Hypothesis (IPH)

"In silent reading, a default prosodic contour is projected onto the stimulus, and it may influence syntactic ambiguity resolution. Other things being equal, the parser prefers the analysis associated with the most natural (default) prosodic contour for the construction."
(Fodor 2002:113)

According to the Implicit Prosody Hypothesis, a syntactic ambiguity may be resolved according to whichever of the alternative structures is most compatible with the default intonational patterns and prosodic groupings of words in that language. Since languages have different prosodic patterns, this can give rise to cross-linguistic

differences in the preferred attachment of a relative clause. Language-specific prosodic constraints may influence the packaging of an RC in relation to its preceding noun, which will tend to influence the syntactic tree structure that is assigned to the ambiguous word string.

Because implicit prosody cannot be directly observed in psycholinguistic experiments, its existence can only be inferred indirectly. Fodor has devised a working research agenda, which tries to establish a link between the observable explicit prosody of reading aloud and the implicit prosody that is hypothesized to occur in silent reading. The four-step methodological procedure proposed for testing the IPH is:

- (1) Find a factor F which can be manipulated in an experiment, and which measurably affects the OVERT prosody of a sentence.
- (2) Show that the overt prosodic difference caused by F measurably influences an ambiguity resolution preference in parsing.
- (3) Show that F does not affect parsing DIRECTLY.
- (4) Include F in a silent reading task. Is ambiguity resolution affected by F as it is the listening task?

If all four points are satisfied, it can be argued that the best explanation for similar ambiguity resolution in silent reading as in listening (i.e. step 4) is that in both cases the parser's preference is mediated by the prosodic contour, whether it be explicit or implicit prosody. These guidelines were put forward to ensure that implicit prosody can be established to be the cause not merely the effect of syntactic parsing preferences.

This research program posits a number of challenging questions. The most challenging part of this program is devising a method to demonstrate that prosodic phrasing is the cause of an observed attachment preference, rather than being merely the consequence of an attachment preference caused by other factors such as semantic or pragmatic biases.

Thus an important question that experimentation on the implicit prosody hypothesis must address is: When all semantic, pragmatic, discourse or focus factors that might bias towards a certain attachment have been controlled out of the experimental materials, is there still a consistent preference for one interpretation over the other, and can it be plausibly attributed to an unmarked default prosodic contour that the speaker of a language projects onto a written input stimulus.

Evidence for the IPH comes from a number of different studies. For example, some indirect evidence comes from a study by Gilboy & Sopena (1996) which suggests that the visual segmentation used in experimental presentations may be responsible for the characteristic preference for high RC attachment in silent reading of Spanish. They used sentence materials displayed visually on a computer screen, in segments of different lengths, and measured silent reading times in a self-paced reading experiment.

Small segmentation: (N1) (de N2) (RC) No significant preference

Large segmentation: (N1- de- N2) (RC) High attachment preference

As discussed above, a prosodic break at the start of an RC can be expected to encourage the dissociation of that RC from preceding words, and hence attachment of it higher in the syntactic tree where it would modify the whole complex nominal.

Hirose (1999, 2003) gave evidence that implicit prosody plays a role in first-pass parsing and garden-path reanalysis in Japanese. Japanese is a left-branching language in which clause onsets are not signaled by complementizers or other such markers, and the head noun follows the RC. Therefore the onset of a relative clause can be ambiguous, at which point the parser must go back to insert its left bracket, based on the verb of the relative clause and the head noun that follows it. In Hirose’s data, in the sentence fragment shown in (8), there is a temporary ambiguity between a simple clause reading (“Morisita truly trusted the new medicine”) and a relative clause reading.

- (8) Mori’sita-ga si’nyaku-o kokoro’kara sinyoosita yuuji’ntati-ni...
 Morisita-NOM new medicine-ACC truly trusted friends-DAT ...

The occurrence of post-verbal noun marked for dative case *yuuji-ntati-ni* signals that the single-clause analysis preferred in the initial first-pass is wrong, and that the sentence must be reanalyzed as one including a relative clause. It is only at the sentence final matrix verb that it becomes clear what kind of relative clause it is i.e., the sentence structure in (9a) or the structure in (9b).

- (9) a. Mori’sita-ga si’nyaku-o kokoro’kara sinyoosita
 Morisita-NOM new medicine-ACC truly trusted

 yuuji’ntati-ni to’otoo a’tta
 friends-DAT finally met

“Morisita finally met the friends who truly trusted new medicine.”

- b. Mori’sita-ga si’nyaku-o kokoro’kara sinyoosita
 Morisita-NOM new medicine-ACC truly trusted

yuuji'ntati-ni to'otoo mi'seta
 friends-DAT finally showed

“Morisita finally showed the new medicine to the friends whom he truly trusted.

Hirose varied the prosodic weight and length of the initial subject phrase in the main clause, preceding the start of the subordinate (relative) clause. Hirose's data show that in the case where there was a short or light subject, there was no prosodic break on first-pass. In the case of heavy subjects on the other hand, there was a prosodic break on first-pass. This study shows that subject length shifts the parser's preferences in the reanalysis of these sentences during silent reading.

In a sentence completion experiment, Hirose created a set of examples in which subject length was manipulated between a single noun, and two coordinated nouns. The subject of the sentence was either short (e.g., *Morisita*) or long (e.g., *Hosokawa-to Morisita-ga* “Hosokawa and Morisita”). In (10a), the initial first-pass clause [Subj Obj Adv Verb] has been segmented after the subject (Subject Reanalysis, SR). In (10b), the division falls after the subject and the object (Subject-Object reanalysis, SOR). Hirose found that SR was preferred 73% for long subjects. For short subjects, there was no such preference for SR over SOR.

(10) a. Subj_{RC}[e_i Obj Adv Verb] Noun_i Adv main-Verb (takes DAT only)
 ‘Subj finally met the friends who truly trusted the new medicine.’

b. Subj Obj_{RC}[*pro* e_i Adv Verb] Noun_i Adv Verb (takes ACC and DAT)
 ‘Subj finally showed the new medicine to the friends whom he truly trusted

In terms of Fodor's 4 step methodology, subject length was the factor F. Hirose found that subject length affected the overt prosody of these sentences. Breaks (measured by pause duration and F0 reset from downstep taken as indices of a prosodic break) were stronger after the long subject than after the short one. In a subsequent listening experiment it was found that an overt prosodic break after the subject or object influenced the parser's choice between SR or SOR structures. When the prosodic break fell after the subject only, there was a strong preference (79%) for the SR analysis. When the prosody was neutral, there was only a 60% preference. When the break was after the object only, there was no bias (52% SR choice). For a long subject, structure (10a) was preferred to structure (10b). For a short subject (Morisita-ga), there was a significant reduction in the preference for (10a). Hirose showed that subject length affects the explicit prosody of these sentences. This prosodic phrasing pattern correlates with the shift in syntactic phrasing preferences in reanalysis.

Syntactic structure assignment is shown to be influenced by prosodic phrasing in both explicit and implicit reading. Prosodic phrasing is affected by phrase weight (length and accentedness). Hirose proposes that a prosodic boundary in first-pass parsing is "recycled" as a clause boundary in reanalysis. Hirose concluded that the shift in the parser's preferences in silent reading as a function of the subject length is most likely an effect of implicit prosody that had been computed silently in the first-pass, and later influenced syntactic ambiguity resolution in reanalysis.

There have been a number of experiments on prosodic phrasing in a range of different languages that have manipulated the length of the RC (short vs. long RC)

(Lourenco-Gomes, 2002 for Brazilian Portuguese; Wijnen, 2001 for Dutch; Bradley et al., 2003, and Walter et al., 1999 for English; Pynte & Colonna, 2000 for French; Hemforth & Kionieczy, 2002 for German; Kamide et al., 1998 for Japanese; Fernández, 2000, 2003 for Spanish and Fernández et al., 2002 for Canadian French). These studies suggest that the effect of RC length on pre-RC boundaries, and on attachment, appears to be a universal phenomenon. For example, in an overt prosody study (step 2 on p.70) by Bradley et al. (2003), the authors report that in English, the mean N2 duration was significantly longer before a long RC than before short RC, indicating a higher probability or strength of a prosodic boundary after N2 in sentences with long RCs.

Lovrić (2003) working with Croatian also used preboundary lengthening as the basis for inferring break positions in overt prosody. But Lovrić was able to investigate the effects on prosody and parsing of a morphosyntactic alternation between prepositional "od" and non-prepositional genitives in Croatian. Croatian has a preposition-less genitive structure as shown in (11a):

- (11) a. *nécaka detektiva*
nephew detective GEN
“the nephew of the detective”
- b. *nécaka od detektiva*
nephew detective GEN
“the nephew of the detective”

However, the Zagreb dialect of Croatian also has a prepositional construction as shown in (11b). This alternative construction was found to have a significant low attachment preference in silent reading compared with the prepositionless version. Lovrić offered a prosodic explanation of this difference in attachment. He proposed that Croatian grammar favors a prosodic break at the left edge of PP. That would separate N1 from N2 in (11b), and it would group N2 with the RC because a break before *od* would tend to suppress the usual break before an RC in Croatian because it would be too close to the break before *od*. These prosodic consequences of the presence of *od* would thus foster low RC attachment.

This hypothesis was supported by the duration data. There was a lengthening of N1 when *od* was present, indicating a boundary at the left edge of the *od*-PP.

Correspondingly there was less lengthening of N2 following *od*, indicating a reduced tendency to insert a boundary after N2 as well as after N1. There was also an RC-length effect as in other languages: N2 was longer before long RCs than short RCs. When RC attachment was forced, N2 was longer before an RC with forced high attachment than before an RC with forced low attachment.

The manipulation of the presence and absence of *od* is particularly informative, because all other aspects of the materials remain the same in this within-language comparison. Also, in accord with the four-step procedure for evaluating the IPH, Lovrić compared attachment preferences in silent reading with those in reading aloud where the properties of the overt prosody could be measured, and found similar attachment tendencies in both cases. Lovrić concludes that syntactic processing is mediated by silent

prosody, on the grounds that the IPH has the explanatory power to account for the effects of *od* as well as the effect of RC-length on attachment in Croatian.

3.4 Summary

This chapter has presented the main ideas of the Implicit Prosody Hypothesis which claims that implicit prosody can have an influence on silent reading. With reference to RC attachment ambiguities, numerous studies have been discussed that have considered the impact of prosodic weight on prosodic phrasing and the preferred interpretation in overt and silent reading. It is the aim of this dissertation to investigate the prosodic phrasing preferences of SA and to test the predictions of the IPH . The following chapter will introduce the relevant linguistic aspects of Arabic that make it an interesting testing ground for this hypothesis.

CHAPTER 4

A DESCRIPTIVE SKETCH OF ARABIC

4.1 Introduction

In an earlier pilot study (Abdelghany & Fodor 1999), it was found that for Arabic sentences corresponding to the classic English “Someone shot the daughter of the colonel who was on the balcony”, there was an overall low attachment preference (63%), comparable to the findings of Ehrlich et al. (1999) for English, Swedish, Norwegian, and Romanian. Furthermore, the low attachment preference for short RCs (69%) was stronger than that for long RCs (56%). Since Arabic is clearly unrelated to these other low-attaching languages, the research challenge is to specify what they have in common that could explain their similar preferences for modifier attachment.

This dissertation offers an explanation for modifier attachment preferences in Arabic, and does so within an account of cross-linguistic variation that considers the determining factors to be the prosodic phrasing of sentences. This chapter introduces a number of relevant characteristics of the Arabic language. It also surveys the properties of the Arabic genitive and modifier constructions which will be the focus of experimentation in subsequent chapters, and outlines the phonological processes in Arabic that will be the tools for demarcating prosodic phrasing patterns in the constructions under investigation.

4.2 Nature of Standard Arabic as a Language Type

4.2.1 Standard Arabic and Diglossia

It is important, first, to make explicit the nature of the language under investigation, that is, Standard Arabic (SA). Standard Arabic, often called Modern Standard Arabic (MSA), is the variety of Arabic most widely used in print media, official documents, correspondence, education, and as a liturgical language. It is the modern variant of literary Classical Arabic (CA). Standard Arabic is not acquired as a mother tongue, but rather is learned at school and through exposure to formal broadcast programs (such as the daily news), religious practice, and print media.

Arabic offers a classic example of *diglossia*, a term introduced by Charles Ferguson's (1959) pioneering work which identified four languages, Arabic, Greek, Haitian Creole and Swiss German as prime examples of languages fitting the pattern that he wished to highlight. Ferguson's definition of "diglossia" was as follows: "A relatively stable language situation in which, in addition to the primary dialects of the language (which may include a standard or regional standards), there is a very divergent, highly codified (often grammatically more complex) superposed variety, the vehicle of a large and respected body of written literature...which is learned largely by formal education and is used for most written or formal spoken purposes, but is not used by any sector of the community for ordinary conversation." (Ferguson 1959:336). Ferguson stated that diglossic speech communities exhibit a prestigious *High* variety and a *Low* variety with no official status, which are in complementary distribution: for instance, the High variety (Classical / Standard Arabic - *arabiyya fusha*) might be used for literary discourse and the

Low variety (colloquial Arabic - *arabiyya ammiyya*), for ordinary conversation. His definition of diglossia specifies that the two varieties in a diglossic relationship must be closely related, thus intending to distinguish diglossia from bilingualism.

Ferguson's definition characterizes diglossia as the side-by-side existence of two structurally and historically related language varieties (High and Low, referred to as H and L) throughout a community, each of which has a distinct role. The characteristic criteria for diglossia as depicted by Ferguson can be summarized as in table 1:

Table 1: A summary of Ferguson's (1959) characteristics of diglossia.

<i>Function</i>	H is a more elegant and formal variety. L is used for less important functions.
<i>Prestige</i>	Attitudes toward H are more positive than towards L. H is the prestigious variety and L is the stigmatized variety.
<i>Literary Heritage</i>	H is associated with a long literary tradition. H is always used in writing. L fulfills few if any written functions. It may be found in cartoons or in the speech of characters in novels.
<i>Acquisition</i>	L is always acquired as a first language. H is always learned in a formal, educational setting.
<i>Standardization</i>	Dictionaries and grammars document the form of H. L usually has no such support.
<i>Grammar</i>	The morphology of L is often simpler than that of H, for example, verb inflections may be reduced. There is pronunciation of grammatical endings such as case and mood suffixes in H that are absent in L. Such suffixes are absent in all of the modern Arabic dialects (L).

Numerous researchers have written about diglossia since Ferguson's 1959 seminal article; linguists, sociolinguists, and other language scholars have used the term

to describe multilingual situations of varying complexity.¹ Fishman (1961, 1992), reformulating Ferguson's definition of diglossia, views it as functional bilingualism and hypothesizes that diglossia could occur in any situation where two language varieties, even unrelated ones, are used in functionally distinct ways. Anghelescu (1974), however, warns against such terminological mix, which she suggests will lead to the use of the term for 'stylistic functional variation' and will disguise its unique psychological linguistic traits.

Another important focus since Ferguson's article has been the study of intermediate varieties of Arabic which cannot be classified as belonging to either the high or the low varieties. Departing from Ferguson's binary model, Badawi (1973) advances a continuum model where levels are defined by sociolinguistic criteria. Badawi notes that only a minority of speakers have command of only one language level in his model, and that most speakers switch between levels.

Badawi's (1973) model for linguistic variation in Egypt presents a language continuum ranging from 'pure' Egyptian Arabic dialect to 'pure' SA (*fusha*). The model presents five levels, but Badawi stresses that he does not see them as distinct varieties. Badawi's five levels are the following:

¹ Wardaugh (1986:88) applied it to the situation of Chaucer's English in England, which co-existed for three centuries in a diglossic situation with Norman French, and also to the use of Latin as the language of scholarship in Europe where the vernaculars were relegated to other roles during the Middle Ages. However, the Standard Arabic of the current period is still a living and evolving language in ways that the Latin of the Middle Ages was not. Many people in the Arab world today know and use Standard Arabic, due in part to a greater literacy rate than that of the Middle Ages, and also because of the spread of mass media (newspapers, television and radio).

<i>Fusha al-turaath</i>	Classical Arabic - CA
<i>Fusha al-asr</i>	Modern Standard Arabic - MSA
<i>Aamiyyat al-muthaqqafiin</i>	Vernacular of the intellectual elite
<i>Aamiyyat al-mutanawiriin</i>	Vernacular of the educated, Educated Spoken Arabic - ESA
<i>Aamiyyat al-umiyiin</i>	Vernacular of the illiterate

Fusha al-turaath or Classical Arabic is the linguistic vehicle of the legacy of Islamic high culture and religion. The norms for oral performance of Classical Arabic are codified, especially for Quranic recitation (*tagwiid*), but also for using *fusha orally* in other religious contexts, e.g., in mosque sermons and religious programs.

Written Arabic is reducible to two varieties: on the one hand, the high Classical Arabic (CA) of liturgy, and the more modern Standard Arabic (SA) of contemporary literature, journalism, technological writing and administration. Mitchell (1990) states that both varieties, CA and SA, constitute the formal written language, and points out that the pronunciation of SA departs relatively little from that appropriate for a straightforward reading of a liturgical text. Mitchell also notes that from the phonetic point of view, the reading of SA in contrast with CA is sometimes subject to influence from the mother tongue, that is, the vernacular language of the region. To this point, Ferguson (1957:67) writes that: “modern pronunciations of Standard Arabic reflect the stress patterns of the native language of the speaker.” Badawi (1973), Holes (1990) and Hary (1996) endorse this view. By the “native language” Ferguson means the spoken (everyday) colloquial dialect. Therefore, SA read by a speaker of Egyptian Arabic might differ prosodically from the same SA read by a Lebanese or Moroccan speaker. Relevant to note here is that

the subjects that participated in this study were homogenous with respect to the colloquial variety of Egyptian Arabic.

It is relevant to the topic of this dissertation that written Arabic with its distinct structural, prosodic and phonological characteristics is an acquired and learned form of the language. Therefore, it is important to distinguish between the oral rendition of Standard Arabic which is primarily a written form of the language, and colloquial Arabic which is primarily an oral form that is not written and therefore cannot have a read counterpart. This spoken/written dichotomy (orality/ literacy) is an integral feature of Arabic as a language type.

The reason that SA was chosen as the language to be studied in the present research is in order to test the Implicit Prosody Hypothesis (IPH) in a comparison of silent and overt reading. It was therefore important to use a written and read medium, which is only present in SA and not in colloquial Arabic. It is interesting to note here that (based on the researcher's own informal judgment), attachment preferences might differ between colloquial and standard varieties as a result of differences in their prosodies. This is an area of research that has rarely been studied in the literature, and is of great interest for future research. Varieties of Arabic that have similar syntax and semantics but divergent prosody could provide an important test of the IPH.

4.2.2 Structural Characteristics of Standard Arabic

Drozdík (1996) characterizes the main varieties of Arabic (SA and colloquial) by means of the formal criteria of “*ʔiraab*” i.e., the system of case and verbal mood

inflections. Drozdík characterizes these inflections as “synthetic indicators of SA”¹. Structural variations are defined by Drozdík in terms of two structural maximum states that map out the typology of diglossia discussed in § 4.2.1: “maximum synthetism”, represented by the synthetic characteristics of SA, versus “maximum analytism”, represented by the analytic structures of the local colloquial varieties. It has been documented extensively that Standard Arabic is of a predominantly synthetic type (see Anis, 1906), in contrast to the analytic colloquial varieties, and that *ʔiraab* constitutes the structural distinctive factor of its synthetic nature. Drozdík divides the proposed synthetic indicators or inflections of SA into two distinct classes: alphabetic indicators, and non-alphabetic indicators. Alphabetic indicators are represented orthographically by alphabetic symbols of the Arabic orthographical system. They indicate case as shown in Table 2 below.

Table 2: Dorzdík (1996) “alphabetic indicators” (Case)

	Masculine Plural	Masculine Dual	Feminine Dual
Nominative	<i>-uun</i>	<i>-aan</i>	<i>-ataan</i>
Accusative	<i>-iin</i>	<i>-ayn</i>	<i>-atayn</i>
Genitive	<i>-iin</i>	<i>-ayn</i>	<i>-atayn</i>
Construct State	<i>-uu, -ii</i>	<i>-aa, -ay</i>	<i>-ataa, -atay</i>

¹ Drozdík uses the term “synthetic” to mean morphologically complex or agglutinative as opposed to ‘analytic’ morphology. The term ‘synthetic’ mainly refers to the inflectional affixes added to express syntactic relationships.

Alphabetic indicators of verbal mood also function as markers of number and gender; the person and gender distinction are marked by prefixes. A detailed description of this is not relevant in the current study.

The non-alphabetic indicators of SA consist of short vowel diacritic markers alone or in combination with other markers such as *tanwiin* (indefinite marker), and *shaddah* (marker indicating geminated consonants). These diacritic markers are all graphically unrepresented in the unvowelized text.

4.3 Arabic Orthography and Reading

4.3.1 The Arabic writing system

Arabic orthography has special characteristics that should be considered in any discussion of the process of reading in sentence processing. The Arabic script system used to write Arabic is a consonantal script, written in cursive horizontally from right to left. The Arabic writing system has been called an *abjad*, a type of writing system in which each symbol stands for a consonant, and the reader must supply the appropriate vowel. It is a term suggested by Daniels (1996) to replace the common terms *consonantary* (consonantal alphabet) or *syllabary* to refer to the West Semitic family of script. According to Daniels, *abjads* differ from alphabets in that only consonants, not vowels, are represented among the basic graphemes. The *abjad* form of writing is well-adapted to the morphological structure of the Semitic languages for which it was developed, because words in Semitic languages are formed from a root consisting of (usually) three consonants, the vowels being used to indicate inflectional or derived forms.

Some Arabic grammatical categories (such as articles, pronouns and prepositional phrases) take the form of affixes or clitics in written Arabic. This means that a string of characters between two spaces can contain more than one lexical word. The reason for this, as far as the prefixes in Arabic are concerned, is that grammatically all words containing only one consonant and one vowel must be linked to the following word. This applies, for example, to the definite article *ʔal* (‘the’), the connectives *fa* and *wa* (‘and’), the prepositions *bi* (‘with’) and *li* (‘for’, ‘in order to’).

A text written with the diacritics is said to be “vocalized” and one without them is “unvocalized” (sometimes the terms “vowelled/ unvowelled” and “pointed/unpointed” are also used.). This is shown in the following example:

With diacritics	Without diacritics
كَتَبَتْ حَنَانٌ خِطَابًا.	كتبت حنان خطابا.
“Hanan wrote the letter.”	

Other than in the Quran and in children’s books, Arabic is normally written in unvocalized form.¹ Long vowels are marked orthographically by the presence of an alphabetic letter, whereas short vowels are marked by diacritics. In the unvocalized form, the reader must determine which short vowel occurs in the word, based on knowledge of the syntax and morphology of the language.

¹ The Quranic text includes pronunciation diacritics that provide an explicit prosodic parse that serve as indices for pause and assimilation.

Thus short vowels¹ are not part of the alphabet in Arabic and are written only as diacritics over consonants in vowelized texts. Generally, however, in written text such diacritics are not present; the reader has to supply the text with these vowels as he/she reads. Abu Rabia (1998) points out that unvowelized Arabic orthography is very homographic as one unvowelized written word can carry multiple meanings.

Therefore the short vowels that are shown in the English transcription of the Arabic sentences are in fact absent in the written Arabic text as it would normally be seen by an Arabic-speaking reader. This is illustrated in 1(a) and 1(b) below:

(1) a. Transcription, including representation of short vowels

qaraʔ-tu kitaaba shaaʕir ʔalathii kaana fii alnadwah
 read-I book the poet who was in the meeting
 “I read the book of the poet who was at the conference”

b. Segmental information provided by Standard Arabic orthography:

qrʔt ktaab ʔlshaaʕr ʔlthii kaan fii ʔlndwh

4.3.2 A Note on Arabic Morphology

In order to give a concise picture of reading in Arabic, it is relevant here to briefly delineate some aspects of the morphological structure of words in SA. The morphology of Arabic is both non-concatenative and concatenative involving suffixes and prefixes called “*ishtiqaq*” in Arabic. Ratcliffe (1990) and Watson (2002) describe Arabic as having two morphological levels: One level affects the stem of the word (non-

¹ These vowels carry syntactic information such as case and tense, while consonants (which form the templatic root) carry underlying lexical meaning.

concatenative inflectional morphology). The other level does not affect the stem of the word. This works by adding affixes to the beginning and end of the word stem (derivational morphology).

The stem of a lexical word in Arabic is further characterized by Watson as having three discontinuous morphemes: the consonantal root, which is the basic lexical unit of the language (McCarthy and Prince 1990:2); the templatic pattern into which the consonantal root is inserted, imposing a meaning additional to that of the root; and the vowels – the vocal melody which marks variations in, e.g., the voice in verbs, agentive relations in nouns, and singular – plural relations.

Arabic words are based on trilateral roots, and their various derivates are formed by the addition of affixes and vowels. Many words look identical if they are written without vowels (Abu-Rabia & Siegel, 1995). Readers reading without vowels may have to rely greatly on context for word recognition, and hence pronunciation.

The division of labor (during written sentence processing in SA) between what the orthographic text graphically presents, and the phonological structure that the reader projects on the basis of linguistic knowledge, is a key process that will be drawn upon and utilized in the course of experimentation discussed in this dissertation in Chapter 6. This process is superficially a matter of projecting individual phones or phonemes, but an important factor in this process at the segmental level is the projection of prosodic phrasing patterns at the phrasal or sentential level. The latter may have consequences for on-line syntactic decision-making, such as RC or AP attachment decisions in complex noun phrases.

4.3.3 The consonants of Arabic orthography

The Arabic writing system is an alphabetic system with 28 basic letters. A distinction should be made between the *Arabic writing system* (the way in which the Arabic language is represented graphemically) and the *Arabic script or alphabet* (a set of letters which are used for that graphemic representation).

Most of the consonants of the Arabic orthographic system (24 out of 28) are composed of one or more base forms with distinguishing variant shapes. There is a close similarity between most of the letters (22 out of 28) to the extent that some of them are only distinguished from each other by additional dots or strokes. Furthermore, the forms of most letters differ depending on their word position. Each letter of the Arabic orthographic system requires three positional variants to account for its initial, medial and final occurrences.

4.3.4 Diacritics and vocalic representation

The three short vowels (/a u i/) in Arabic are represented by diacritics. The diacritic marks signifying vowels appear in the form of short strokes and shapes below or above the printed line. They are easily separable from the main characters that form the line of print. There are two kinds of diacritics in Arabic. *Morphological* diacritics are the diacritics of a word characterized by word structure. *Syntactic* diacritics are short vowels assigned to the edges of words and they are assigned on the basis of the syntactic analysis for the whole phrase. The relevant syntactic properties are case and mood. There are also diacritics to indicate gemination “*shadda*” (doubling of a consonant), and other similar

devices to represent other phonetic properties such as “*tanwiin*” (n-form) which will be discussed in §4.5.3.

The effect of the missing vocalic structure is shown in example (2) from Maamouri (1983). If we look at what would be in the Arabic writing system for the full graphemic equivalent of the following consonantal root form K-T-B-T, we will have the five variants shown in (2) (transliterated here into roman orthography) with their corresponding gloss:

(2) [From Maamouri, 1998:51]

(a) katabtu	‘I wrote’
(b) katabta	‘you (singular/masculine) wrote’
(c) katabti	‘you (singular/feminine) wrote’
(d) katabat	‘she wrote’
(e) kutibat	‘it (singular/feminine) was written’

4.3.5 Arabic script, Vocalization and the “*Tashkiil*” Task

Maamouri indicates that “vocalization is an important idiosyncrasy of the Arabic writing system” (Maamouri, 1998:52). As previously mentioned, the diacritical markings which represent the Arabic vowels, do not, as a rule, appear in most printed materials.

Schools use a vocalization task called *tashkiil*¹ as part of the standard Arabic language curriculum. Young learners are asked to vocalize all their texts by introducing the required diacritics which represent the vowels. This exercise is meant to reveal and test the student’s internalized knowledge of the grammatical rules of SA which is

¹ The literal meaning of the word “*tashkiil*” is “to give form or shape to something”.

reflected in the positioning of appropriate diacritics for morphologically correct vocalic patterns at the word level, and grammatically acceptable case endings at the sentence level. When used in school books, vocalized texts are intended to assist the young and inexperienced learner. The use of diacritics seems to be limited to whatever length of time is considered sufficient for the learner to be initiated into reading without them.

The role of projecting the final vowel (representing case or inflectional) endings in sentence reading is known in traditional Arabic grammar terminology as ‘*ʔiʕraab*’ (‘declension’) and it is one that requires an active prior knowledge of syntax. The exercise of marking the correct *ʔiʕraab* is a central activity in a typical Arabic language classroom.

In Standard Arabic with full ‘*ʔiʕraab*’, nouns with regular (Arabic *muʕarab* ‘inflectable’) form are marked with one of three cases: the *nominative* (Arabic *marfuuʕ* ‘raised’), the *accusative* (Arabic *mansuub* ‘lifted’), and the *genitive* (Arabic *majruur* ‘attracted’). The cases are marked with the suffixes *-u*, *-a*, and *-i* respectively. Singular nouns with irregular (Arabic *mabnii* ‘fixed’) form are not marked for case. Most morphologically indefinite nouns (including proper names) which end in consonants are marked with a final [n] following the case-vowel (Arabic *tanwiin*, ‘addition of [n]’).

4.4 Syllable Structure in Standard Arabic

This section will outline some relevant properties of the syllabic structure of Arabic as this will be called upon repeatedly to describe some of the key phonological processes in the prosodic phrasing of Arabic sentences during reading.

4.4.1 Syllable Types

Arabic has five syllable types (CV, CVC, CVV, CVVC, and CVCC). Arabic phonology has a constraint on syllable onsets: they must always be a single C. Thus, no syllable in Standard Arabic begins with V, CC (geminate) or CC (non-geminate). It will be demonstrated below that the constraints on syllabification in Arabic are prime factors impacting patterns of word juncture and prosodic boundary placement. In Arabic, syllables may be light (CV), heavy (CVC, CVV) or super heavy (CVVC, CVCC)¹.

Heaviness scale of syllables in SA

CVVC, CVCC > CVV, CVC > CV

To summarize: syllables in Arabic are delimitable by the following distributional facts:

- Begin with a consonant
- Contain a vocalic nucleus
- No syllable-initial consonant clusters
- No sequences of more than two consonants.
- No open syllables at phrase boundary

Syllable structure in Arabic is expressed in terms of Consonant and Vowel. Vowels may occur short or long. Geminate and non-geminate consonant sequences and clusters are distinguished here, as suggested by Mitchell (1990), by the use of

¹ Syllables in Arabic are described with reference to weight as well as length.

numerals, i.e. $-C_1C_1$ (geminate) and C_1C_2 (non-geminate). Any syllable can be derivable from the expression:

$$CV(V)C_{0/1/2} \quad [\text{Mitchell (1990)}]$$

Mitchell uses the brackets to indicate a potential addition of vowel length and zero indicates the absence of a final consonant in a syllable. If C_0 occurs then the syllable is open, otherwise it is closed by means of one or two consonants at the end of the syllable. Sequences of more than two consonants are not allowed. Two consonant clusters, geminate or non-geminate, occur only at the end of a single syllable that is final or pausal.

Figure 1, adapted from Mitchell (1990), is a summary of syllable structure in SA.

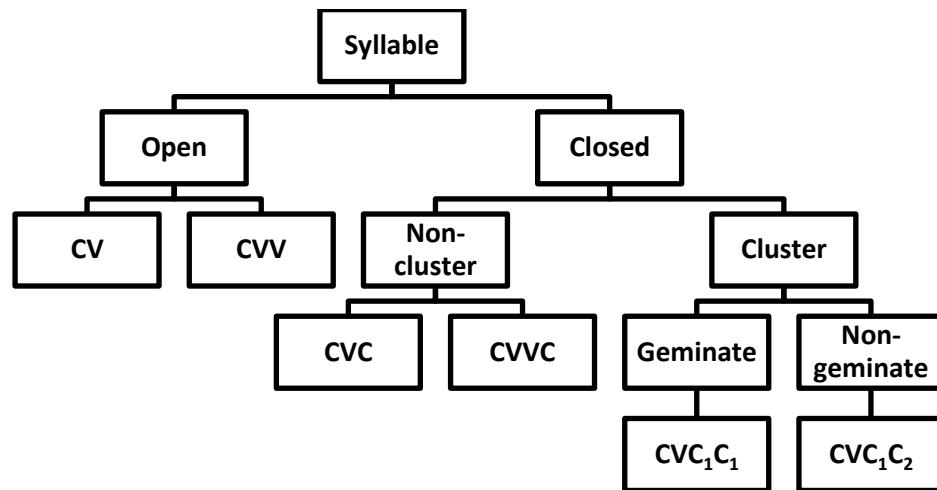


Figure1: Syllable Types of Arabic adapted from Mitchell (1990).

4.4.2 The Consonant / Vowel Unit and Syllable Patterning

A consonant in Arabic is associated positively or negatively with a vowel (*harakah* “movement”) $C\pm V$, where $-V$ signifies no vowel¹. A consonant with a vowel is called “*mutaharakah*” (‘moving’) in Arabic, with the three subdivisions of *fathah* /a/, *kasrah* /i/ and *dammah* /u/ whereas the lack of a vowel is termed “*sukuun*”² (‘rest’ or ‘vowellessness’). Mitchell points out that “this terminology invokes the metaphor of the free flow or movement of speech in the form of open syllables (CV) and its break by the application of *sukuun* to a consonant” (Mitchell 1990:60). A consonant letter in Arabic is said to be “*mutaharikah*” (‘moving’; ‘vowelled’): either “*maftuuhah*” (Ca), “*maksuurah*” (Ci), or “*madmuumah*” (Cu). When there is no vowel it is called “*saakinah*” (C) (‘resting’ or ‘vowelless’).

- (3) “write”: a. katab
b. kataba

Sukuun and *harakah* are used to distinguish disyllabic ‘katab’ from trisyllabic ‘*kataba*’, in which [b] is *saakinah* in 3(a) and *mutaharikah* in 3(b).

¹ In Arabic CV units are symbolised orthographically in vowelized text by a consonant bearing a vowel diacritic

² There is also a written diacritic for *sukuun*. See Ingleby & Baothman (2006) on the relation of *sukuun* to syllable structure and patterning in Arabic.

4.4.3 The length feature

In addition to gemination as a syllabic quantative and morphological device there is also the lengthening of the three vowels, each of which is subject to a short/long contrast. Syllable types are reducible to three quantities:

- Short (CV)
- Medium (CVV, CVC)
- Long (CVVC, CVCC)

The types CVV, CVVC are differentiated quantitatively from CV, CVC, and CVCC by vowel length, indicated in the script by the ‘letters of prolongation’ or long vowels alif (aa), waaw (uu) and yaaʔ (ii). Long syllables occur mostly pre-pausally, so that continuous speech is mostly made up of short (CV) and medium (CVV, CVC) syllables.

4.4.4 Phonemic Length in Arabic and Pre-Boundary Lengthening (PBL)

The literature on the prosodic analysis of speech suggests that there is a universal tendency for the right edges of prosodic phrases to be demarcated by certain types of acoustic cues or features such as lengthening of the final stressed syllable of the phrase, presence of a pause at the locus of the boundary, specific pitch movements and a fall in amplitude (Vaissière, 1983; Hayes, 1997; Byrd, 2000). In many languages, these cues have been shown to facilitate boundary identification for hearers. Of specific relevance here is increased segment duration preceding the phrase break, or what has been called “pre-boundary lengthening” (Gussenhoven, 1990) It is important to consider how this phonetic pre-boundary lengthening (PBL) relates to phonemic length distinctions.

It has been argued that languages with phonemic length distinctions, such as Finnish, Estonian (Lehiste et al. 1965) and Skolt-Sami, a Finno-Ugric language (McRobbi-Utasi 1996) do not have PBL, probably because confusion could result if length were used for additional functions. These studies argue that PBL is not present or is “perceptually irrelevant” in languages where length is phonemic.

Arabic is a language that has phonemic vowel length distinctions. Arabic has six vowels, three short vowels and three long. The long vowels have properties that resemble those of their short vowel versions, but they have longer durations.

Long vs. short /a / /a:/

Long vs. short /i / /i:/

Long vs. short /u/ /u:/

Length is phonemic in Arabic and the difference in the length of a vowel makes a difference in word meaning. The following minimal pairs in example (4) illustrate the phonemic contrast between short and long vowels:

(4)

masa:kin	(houses)	masa:ki:n	(poor people)
jamal	(camel)	jama:l	(beauty)
qutila	(was killed)	qu:tila	(was fought against)

As mentioned earlier, syllables with long vowels are considered heavy syllables and almost always bear stress. Al-Ani (1970) reports that the relative duration of the short vowels in medial and final position is 100-150 msec, while for long vowels it is 225-350 msec. Therefore it is not implausible that it would be difficult for hearers to distinguish

PBL from phonemic length distinctions. This hypothesis is still in need of experimental testing, which I hope to undertake in future studies. Fortunately, it is possible to set this question aside in this dissertation because Arabic will be shown to utilize other means for signaling boundary placement, such as phonological changes in word endings that will be discussed in § 4.4.8.

4.4.6 The Syllabic basis of Stress¹ in Arabic

Standard Arabic word-level stress is predictable from the internal syllable structure of the word. Arabic stress assignment is to be regarded as morphological stress², not lexical stress. In languages where the location of accent is on a fixed syllable in the word, the exact boundary between words can be uniquely determined³.

Languages vary according to whether accent is rule-governed (predictable) or lexical. Ewen and Hulst (2001) explain this aspect as follows:

“In many languages in which accent placement is predictable, it is the segmental make-up of the syllables which is relevant, as well as the position of a syllable in a word: thus heavy syllables are more likely to bear accent than light ones. In some languages, the accentual rules seek out a heavy syllable, and only if they fail to find one in the relevant domain will accent be assigned to a syllable in a particular position in that domain.” (Ewen & Hulst, 2001:198)

¹ The term ‘stress’ here denotes word-level lexical stress, whereas the term ‘accent’ denotes a pitch movement associated with a stressed syllable.

² Morphological stress assignment is typically described as falling on a particular location in the word, depending on the internal structure of the syllables making up the word. Lexical stress is where the meaning of certain words depends on the position or type of stress produced on or near the stressed syllable of the word.

³ It is relevant here to point out, as a prelude to further discussion below, that accent plays an important demarcative role in parsing sentences into words (see Ewen & Hulst 2001 for a detailed discussion).

In languages such as those mentioned above, of which SA is one, accent rules are described as being sensitive to the structure of the syllables. This sensitivity is further described as being *quantity-sensitive*; a term, which Ewen and Hulst note, suggests that the accent rule is sensitive to length distinctions. However, using the term *weight-sensitivity*, Ewen and Hulst point out that the distinction between heavy and light syllables may also involve factors such as whether the syllable is open or closed (closure). They also point out that *quantity* and *closure* may be independent factors in the determination of weight, and that other accent-attracting properties may also play a role.

The stress patterns of SA are derived from an implementation of the stress assignment procedure (Al-Ani, 1970; Mitchell, 1990 and Watson, 2000) presented below.

Potentially, each word in Arabic has one stress. Function words such as clitics, however, are not stressed. The position of the stress is affected by the number and type of the syllables involved. The stress rules of Arabic are summarized as follows:

A-When a word consists of a string of the CV type syllables, the first syllable receives the

primary stress and the other syllables receive no stress.

ka.ta.ba CV-CV-CV 'he wrote'

B- When a word contains only one heavy or super-heavy syllable, this receives the primary

stress, no matter what its position is, and the rest of the syllables receive no stress:

ki. <u>taab</u>	CV- <u>CVVC</u>	"a book"
ʔu. <u>laa</u> .ʔi.ka	CV. <u>CVV</u> .CV.CV	"those"
yu. <u>ʕal</u> .li.ma.hu.	CV. <u>CVC</u> .CV.CV.CV.	"he teaches him"

C- When a phrase contains two or more heavy syllables, the heavy syllable nearest to the end of

the phrase (the last syllable is not considered) receives the primary stress.

yu-jaa-di-**luu**-kum CV.CVV.CV.**CVV**.CVC “they argue with you”

The major feature is that stress placement is calculated from the end of the word not the beginning. It is important to point out here that Arabic words are composed of several morphological elements, including case endings and pronoun suffixes of various sorts, so the length of words may vary considerably. Ryding (2000) distinguishes between two kinds of stress rules in SA: one for contextual or what she calls full forms and one for pausal forms. A summary of examples presented by Ryding is represented here in the following:

Full form stress rules:

- 1- Stress is never on the final syllable
- 2- Stress is on the penultimate syllable : stress is on the second syllable from the word (the penultimate) if that syllable is strong (CVC CVV):

ju huu dun	“efforts” (indef.nom.)	
darrass uu haa	“they taught her”	
yakt ub na	“they” (f.)	[Ryding, 2000:37]

3-Stress is on the antepenultimate: if the second syllable from the end of the word is weak

(CV), then the stress falls back to the third syllable from the end (the antepenultimate):

mak tab atun	“library” (indef-nom.)
ʕaas i matun	“capital” (indef-nom.)

kullunaa	“all of us”	
yuhaawilu	“he tries”	[Ryding, 2000:38]

Therefore in full-form pronunciation SA, stress falls either on the second or third syllable from the end of the word. If a suffix is attached to a word, it increases the number of syllables and may change the stress pattern:

jaami fatun	“university”	
jaami fat unaa	“our university”	[Ryding, 2000:39]

Pausal form stress rule:

The same basic set of rules applies to pausal forms, but there is an important additional rule for pause form pronunciation: Stress falls on the final syllable of a word if that syllable is a super heavy one (CVCC or CVVC):

waziir	“minister”	
mubaah atha t	“discussions”	
hu duu d	“boundaries”	
haa walt	“I tried”	[Ryding, 2000:39]

To summarize SA stress falls on either the second or the third syllable from the end of the word or, in pausal form, on the final syllable if it is super heavy.

Having briefly presented some relevant properties of the syllable structure of SA and its relation to stress placement, the next section will present a brief discussion of phrase level syllabification as this will be a key reference point in the experimental sections of this dissertation.

4.5 Re-syllabification and the Prosodic Hierarchy in SA

As described extensively in the literature on intonational prosody, the spread of surface pitch contour across an utterance occurs from a linear sequence of the following:

-Pitch accents: pitch movement associated to stressed syllables

-Edge tones: pitch movements which align to the edges of phrase-level constituents.

The positioning and patterning of pitch accents in an utterance has been said to reflect the utterance's prosodic structure. Studies in the literature have used these intonational cues of pitch accent as a key indicator for prosodic phrasing. Furthermore, the description of prosodic structure has made use of a prosodic hierarchy in explaining elements in a series of hierarchically ordered phonological constituents known as the prosodic hierarchy (Selkirk 1981, 1986; Nespor & Vogel 1986, Hayes 1989; Pierrehumbert & Beckman 1986, 1988; also see § 2.7 above.). However, models of prosodic structure differ both in terms of the number of levels they posit and the way in which those levels are defined¹. The position of constituents in prosodic hierarchies also differs.

One potential problem that surfaces for all models of prosodic structure which posit a word level constituent is the failure of the boundaries of syllables and feet to consistently align with proposed phonological word boundaries. In a discussion regarding the relationship between feet and phonological words, Nespor and Vogel point out that:

¹ See Cambier-Langeveld 2000 for a detailed survey of prosodic constituents and prosodic hierarchies.

"as required by the Strict Layer Hypothesis . . . , all the feet of a given string must be grouped into phonological words, and no other category may be so grouped. Each foot is thus exhaustively included in a ω ; that is, it is never the case that the syllables of a single foot belong to two different phonological words." (Nespor and Vogel, 1986:109)

The authors deal with phenomena such as “liaison” in French by positing two levels of syllabification – one at the phonological word level, and a second *resyllabification* at a higher level. In an attempt to account for this, Nespor and Vogel (1986) suggest a variation across languages such that there are some languages (like English and Dutch) where syllabification tends to occur within phonological word boundaries and others (like Spanish and French and in this case Arabic) where syllabification across phonological word boundaries is possibly the default. They suggest two derivational stages of syllabification - one at the word level which happens first and a second stage “resyllabification” at some higher level which can only occur on the basis of the first.

Others have taken a similar approach. Peperkamp (2000: 5) writes that “post-lexical re-syllabification constitutes a potential problem for the Strict Layer Hypothesis. Recall that the second clause of the SHL requires prosodic constituents to be properly nested within the constituents that dominate them. Syllabification, therefore, should not cross prosodic word boundaries. In many languages however phrasal re-syllabification applies across prosodic words.”

Thus, re-syllabification which is a post-lexical prosodic restructuring results in the formation of post-lexical prosodic words, which differ from the lexically built prosodic words from which they are derived.

4.5.1 Phrase-level Prosody in Standard Arabic

Hellmuth (2006) notes that Egyptian Arabic (EA)¹ appears to pose a challenge to the theory of phrase-level prosodic structure which is based on analysis of pitch accent distribution. According to Hellmuth, the domain of pitch accent distribution in EA is the prosodic word, not the phonological phrase. Her data strongly suggests that the prosodic word is the constituent level of the prosodic hierarchy which functions as the domain of pitch accent distribution in EA. Based on her corpus analysis, Hellmuth distinguishes between two properties of EA: rich pitch accent distribution and large prosodic phrases.

In EA, as described by Hellmuth, pitch accent distribution seems not to be predictable on the basis of prosodic structure at the phrase level as is possible for other languages such as English and European Portuguese for example. The results of Hellmuth's (2006) analysis provide distributional evidence for the generalization that in Egyptian Arabic (EA) there is a pitch accent on every content word in her corpus across all contexts and speech styles. She estimated that over 95% of content words in EA are accented. Moreover based on a literature survey it is apparent that EA and SA are very similar in this regard. In a corpus study of the pronunciation of Standard Arabic by

¹ Hellmuth uses the term to mean the colloquial variety of Arabic spoken by Egyptians.

Egyptian Arabic speakers, El Zarka (1997:356) and Rifaat (1991:175) confirm that, in neutral declaratives, every phonological word receives a pitch accent.

As described by Hellmuth, a typical EA declarative intonation contour shows an overall falling pattern, with a rising pitch accent localised around the stressed syllable of each content word. In a study of SA, Rifaat (1991) also found that in declarative statements, the pitch height of H and L turning points fall through successive stressed syllables. Furthermore, Hellmuth discusses a study by Ibrahim, El-Ramly & Abdel-Kaderet (2001) on EA that reports similar results for declarative questions in a production study of elicited speech. Ibrahim et al. (2001) find that declarative sentences show declination as observed by other authors, with both upper and lower trend lines falling throughout the sentence.

Most Arabic declaratives observed in the literature show continuous declination throughout the utterance. Final lowering is observed by both Rifaat (2004) and El Zarka (1997) in the pronunciation of SA. The majority of pitch movements observed in Hellmuth's corpus were rising pitch movements, localized around the stressed syllable of each content word. El Zarka (1997:235) in her corpus study of the production of SA argues for a single pitch accent occurring in all positions, both final and non-final. She argues that the 'only stable element' of the unmarked pitch accent is the H peak itself, which she suggests therefore is the element phonologically associated with stressed syllables.

The model proposed by Hellmuth for EA makes the key claim that EA has a default pitch accent which is found on all accented syllables. As presented above, this

view is shared by other authors as regards distribution and peak salience. Hellmuth's claim is that EA intonation is rooted in two facts: that not only is every content word accented in EA but each content word also bears a pitch accent with the same phonological specification: a default LH* tone.

Hellmuth reports on other languages that have been reported to share these prosodic properties in the literature. Hellmuth refers to Jun's (2005) typological survey of 21 languages where the author points out that Spanish and Greek have a pre-nuclear (non-final) accent "on almost all content words, and further, that the type of pitch accent is basically the same" (Jun 2005). These are similar to the two other co-occurring properties established by Hellmuth to hold for EA.

Other languages for which descriptions report both a high distribution of pitch accent and a predominant pre-nuclear pitch accent type are Northern European Portuguese (Vigario & Frota 2003), varieties of Italian (Grice et al. 2005), Tamil (Keane 2004) and Danish (Grønnum 1983, Gussenhoven 2004:223).

Jun points out a parallel correlation in other languages between less populated pitch accent distribution and greater variety of pitch accent types (e.g. in English & German). She goes on to note that the formulation of her typological survey cannot capture "differences between stress languages that differ in the frequency and the type of postlexical pitch accent" (Jun 2005:447). These are exactly the same two co-occurring properties established by Hellmuth to hold for EA.

“In the case where pitch accent occurs at a regular interval (i.e. on almost every content word), with a similar type of pitch accent, each of the accents would provide a cue for a word boundary, functioning similarly to the Word boundary tone in Serbo-Croatian of the Accentual Phrase boundary tone in Korean. ... The perceptual equivalence of word segmentation, whether marked by the head tone or by the edge tone of the unit, is not captured in the [AM] model” (Jun 2005:447).

Jun further suggests that rich pitch accent distribution may serve as a perceptual cue at the word-level. This can be achieved by marking the head of the word with pitch marking.

To recap, Hellmuth’s study shows EA as a language that has rich pitch accent distribution. Hellmuth’s data reveals three correlated properties of EA:

- high frequency of pitch accents (one on every word),
- pitch accents of consistent form (one pitch accent type in pre-nuclear position)
- pitch accents with word-level prominence function (which emerges as a lack of deaccenting i.e.- the presence/absence of pitch accents in EA is unrelated to focus structure).

These three properties are described by Hellmuth and explained in detail in her corpus analysis as well as shown to be characteristic not just of EA but of a range of unrelated languages¹. In her discussion, Hellmuth refers to Jun who suggests a possible

¹ Hellmuth’s survey includes Spanish, Greek, Northern European Portuguese, Italian, Mawng, Hindi, Danish, Halha Mongolian, Tamil, Aleut, Tunisian Arabic, Central Alaskan Yupik, Biniñ Gun-Wok and Iwaidja.

functional explanation for rich pitch accent distribution, namely as an aid to word segmentation: ‘where pitch accent occurs at a regular interval... with a similar type of pitch accent, each of the accents would provide a cue for a word boundary’ (Hellmuth, 2005:447). In support of this explanation is the fact that many languages with rich pitch accent distribution display relatively fewer other cues to word demarcation.

Based on a survey of more than ten languages, Hellmuth suggests that rich pitch accent distribution can be viewed as an independent parameter of prosodic variation. Hellmuth also claims that rich pitch accent distribution is rooted in the phonological grammar of a language and she proposes a formal account within an OT framework. Her analysis proposes that typologically rich pitch accent distribution in some languages arises due to a phonological constraint requiring the head of every Prosodic Word (PWd) to be associated with a phonological tone. The requirement is formulated by Hellmuth as an OT markedness constraint (Prince & Smolensky 2004), as follows:

PWD → T: A mora that is head of a PWd is required to be associated to tone.

[Hellmuth 2007]

Hellmuth suggests that, whilst in many of the intonation languages which have been studied to date pitch accents do indeed have discourse function (such as in the Germanic languages), there are other types of intonation language in which pitch accents have instead a word-level prominence role. A related suggestion, which will be drawn upon later, is that made by Nespor and Vogel (1986), that there are some languages (like

English and Dutch) where syllabification tends to occur within phonological word boundaries and others (like Spanish, French and in this case Arabic) where syllabification across phonological word boundaries is common. The domain of syllabification in EA and SA is suggested to be the Phonological Phrase (Watson 2002:61), with the result that that syllables frequently cross word boundaries.

In the next section, I will briefly describe some of the phonological processes in SA that are relevant to the process of resyllabification across word boundaries mentioned above. These processes will be an important point of reference in illustrating the prosodic account of reading in SA presented in this study.

4.6 Segmental Phonological Processes in SA

4.6.1 Prothesis (*epenthesis*)

Prothesis is defined as the insertion of an initial segment usually with phonotactic motivation (Lass, 1984). It is a type of epenthesis which involves the addition of a segment to the beginning of a word (Trask, 1996). In Standard Arabic, a glottal stop followed by a short vowel is added to the beginning of the words that begin, in their underlying representations, with a sequence of consonants (complex onset). This phonological process is necessary in order to satisfy the constraint that a word must not begin with a consonant cluster **#CC...* (see §4.4.1).

In SA, there are many nouns and verbs whose input forms begin with more than one consonant. For example, each noun in example (5) below (Gudua, 2000:64) begins,

in its input form, with a complex onset. The output form of the noun includes a glottal stop followed by a short vowel added to the beginning of the word:

(5)	nti.laaq	ʔin.ti.laaq.	“departure”	
	mra.ʔah	ʔim.ra.ʔah	“woman”	[Gudua,2000:64]

The underlying forms have syllable structure sequences that are unacceptable syllables in SA (*CCV or *CCVCC). This phonotactic constraint is also evident in Arabic verbs. The imperative form of the three consonantal root verb begins with a complex onset. In the output form a glottal stop followed by a short vowel is added to the beginning of the word in order to break the complex onset and, consequently, to re-syllabify the word into two syllables as shown in example (6):

(6)	ktub.	ʔik.tub	“write”
	qraʔ.	ʔiq.raʔ.	“read”

The insertion of a glottal stop followed by a short vowel occurs not only in words whose underlying forms begin with a cluster of consonants, but also in words that come to begin with a cluster by adding the definite article /l/. Recall the phonotactic rule that no word in Arabic begins with a vowel (see §4.4.1). Taking this constraint into consideration, together with the fact that the definite article in Arabic consists of only one segment (consonant /l/), we expect any noun to begin with a cluster of consonants whenever the noun is preceded by the definite article. To satisfy the *#V constraint, a

glottal stop followed by a short vowel is added to the beginning of each definite noun so the following are re-syllabified as illustrated in example (7):

(7)	kalb.	“ dog”
	*lkalb.	“the dog”
	ʔal.kalb.	“the dog”

4.6.2 Apocope

Apocope is defined as the deletion of one or more segments from the end of a word (Trask, 1996). In Standard Arabic, short vowels are omitted at the end of a phonological phrase. The deletion of vowels decreases the number of syllables of the word as the remaining stray consonant joins to the preceding syllable as shown in (8) from Gudua (2000):

(8)	fii.lki.taa.bi	“in-the-book”	
	fil.ki.taab		[Gudua, 2000:66]

4.6.3 Paragoge

Paragoge is defined as the addition of one or more segments to the end of a word (Trask, 1996). One relevant type of paragoge in Standard Arabic will be mentioned here; namely, the addition of an /n/ to the end of some nouns in particular contexts. This phenomenon is known in the literature of Arabic grammar as 'tanwiin'.

Tanwiin, in traditional Arabic grammar, is defined as an /n/ added to the end of the noun in pronunciation, though not in writing, (Qamhawi, 1969). This /n/ is added to most indefinite nouns in contextual non-final position only. Whenever the noun precedes

a pause, the /n/ is omitted. In Arabic orthography, this /n/ is not represented by the regular letter for /n/, rather it is indicated by a double stroke of the diacritic that represents the short vowel preceding the /n/. Gudua (2000:67) uses the following example in (9) from the Quran to illustrate the process of paragoge of /n/ in Arabic:

- (9) "yakh.lu.qu.kum..fii .bu.tuu.ni..ʔum.ma.haa.ti.kum. **.khal.qan.** .min..baʕ.di. **khalq.**".
 forms you in wombs mothers your formation after formation
 "He (God) forms you in the mothers' wombs formation after formation..."

In this part of verse 6 of chapter 39 of the Quran the noun '*khalq*', which means 'formation or creation', appears twice. The first time, it is composed of two syllables, .khal.qan. CVC-CVC (let us call it the first word). The second time, it consists of one syllable, .khalq. CVCC, (let us call it the second word). The composition of two syllables is due to the paragoge of /n/, and to the existence of the low short vowel (the accusative marker /a/) before /n/. This is because the first word (.khal.qan.) is not followed by a pause (i.e. it is not in final position). Yet, when the second word 'khalq' occurs at the end of the phrase, it consists of one syllable only. This is due to the prohibition of the paragogic /n/ at the end of the phrase, on the one hand, and the deletion (apocope) of the final vowel, on the other hand. However, the second word can be re-syllabified to become two syllables, like the first one. This will happen if another part from the verse is added to the example in (9) as in (10) :

(10) "yakh.lu.qu.kum..fii. .bu.tuu.ni..ʔum.ma.haa.ti.kum. *khal.qan.* .min. .baʕ.di. *khal.qin.* .fii.
.thu.lu.maa.tin..tha.laath."

"He forms you in the mothers' wombs, formation after formation in three veils of darkness."

Since the second word is no longer at the end of the phrase, the paragogic /n/ is obligatory. Consequently, its syllable structure is changed from .khalq. to .khal.qin.

4.6.4 Liaison See § 4.9.

Having noted some relevant factors pertaining to the orthography and phonology of Arabic, the following section will consider syntactic and semantic issues, including definiteness, the genitive construction, and relative clauses in Arabic, and will go on to discuss the characteristic prosodic phrasings associated with the ambiguous construction under investigation, which involves all three of these phenomena.

4.7 Definiteness and determination in Arabic

4.7.1 States of Definiteness¹

The Arabic noun phrase can take one of three states of definiteness²:

- Definite State
- Indefinite State
- Construct State

¹ Definiteness here is more of a morpho-syntactic category rather than a semantic category.

² Fassi-Fehri (2006) investigates the internal structure of Arabic noun phrases within Kayne's (1994) Anti-Symmetry approach. He examines the various properties of nominal phrases and suggests that they are derivable from parametric differences in the properties of the inflectional categories. He specifically considers determination in various Semitic languages and dialects.

The definite state is marked by the article ‘*ʔal-*’, the indefinite by either no marking (zero article) or an ending ‘*-n*’ (which is called *tanwiin* “nunation”) which marks the indefiniteness of nouns. The construct state, shown below in table 3, is not marked and occurs only as the first member of a genitive construction with definiteness indicated on the second member.

Table 3: States of Definiteness for the word “bayt” (house) in SA.

	Indefinite	Definite	Construct
NOM	bayt-u- n	ʔal -bayt- u	bayt-u
GEN	bayt-i- n	ʔal -bayt-i	bayt-i
ACC	bayt-a- n	ʔal -bayt- a	bayt-a

4.7.2 The Definite Determiner

The pronunciation of the definite article *ʔal* in Arabic depends on the phoneme that comes after it. If the following segment is coronal, the lateral phoneme “l” of the definite article is not pronounced. The lateral consonant [l] of the morpheme [ʔal] totally assimilates to the following consonant if this consonant is characterized as [+coronal] and [+anterior]. The output of the total assimilation rule functions as the input of the gemination rule whereby the two identical consonants become a geminate one. The diacritic *shadda* indicating geminate appears orthographically on the consonant. Whenever two identical consonants appear next to each other, only one consonant is

written, and the *shadda* is written indicating that it is geminated. Here for example (11) the underlying form [ʔal-naar] becomes “annaar”:

- (11) [ʔal-naar] **annaar** “the fire” النار

This assimilation process will be a key factor in understanding the phonological processes occurring across word boundaries that will be discussed in § 4.9.

4.7.3 Degrees of Indefiniteness

In order to express the indefiniteness of a noun in Arabic there is no article involved, but there is what is called “nunation ‘tanwiin’”: the noun will have a final /n/, as in:

- (12) kitaab-(u)-(n)
 book-nom-indef.
 ‘a book’

Note here that the *-n* form carries the nominative case marking vowel “u” preceding the “n”. This n-form is not orthographically represented except in fully vocalized writing (where the *tanwiin* diacritic is marked on the last letter of the word to indicate nunation). Therefore in reading the unvowelized text, there is an /n/ sound in pronunciation but there is no /n/ diacritic in the unvowelized writing to indicate nunation.

4.7.3.1 Indefinite- Specific Marking

Brustad (2000) suggests that definite and indefinite marking represent two ends of a continuum of definiteness, which includes an indefinite-specific range that may be expressed syntactically by one of several strategies.¹ This includes nouns that are syntactically indefinite but carry a degree of specific reference that may be reflected in a number of possible syntactic constructions. An indefinite noun that carries a degree of specificity may attract a degree of definite syntactic marking.

As explained above nunation (“*tanwiin*”) refers to the /n/ endings in /-un/, /-an/, and /-in/ that function as indefinite markers on nouns and adjectives. Brustad points out that nunation marks indefinite nouns only when occurring in a Noun + Attributive Adjective combination. Ingram (1994) illustrates with the following distinctions:

(13)	Indefinite	bayt	“house”
	Indefinite (marked)	bayt-u-n	“a (particular) house
	Definite	ʔal-bayt	“the house”
	Possessive	bayt-ik	“your house”

The general schema suggests that /n/ functions as an indefinite-specific marker. Nunation occurs on *specified indefinite nouns*, i.e., indefinite nouns that are modified by an adjective as in (14).

(14)	baytun jameel	“beautiful house”

¹ The principle of gradience in the specification of nouns is a studied phenomenon in language typology. In natural language, many grammatical features such as definiteness, number and animacy interact with each other, and behave more like continua than like strictly delimited categories (Comrie 1981, Givón 1979, Croft 1990).

Brustad notes that the fact that this ending occurs on indefinite nouns that are modified in some way is significant, for it indicates that such a noun is not purely indefinite, but has a degree of specificity. Another important point made by Corriente (1977:121-2) is that nunation has “the function of linking constituents”, the constituents in question being an indefinite noun and a following modifier.

4.8 The Arabic Genitive Construction

There are two kinds of genitive constructions in SA:

- The Synthetic or Construct State with no preposition,
- The Analytic or Free State with a preposition.

However, as has been pointed out by Fassi-Fehri (1993), the Standard Arabic system is essentially synthetic and makes little use of the analytic form (see also §4.2.2).

4.8.1 The Construct State “*Idaafah*”

The construct state is the primary means of expressing possession in Standard Arabic, though in many of the modern colloquial dialects the construct state has given way to prepositional phrases in most contexts¹.

¹ Guella (2007), in a cross-dialectal comparative study of Arabic dialects, notes that there appears to be a significant tendency towards a shift from the synthetic genitive structures to a more analytic construction.

The construct states in Standard Arabic (also called synthetic genitives) are head-initial structures comprising a head noun and a genitive noun phrase. The construct phrase (called “*Idaafah*” (annexation) in Arabic syntax) is one of the most common in Arabic¹. The first word in the construct phrase “the head” (N1) is called “the annexed” (*al-mudaaf*), while the second (N2) is described as “that to which annexation is made” (*al-mudaaf ilaih*). The relation is hierarchical: the first term (*al-mudaaf*) governs the second term (*al-mudaaf ilaih*). The construction as a whole is a nominal phrase. The first term must be in construct state, and thus cannot be marked definite or indefinite. Recall there are only three states of definiteness as shown in 15(a): definite, indefinite and construct and a noun can only be in one state as illustrated in the following examples in 15(b):

(15)

a.	bayt- (u)(n)	“a house”	[Indefinite]
	ʔal-bayt	“the house”	[Definite]
	bayt ʔal-ragul (baiyt-u-rragul-i)	“house the man”	(the man’s house) [Construct]
-
b.	*ʔal-bayt ʔal-ragul-i	“the house the man”
	*bayt-un ʔal-bayt-i	“a house the man”

¹ Ryan & Kulick (2008), in a recent corpus study of a hundred thousand words from the Arabic Treebank3 ANNAHAR corpus (Maamouri et al. 2007) which consists of 600 stories from the *An Nahar* newswire text, extracted 9472 idaafas (construct state NP constructions) of which 3877 have modifiers. The average number of idaafas per sentence was 3.06.

Genitive constructions of multiple terms are possible. In this case, all but the final term take construct state, and all but the first member take genitive case¹ as illustrated in (16):

- (16) raʔay-tu bayt-a ʔ ibn-i ʕam-i ʔal- mudiir-i
 saw – I house-ACC son-GEN uncle-GEN the- manager-GEN
 “I saw the house of the son of the uncle of the manager.”

The construct state construction is very common in Semitic languages. It has been the focus of many studies in Hebrew and Arabic; see Shlonsky(2004), Fassi-Fehri (1999), and Ouhalla (2006) as well as in Amharic; see Ouhalla (2006) and den Dikken (2007).

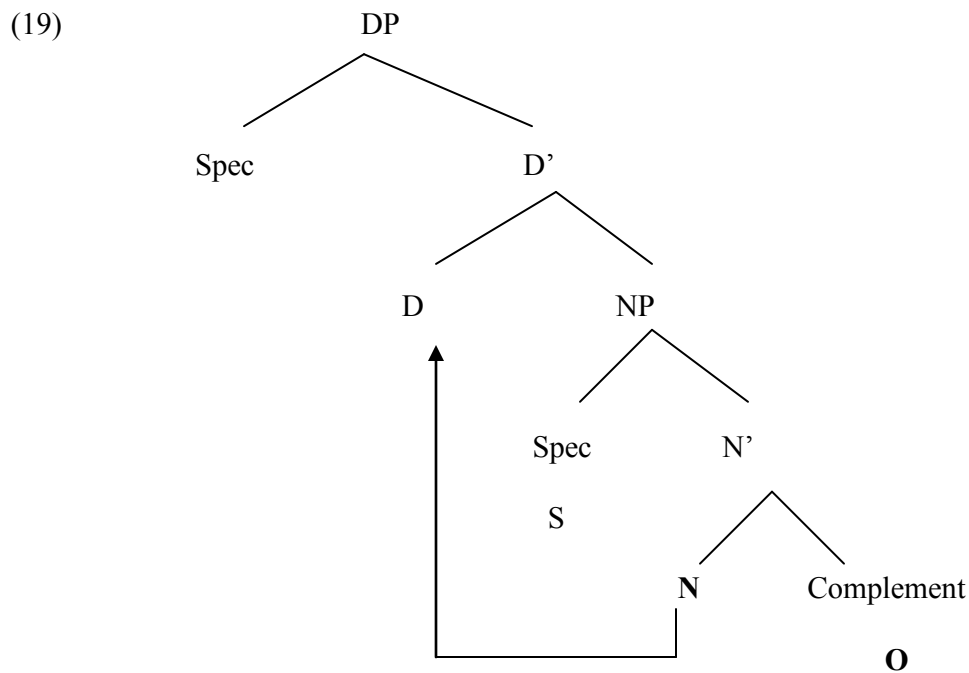
Fassi-Fehri (1993) examines the internal structure of Arabic noun phrases in the light of the proposal in Abney (1987) in which traditional NPs are analyzed as DPs, headed by the determiner (D) and with an inflectional structure paralleling that of a clause. The Arabic genitive construction is described as typically reflecting word order properties parallel to those of VSO clauses; i.e., the usual order is NSO. Consider the following examples (from Fassi-Fehri, 1993):

- (17) daxal-tu d-daar-a
 entered-I the-house-acc
 I entered the house.
- (18) ʔaqlaqa-nii ntiqaad-u r-rajul-i li-l-mashruuʕ-i
 annoyed-me criticizing-nom the-man-gen of-the-project-gen¹

¹ In many cases, though not all, a construct state construction becomes a fixed coined phrase, the *idaafah* being used as the equivalent of a nominal compound in Indo-European languages (which does not exist in Semitic). For example, *baitu-l-taalibaat* may mean either “house of the (certain, specific) students’ or “the student hostel”. It is very important to clarify here that not all construct state constructions are noun compounds with non-compositional meanings.

The man's criticizing of the project annoyed me.

In (17), the NP object is headed by a noun that carries a definite article which is prefixed to it and assimilated to the first consonant of the noun. In (18) the head of the sentence-final complex subject NP is a deverbal nominal “intiqada-u” (criticizing) taking an agent “rajul” (man) and a theme “mashruu” (project) as arguments both in genitive case. In order to account for the distribution of these constituents within the nominal phrase, Fassi-Fehri assumes a DP structure for noun phrases, as in (19):



¹ This noun (Subject) is marked genitive because it is preceded by a genitive case marker: the preposition “li” which assigns the genitive case ending “i” to the following noun (Object). Case in Arabic is structural case, not inherent case. A noun that is the complement of a noun receives genitive case, as do the complements of all prepositions. Case in SA is indicated by suffixes; in most instances these are short vowels: -u for nominative, -i for genitive and -a for accusative.

The article in (18) is generated under D, and the head noun under N; N then raises to D, given the affixal nature of the article. In (18), the DP subject is generated in Spec of N, and the object is generated in the complement of N. N's raising then gives rise to NSO order.

Other syntactic analyses of Semitic construct state nominals are offered by Ritter, (1988), Mohammed, (1988), Borer, (1994, 1996, and 1999), Shlonsky, (2000), and Siloni, (2000). A detailed critical account of these different syntactic views, however, is beyond the focus of this dissertation.

It will suffice for the purposes of this dissertation to give a brief outline of what is common to these different approaches. Analyses of the construct in Arabic include Aboudi (1985), Mohammad (1991), Hazout (1991, 1994, 1995, 2000), Fassi-Fehri (1993), Borer (1996), Siloni (1996a, 1996b, 1997a, 1997b, 2000, 2002), Benmamoun (2000), Kremers (2003) and Shlonsky (2004).

The most influential type of analysis assigns to the construct a structure parallel to the structure of a clause as illustrates in example (13) (Aoun 1977; Ayyoub 1985; Mohammad 1988; Fassi-Fehri 1993; Ouhalla 1994; see also Ritter 1988, 1991, 1993, 1995).

Specific analyses of this type differ in theory-specific details but claim that the construct state consists of a Determiner Phrase (DP) with a phonologically null head whose complement is a nominal projection headed by the construct head. The construct head rises to and incorporates with the head of the DP. The inner-NP is inserted as the specifier of the lexical projection (or in some proposals, of an intermediate functional

projection) to which genitive case is assigned. The inner-NP and the construct head 'agree' in definiteness under a specifier-head relation in one of these projections:

(20)

- a. kitaab-u l-walad-i
 book-nom the-boy-gen
 "the boy's book"

$$b. [_{DP} [_{D} \text{kitaab-u}_i] [_{NP} [_{DP} \text{l-walad-i}] t_i]]^1$$

The structure of the construct state therefore parallels the structure of an Arabic clause in VS word order. This approach captures several of the key properties of the construct state, such as the adjacency requirement, definiteness inheritance, and the nesting of modifiers which will be presented in § 4.6.2 below.

Other different approaches are taken by Borer (1996), Benmamoun (2000), Siloni (2003) and Shlonsky (2004). Borer, Benmamoun, and Siloni propose that the construct head and inner-NP undergo 'morphological merger', in which the syntactic structure in 21(a) undergoes morphological re-bracketing as in 21(b):

(21)

- a. [_{DP} kitaab-u [_{NP} l-walad-i]]
 b. [_{DP} kitaab-u-l-walad-i]

¹ It is of relevance to mention here that example (12) includes a basic noun form with a genitive modifier whereas the examples in (14) include verb-derived nominals with a genitive modifier and a prepositional phrase.

Shlonsky (2004) proposes that the construct head is actually a phrasal constituent which has been raised to the left of the inner noun, which is in an intermediate specifier position of a functional structure as shown in (22).

(22)

- a. $[_{DP} D [_{FP} [_{DP} l\text{-}walad\text{-}i] [_{F'} F [_{NP} kitāb\text{-}u]]]]$
 b. $[_{DP} [_{NP_i} kitāb\text{-}u] [_{D'} D [_{FP} [_{DP} l\text{-}walad\text{-}i] [_{F'} F t_i]]]]$

Setting aside now the means by which the syntactic structure of the Construct State in SA is derived, the following is a recap of the key descriptive characteristics of Construct State in Standard Arabic which is illustrated in example (23) below:

- N2 is case-marked Genitive
- There is no preposition between N1 and N2
- The head noun (N1) of the NP complex cannot be modified by a determiner.
- N2 has an optional definite determiner

- (23) xa:dimat (al)-mumathilat-i
 servant(fem./sgl.)Acc (the) actress(fem./sgl.)Gen.
 “the servant of the actress...”

4.8.2 Combinatorial restrictions on the Construct State

The head noun of the genitive construction can carry neither ‘tanwiin’ nunation (see §4.5.3) nor the definite article.

(24)

* qara?-tu kitaab-**an** ashaair (unacceptable “n” form on N1)
read-I book the poet
“I read the book of the poet”

(25)

* qara?-tu **al**-kitaaba ashaair (unacceptable “definite article on N1)
read-I the book the poet
“I read the book of the poet”

4.8.3 Definiteness Spreading

This is a structure where there is inheritance of definiteness from the genitive noun. A definite N2 in the construct state causes the entire NP complex (N1+N2) to be interpreted as definite. The +/- definite value that is overtly marked on the N2 is associated with each N in the NP complex. The head noun of the genitive construction can be shown to agree in definiteness with the possessor. Thus although the head noun is not carrying a definite article, it behaves as if it were carrying one. Evidence for this comes from the semantic interpretation and from definiteness agreement with modifiers. A disambiguated sentence like (26) means “the house of the man” not “a house of the man”. (26) is inappropriate if the discourse does not provide a unique referent for “house of the man”.

(26) daxal- tu daar-a r-ragul-i l-waasiat-a
entered-I house-acc the man-gen the-large-acc
“I entered the large house of the man.”

With regards to adjectival and relative clause modification, the behavior of the noun heading the genitive construction is exactly like that of a head noun carrying a definite article: modifiers must agree in definiteness with the head noun. When the modifier does not agree in definiteness with the head noun as in (27), the structure is ungrammatical:

- (27) * daxal-tu daar-a ragul-i waasiat-a
 entered-I house-acc the man-gen large-acc
 “I entered the large house of the man.”

When the genitive NP is indefinite, the head N is also indefinite, so the modifying adjective must be indefinite, i.e., it cannot bear the article as in (28).

- (28) * ghanat bint malikin al-jameelah
 sang a daughter a king the-beautiful
 “The beautiful daughter of a king sang.”

When the head noun of a genitive construction is modified by a relative clause which begins with a relative marker (which is inherently definite), this head noun must be definite. The relative marker behaves like the article with adjectives; it must occur with definite head nouns and cannot occur with indefinites.

- (29) *ghanat bint malikin ?allati kaanat jameelah gidan
 sang a daughter a king who was beautiful very
 “A daughter of a king who was very beautiful sang.”

4.8.4 Prosodic characteristics of the Construct State

Siloni (2000), working with Semitic languages including Hebrew and Arabic, explains that the head of the construct does not bear main stress; main stress is shifted forward and falls on the non-head noun. Since the head is a stressless weak form, it is phonologically dependent on the non-head member. “The head of the construct does not constitute a prosodic word in itself as it lacks main stress. Rather, it is part of the subsequent word; that is, it forms a prosodic word with the head of the genitive.” (Siloni, 2000:5). This sometimes leads to phonological reduction of N1 (see §4.6.5 below).

The main claim advanced by Siloni’s hypothesis is that the construct state word is formed at PF; it is a post spell-out¹ phenomenon, a word only in phonological terms.² At PF there is a prosodic word containing the head of the construct and the head of its genitive member. Siloni develops an account of constructs that derives their word status from the need to check Case. The other characteristics of constructs are then derived from their prosodic structure. The idea is that in the construct state in Semitic languages, the head undergoes phonological changes when it checks Case. She argues that the nominal head is a lexical word, which nevertheless shows phonological properties typical of function words: it is a stressless (reduced) form.

¹ Spell-out is the point in the computation of a linguistic expression at which the derivation splits into two, heading towards the two interface levels, LF and PF.

² Benmamoun (2004) also argues that the merger of the members of the CS takes place in the post-syntactic component and that the merger is due to morphological reasons, namely, the need to spell-out morphological features

4.8.5 Construct State (CS) and Adjacency

Many studies have pointed out that the Semitic N1 + N2 construction obligatorily constitutes one prosodic unit with no break intervening between N1 and N2 (Ibn Alanbary (1961), Hablas, (1993), Mohammed, (1999) and Siloni, (2000)). Also, nothing modifying the first term of the CS can be inserted between the two members. All modifiers of N1 (adjectives or RCs) must follow the entire CS. Strict adjacency between N1 and its possessor complement is one of the signature properties of Semitic construct state nominals (Shlonsky, 2001).

“Traditional Semitic scholars”, writes Shlonsky, “recognized very early that the phonological boundaries between the noun and its complement in the construct state are weak and that phonotactic as well as metrical processes sensitive to word boundaries take the Construct State nominal to be a single phonological word.” Shlonsky (2001:7).

A prosodic boundary¹ after N1 is thus not a phrasing option in Arabic construct state prosody (unlike in English complex NPs for example). Where an RC follows N2, the speaker has only two options: either to break prosodically after N2 or to make no break at all inside the (N1 N2 RC) construction (though of course there may be a break either before or after it or both). These two options of prosodic phrasing within the construct state will be demonstrated below.

As noted above, the (in)definiteness of every member of the construct state is determined by the final member: “if the last member is alpha-definite, then every member of that CS will necessarily have the same value assigned to alpha” (Mohammed, 1988). Thus,

¹ It is important here to distinguish between “adjacency” which refers to word sequence and the absence of a “break” which is a matter of prosodic phrasing.

once an overtly marked definite noun is used, the CS is closed (except for the possibility of modifiers). No further nominal members are permitted as shown in the example (30):

- (30) bayt –a ibn-i- saahib-i **ʔal-** sayaarah
 house- ACC son-GEN owner-GEN the-car
 “The house of the son of the owner of the car”

4.8.6 Phonological changes of N1 in Construct States

Phonological changes and reductions in N1 in the construct state include:

The feminine ending:

The /t/ which surfaces on feminine construct heads (ʕammat versus ʕammah, “aunt”):

- (31) ʕammat al-walad
 aunt the boy
 “the boy’s aunt”

Some feminine words in Arabic can either end in “h” or “t”. The “h” is a pausal sound form while the “t” is a contextual form. The /t/ binds and syllabifies with N1 and with the following word N2. This /t/ is considered to be a cohesive or linking element that phonologically binds N1 to N2. If the feminine /t/ on N1 is missing, as in example 32 (b) below, the output is ungrammatical.

- (32)
- a. xa:dimat almumathilah **h** ʔallati ...
 servant the actress who
 - b. * xa:dimah ʔalmumathilah **h** ʔallati ...

servant the actress who

- c. xa:dimat almumathilatillati ...
servant the actress who

In example 32(a), “t” on N1 is obligatory but “t” on N2, as in example 32(c), depends on whether there is a prosodic boundary separating N2 from the relative marker. The “h” ending on N2 in (a) is a pausal form suitable for where there is a break (a pause) between N2 and the relative clause, while the ending on N2 in (c) binds N2 and the relative clause into one phonological phrase. Other phonological variations on N1 in the construct state include:

The dual and plural:

The dual and plural endings are deleted exclusively on the head (N1) of a nominal construct state (e.g., *kitaabay*, versus *kitaabayn*” ‘two books’, and *muallimii* versus *muallimiin* ‘teachers’). The examples in (33) from Mohammad (1988) illustrate this point. Examples (a) to (d) do not contain a construct state:

(33)

- a. qaraʔtu kitaab-ayn
read.1s. book-ACC.dual
“I read two books”
- b. qaabaltu muʕallim-iin
met.1s. teachers-ACC.pl.m
“I met teachers.”

- c. wasalat muṣalimat-aan
 arrived.3sf teacher-NOM.dual.f
 “Two (female) teachers arrived”
- d. wasala muṣalim-uun
 arrived.3sm teacher-Nom.pl.m
 “Teachers arrived”

Compare the above examples in (33) with the examples in (34) below where the NPs are in the Construct State:

(34)

- (a) qaraʔtu kitaab-ay ṣaliy-in
 read.1s. book-ACC.dual ali-GEN
 “I read Ali’s two books”
- (b) * qaraʔtu kitaab-ayn ṣali-yin
 read.1s. book-ACC.dual Ali-GEN
 “I read Ali’s two books”
- (c) wasalat muṣalimat-aa ṣali-in
 arrived.3sf teacher-NOM.dual.f Ali-GEN
 “Ali’s two (female) teachers arrived.”
- (d) * wasalat muṣalimat-aan ṣali-in
 arrived.3sf teacher-NOM.dual.f Ali-GEN
 “Two (female) teachers arrived.”
- (e) qaabaltu muṣalim-ii ṣali-in
 met.1s. teacher-ACC. pl.m. Ali-GEN
 “I met Ali’s teachers”
- (f) * qaabaltu muṣallim-iin ṣali-in
 met.1s teachers-ACC.pl.m Ali-GEN
 “I met Ali’s teachers.”

The final /n/ of the plural and dual form is what is deleted in the above CSs. Specifically; the /n/ is omitted from the endings of the masculine plural /uun/, /iin/ and the masculine and feminine dual /aan/ and /ayn/. The examples above show that the construct state creates a specific condition for the deletion of the dual and plural ending. The construct state is the only environment in which this kind of deletion takes place.

4.8.7 Free State Genitive (Analytical Genitive)

There is also an alternate genitive form in Arabic that corresponds more closely to the English N-of-N construction since it contains an overt preposition. These are *to*-phrases (like *of*-phrases in English and Hebrew):

(35)

qaabal-tu sadiiq-a-n li (ʔal) shaaʔir-i- ʔalalathi kaana fi (ʔal)nadwah
 met -I friend-nom-indef to the poet who was in the
 meeting
 “I met a friend of the poet who was in the meeting.”

In this “analytic genitive” (also called “free state” or “absolute state”), N2 (the possessor) “*ashshaaʔir*” is case marked genitive by a preposition “*li*” which has the same form as the dative preposition¹ (corresponding to “to” or “for” in English). In this form of the complex NP construction in Arabic, the RC is unambiguously attached to N2. The definite relative clause “*alathi kaana fi ʔal-nadwa*” in the above example modifies “*ʔal-shaaʔir*” and cannot modify the indefinite noun “*sadiiqan*” (see p148).

¹ For a detailed analysis of the difference between dative and objective “li” see Fassi-Fehri (1993). Fassi-Fehri calls the ‘li’ in analytic genitives a “nominal objective marker” as distinct from “li” in the dative sense of “to give something to someone”.

When N1 is definite, there are two interpretations (though the second is questionable) associated with the attachment of the RC modifier. The ambiguity can be described as one between a restrictive reading (N2 reading) associated with the phrasing in 36 (a) (where # signifies a prosodic break) and an uncommon non-restrictive reading (N1 reading) associated with the highly dispreferred phrasing in 36 (b). The segmental phonological edge effects on N1 “*sadiiq*” and N2 “*shaafir*” are characterized as prosodic cues for the different meanings: here in example (36) are the two possible phrasings:

- (36) a. qaabal-tu- ssadiiq # li shshaaʕir-i- llathi kaana ʔi- n-nadwah
 met -I the friend to the poet-GEN who was in the-meeting
 “I met the friend of the poet who was in the meeting” 2
- b. qaabal-tu- ssadiiq-a li shshaaʕir # ʔallalathi kaana ʔi - n-nadwah
 met -I the friend-ACC to the poet who was in the-meeting
 “I met the friend of the poet who was in the meeting”

In a comparative study of the construct state and the analytic genitive in Arabic colloquial dialects, Harning (1980) explored the relative frequency of the analytic genitive and factors that motivate its use. Harning characterizes the genitives which use a genitive exponent (in this case the preposition “*li*” to express a possessive relationship between two nouns) as a “dialectal innovation”, reflecting the view that colloquial Arabic has long been in the process of shifting from a synthetic to an analytic form, one “whose syntactic relationships are expressed through strings of discrete morphemes”.

The colloquial analytic exponent *bitaaʕ*, as illustrated in (37), inflected for gender and number, is used in Egyptian colloquial Arabic in the analytic genitive in alternation with the more standard *li* preposition.

(37)

[CONSTRUCT STATE]	[FREE STATE]
beet il-mudiir	ilbeet bitaaʕ
il-mudiir	
house the- manager	the house belonging the- manager
“the manager’s house”	“the house that belongs to the manager”

Information-theoretic factors such as focus are proposed to be what is relevant to the choice of which form to use. Consider the following example from Brustad (2000). While it is grammatically possible to translate “The Yemeni Language Center” using a construct state in colloquial Arabic, as in (a), the preferred rendering uses the preposition /li-/ as in (b):

(38)

- a. Markaz al-lugaat al-yamanii
Center the- languages the-Yemeni
- b. Al-markaz al-yamanii li-l-lugaat
The center the Yemania for languages

In example (38) above, the preferred title (b) places a contrastive focus¹ on “*languages*” that is not conveyed by (a), and for this reason (b) is favored, since the title refers to “the Yemeni Language Center”, as opposed to “the Yemeni Cultural Center”, “the Yemeni Recreation Center”, or any other center in Yemen. By contrast, (a) places a

¹Focus here is perceived as a function of the word order, not by any intonational marking.

focus on Yemeni, and might refer to a “Yemeni Language Center” as opposed to an “Egyptian” or “Syrian” “Language Center”. Brustad shows that the construction involving the preposition *li* often conveys a specific kind of pragmatic information that the construct phrase does not. The exponent, states Brustad, lends N2 “greater textual prominence, signaling a relatively high degree of individuation, contrastive focus, or the first mention of an entity in discourse” (Brustad, 2000:75).

Marçais (1977) in a study of the genitive construction in North African dialects of Arabic, points out that the morphological form and weight of the phrase play a role in the choice between the construct and the free form. He attributes the use of the latter to a multi-term noun phrase, suffixed or otherwise modified nouns, or to a phrase in which direct annexation would upset the syllabic structure (op.cit.:77). For the following colloquial Egyptian pair in example (39), El-Tonsi (1982: 19) notes strong preference for (a) over (b):

(39)

a.	maʕab it-tinis bita in-naadi court the-tennis gen the-club the tennis court of the club	[analytic genitive/ free state]
b.	maʕab tinisi n-naadi court tennis the-club the tennis court of the club	[construct state]

Moreover Ryding (2000) describes the stylistic choice involved in choosing between the construct and the analytic genitive in SA and states that, in certain cases, the construct state

is avoided when N1 is modified by an adjective or a phrase that would otherwise have to be placed after N2. This is illustrated by Ryding with the following examples in (40):

(40)

ʔal-qism-u ʔl-ʔakhiir-u min-a l-kitaab-i
The-part-nom the-last-nom of the-book-gen
“the last part of the book.”

khusuuf-u-n juzʔiyy-un li-l-qamar-i
eclipse-nom-indef partial-nom-indef of the-moon-gen
“partial eclipse of the moon”

4.9 The Arabic Relative Clause

4.9.1 The Relative Marker (RM) in Arabic

The relative marker¹, which is called a “relative noun” (*ʔism mawsuul*) in Arabic grammar, is marked for gender, number and definiteness and, like adjectival modifiers, it agrees with the noun it modifies in these features.

Table 4: Different forms of the Relative Marker in Standard Arabic

	Masculine	Feminine
Singular	<i>ʔallathii</i>	<i>ʔallatii</i>
Dual		
Nominative,	<i>ʔallathaani</i>	<i>ʔallataani</i>
Genitive &	<i>ʔallathayni</i>	<i>ʔallatayni</i>
Accusative		
Plural	<i>ʔallathiina</i>	<i>ʔallawaati/ ʔallaati</i>

¹ This is different from the term “relative pronoun” used in describing other languages. This difference will be explained below.

The relative marker in Arabic is inherently definite¹ with the definite marker “ʔal” affixed at the beginning of the word. Therefore, a relative clause in Arabic can only modify a definite NP. De Vries (2002), in a detailed typological survey of relative constructions², characterizes a relative marker as a type of particle that has the attribution function³. It is characterized as a D-like element (it cannot be in the complementizer position C)⁴ which agrees with the head noun and bears Case.

A relative clause in Arabic has normal word order (i.e., as in matrix declarative clauses) and follows the noun it modifies. The relative clause may contain a resumptive pronoun (clitic) at the underlying position of the relativized constituent as shown in example (41) below. There is no *wh*-element, in the sense of an item that also functions

¹ Arregi (2000) states that relative operators can be morphologically related to either a *wh*-word as in English or a definite article as in

German and Spanish; see examples (1) and (2) from Arregi (2000).

(1) Peter bewundert den Mann, *der* das Bier erfand (German)
 Peter admires the man the the beer invented
 ‘Peter admires the man who invented the beer’

(2) el hombre con el que estuvimos hablando ayer (Spanish)
 the man with the that we-were talking yesterday
 ‘the man we talked to yesterday’

² De Vries (2002) states that cross-linguistically as well as language-internally there are many types of relative clauses: parametric freedom exists with respect to almost every aspect of the construction. He cites 11 degrees of freedom. Given these 11 degrees of freedom, he calculates a potential 4608 types of relative constructions. He investigates 223 relative strategies in 172 languages.

³ Lehmann (1984) states three possible functions of a relative element:

- (i) *Subordination*: “A relative clause is a subordinate clause. This can be indicated by a designated pronoun or particle”.
- (ii) *Attribution*: “The relative clause is attributed to the head. The relative element shows [ϕ -feature] agreement with the head”.
- (iii) *Gap Construction*: “The instance of the head within the relative clause is marked by a representative. It fills the gap and bears Case”.

⁴ Ouhalla (2004) discusses “a parametric distinction relating to the categorical identity of the relative clause”: that it is a CP in some languages and a DP in others. The first type is found in languages where the relative complementizer is the same as the normal complementizer of sentential complementation (e.g. Hebrew). The second type is found in languages where the relative complementizer is a determiner (e.g. Arabic).

as a question word.¹ The relative clause is introduced with a relative clause marker, as described above.

- (41) ʔal-ra_guli_i allathi ra'aytu-hu_i
 the-man REL saw-I-him
 “the man who I saw”

Kremers (2003) shows that relative clauses in SA have syntactic and distributional properties similar to those of adjective phrases. The SA relative clause marker agrees with the antecedent in gender and number as shown in examples (42) below:

- (42)
- a. al-mar'ah allati ra'aytu-haa
 the-woman REL.SG.F I.saw-her
 “the woman who I saw”
- b. al-rigaal_i allathiina ra'aytu-hum_i
 the-men REL.PL.M I.saw-them
 “The men who I saw’
- c. al-nisaaʔ_i allaatii ra'aytu-hunna_i
 the women REL.PL.F I.saw-them
 “The-women who I saw.’

The relative marker also has dual forms. These forms have an additional property: they agree with the head noun in case as shown in (43):

¹There is a special kind of relative element in Arabic distinct from the relative marker “*man*” which is used also as a question word and as a relative pronoun in headless relative clauses only. This relative element does not have a definite article and does not have agreement features.

- (43) lam ʔagidi -l-ragulaayni -llathaayni bahathaa ʕannii
 not I.found the-men.DUAL.ACC REL.M.DUAL.ACC they(DU).searched for-me
 'I did not find the two men that were looking for me'

So we see that the relative marker agrees with the antecedent in gender, number and Case. It also agrees in definiteness. Therefore when the antecedent noun is indefinite, there is no relative marker:

- (44) ʔishtaraa Ahmad kitaab-an lam yaqra'-hu ba^cdu
 bought Ahmed book-ACC.INDEF not he.read-it yet
 "Ahmed brought a book that he had not read yet"

In example (44), the antecedent *kitaab* is immediately followed by a clause¹.

Ouhalla (2004) argues that the relative clause has a DP structure in Arabic. The following syntactic analysis is offered by Ouhalla for the relative clause in Arabic:

[DP D [TP]]

Ouhalla considers the syntactic structure in 45 (b) for the analysis of the example in (45) where the relative clause is located in a left-branching Spec position of N rather than being adjoined to NP. The Det-N-initial order is derived by head raising of N to D.

- (45) a. ʔal-batta ʔallati ʔakalnaa-ha
 the-duck RM ate-we-it
 "the duck that we ate..."

¹ This is sometimes called an indefinite relative clause in the literature. It can be a nominal clause or verbal clause (see below for details.) These are also sometimes called participial relative clauses. There seems to be a significant pragmatic difference between referring definite heads of relative clauses and indefinite heads, a difference which has prosodic consequences. A study of this difference is a worthy topic of investigation but a detailed discussion of this is beyond the scope of the current study.

- b. [DP the [NP[DP the_Agr [TP we.ate-it]] [N' duck]]]
 [DP the [N duck]_i] [NP[DP the + Agr [TP we.ate-it]] [N' [e]_i]]

[Ouhalla,2004]

It is beyond the scope of this dissertation to discuss the different theoretical approaches to the syntax of relative clauses, but see De Vries (2002) for an extensive and detailed analysis of the syntax of RCs within a rich typological discussion, and Ouhalla (2004) for an analysis of Semitic relatives. It will suffice here for the requirements of further discussion regarding relative clauses as modifiers of complex noun phrases to point out the following types of relative clauses in Arabic.

4.9.2 Types of Relative Clauses in SA

4.9.2.1 Headed Definite Relative Clause

A headed relative clause is a clause that is bound to an overt head (antecedent) in the matrix clause by a relative marker that agrees with it in number, gender, definiteness and sometimes case. This type of relative is the most common in SA and is the type of relative that will be used in experimentation in this study. An example of a headed definite relative clause is illustrated in (46).

(46)

ʔal-kitaabu -llathii qraʔ-tu-hu
 The-book which read-I-it
 "The book which I read.."

4.9.2.2 Free/ Headless Relative Clause

Free relatives¹ in SA are relatives without an overt nominal head (an antecedent). They behave syntactically just like a noun phrase i.e. they can be in object position, subject position or in a genitive construction.

(47)

ʔalathiina ʔakhuthuu ʔihtiyaataati-him najaw min al-ʔiʕsaar
who-mas.pl. took-mas.pl precautions escaped –mas.pl from the-hurricane.
“Those who took precautions escaped from the hurricane”

In (47), the relative clause “*ʔalathiina ʔakhuthuu ʔihtiyaataati-him*” has no antecedent and the whole relative clause is the subject of the verb “*najaw*” (escape).

4.9.2.3 Indefinite Relative Clause without a relative marker RM

A relative clause can refer to an indefinite noun phrase in the matrix clause, in which case the relative marker is not present. This type of relative clause can either be a nominal clause² or a verbal clause. The indefinite relative clause follows the main clause without a relative marker linking them. Ryding (2005:145) points out that the two clauses “are like two independent sentences implicitly linked because the second refers back to the first”. In this type of modification, the modifying clause must include a resumptive pronoun referring to the modified noun³. In the following example, the clausal modifier

¹ For a detailed typological study of headless relatives see De Vries (2002), Bianchi (2002) and Grosu (2002).

² A nominal clause in traditional Arabic grammar refers to a clause which starts with a noun and has no verbal element or a zero copula.

³ See Kremer (2003:115) for a proposed syntactic analysis of the resumptive pronoun and indefinite relative clauses. Kremer draws on the similarity between relative clause modification and adjectival modification in Arabic and derives them from the same underlying structure.

“*inwaanu-hu ʕagiib*” with the resumptive pronoun “*hu*” is a nominal clausal modifier modifying “*kitaab*”.

- (48) qaraʔ-tu kitaab-a-n ʔinwaan-u-hu ʕagiib
 read-I a book-ACC-INDEF title-NOM-its strange
 “I read a book that had a strange title.” or “...whose title was...”

4.9.2.4 Appositive Relatives¹ “*wa* + RC”

The conjunction *wa* (‘and’) in Arabic is sometimes used before a relative clause. It will be shown in chapter 5 that in this case, there is a prosodic boundary before the conjunction. This kind of relative clause has the semantics and pragmatics of nonrestrictive relative clauses.

- (49)
 baʕda intihaaʔ al-bayaani attadriibiy ***wa*** ***ʕlathii*** ʔathbata ʔalkafaaʔata ...,
 after finishing the presentation training and that proved the required proficiency...,
 “After finishing the training presentation, and that proved that they had the required proficiency..”

Kempson (2003) argues that nonrestrictive relative clauses are semantically like conjunctions, occurring wherever clausal coordination is possible. The relative is construed as an independent conjunct as in the English example in (50) below:

¹ Peterson 1992, 1999, 2004, argues (in line with McCawley 1982, Hageman 1988, Fabb 1990, Espinal 1991, Hannay & Keizer 1992, Kempson 2003) that non-restrictive relative clauses belong to the class of “non-syntagmatic” relations (non-syntagmatic relations include address terms, interjections, parenthetical clauses and appositional structures.) Appositional structures, including non-restrictive relative clauses, should be analyzed as being syntactically distinct from their host construction. Linking the two structures- the apposition and its host- would be at the semantic/discourse level.

(42)

John, who is the smart one in the group, is coming with us.
John, and he is the smart one in the group, is coming with us.

4.9.2.5 Explicit Restrictive Relatives *maa...min* construction

In a corpus study of the Quran, Gensler (2004) examines the *maa...min* construction in Arabic. The basic structure of this construction is: *ma ... min* [“what ... from/of”] which can have the following variants:

- Variant 1: *man ... min* [“who ... from/of”]
- Variant 2: *allathii ... min* [“that-which ... from/of”]

The *maa ... min* construction is very common in standard and colloquial Arabic. Similar constructions exist in other languages (examples in (51) below are from Gensler, 2004):

(51)

English: All I’ve been able to get hold of by way of literature is sound tapes.
What I bought of books..

French: Je n’ai pas aimé ce qu’il nous a servi comme vin.
I didn’t like what he served us as wine.
“I didn’t like the wine that he served.”

This construction has the effect of restricting reference, but as Gensler indicates it restricts in a “backwards” way. Semantically, modification with a relative clause starts with a set defined by the head noun, and then its reference is further restricted with the relative clause:

books – the books that I bought

With *maa/ ... min*, it is the reverse: “the construction starts with a set defined by a headless relative clause and then its reference is narrowed down by specifying a particular noun¹”: With this construction, the fact of “restriction of reference” is said to be “explicitly coded” and built-in by use of the word *min* (from/of): “from noun(s)” is a literal statement that you are taking entities “from a given set. The following examples in (52) from the Quran are cited in Gensler’s study:

(52)

- a. *maa* anzala allahu min al-samaa‘i *min* maa’in
what he-brought down Allah from the sky from water
“the water which Allah brought down from the sky” (2:164)

- b. min ba’da *alathii* jaa’ka *mina* l’illmi
from after what come-you from the knowledge
“after the knowledge that has come to you” (3:61)

To recap this section, the following figure gives a summary of the types of relative clauses in Arabic:

¹ The noun complement of *min* item cannot be a singular count noun. It must be either a plural or a mass noun, or abstract, generic, etc.

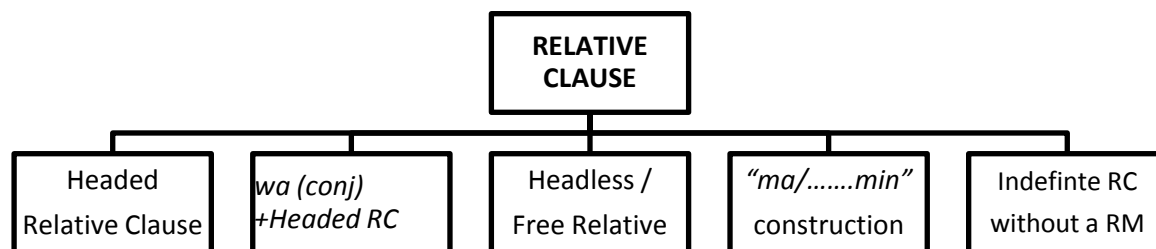


Figure 3: Types of Relative Clauses in Standard Arabic

4.9.3 Restrictiveness and Non-restrictiveness¹

In Gensler’s study of the distribution of relative clauses in the Quran, it was found that restrictive relative clauses are not the dominant type of relative clause in the Arabic Quran text which will be supported in the corpus data reported in Chapter 5, §5.2.

Gensler’s analysis indicates that relative clauses with non-restrictive semantics strongly outnumber those with restrictive semantics in the Quran. 66% of relative clauses are non-restrictive while 35% of headed relatives in the Quran are restrictive. There are few clear-cut instances of restrictive semantics notes Gensler. By contrast, non-restrictive relative clauses are very common in the Quranic text.

¹ It is well known that English restrictive relative clauses differ from nonrestrictive relative clauses in phonology, orthography, semantics and syntax (Jackendoff 1977, Huddleston 1984, McCawley 1988, among others). See, for instance, the contrast between examples (1a) and (1b) from Lyons (1977:760).

(1) a. The soldiers who were brave ran forward.
b. The soldiers, who were brave, ran forward.

As a result of these findings, Gensler points towards rethinking the importance given to restrictive relatives in the literature. He notes that “restrictive relatives have been given conceptual priority in typological approaches to relative clauses but no argument seems to have been given to ground this assumption” (Gensler, 2004:7). Gensler argues that studies are in need of a functional (semantic, cognitive) definition of the relative clause that might shed more light on the (non)restrictive phenomena.

In principle, the same issue may arise for any nominal modifier: Adjective, Genitive, and Relative Clause. Any of these can be restrictive or nonrestrictive. But for adjectives and genitives, Gensler notes that restrictiveness is not generally considered as a major parameter, let alone as a definitional one. In the semantics literature, any nominal modifier may serve at least two major functions: to restrict reference of head noun (extensional narrowing) or to enrich semantics of head noun (intentional expansion) (see Lehmann, 1984: 188-195)

Gensler (2004) poses a number of important questions and proposes a working agenda to make the (non) restrictive observation into an empirical question: On the formal side: how many languages are there in which “restrictiveness” is an important formal parameter of the grammar? On the semantics side: in various languages, in various corpora, how often are relative clauses actually used to restrict reference?

In Gensler’s Quran corpus of relative clauses with the relative marker *allathii*, the vast majority are headless. Of headed relative clauses with the relative marker *allathii*, a strong majority are non-restrictive in semantics. Gensler concludes that relative clauses in the Quran are not used predominantly to restrict reference.

But from the point of view of prosody, which is the relevant question in this dissertation, what matters is whether different discourse-semantic functions of relative clauses trigger different patterns of prosodic phrasing. The implication of this idea for the notion of default prosodic phrasing is also a relevant research question. Is there a default discourse function in a particular language for relative clauses? Is restrictiveness or non-restrictiveness the default in a given language?

It is often stated that restrictive and non-restrictive relative clauses in English have different prosodic structures. Experimental evidence is presented by Watson and Gibson (2004):

Table 3: Data from Watson and Gibson (2004) showing mean percentage of pre-relative clause intonational boundaries

	Subject modifier	Object modifier
Restrictive interpretation	10.0%	38.6%
Nonrestrictive interpretation	27.7%	49.1%

Watson & Gibson suggest that discourse structure affects intonational phrase placement. In their data, “relative clauses with non-restrictive readings and relative clauses that modified a direct object were more likely to be preceded by an intonational boundary than relative clauses with restrictive interpretations and relative clauses that modified a subject” (2004:47). These data suggest that speakers utilize intonational boundaries to disambiguate types of relative clauses.

If there is variation across languages with regards to the discourse function of relative clauses, this would have inherent implications for the default prosodic phrasing

patterns of sentences with relative clauses. This is an area of study that would be very useful for future research.

4.9.4. Relative Clauses in Arabic and the Length Factor

In Standard Arabic, a relative clause cannot be shorter than two prosodic words. The shortest relative pronoun (ʔal.**la**.thi) is more than two syllables with one stressed syllable (shown here in bold font). The longest is (ʔal.la.**thii**.na). Furthermore every predicate (in the relative clause) has at least one stressed syllable. Therefore it follows that every RC must have at minimum two prosodic words / accentual phrases. An example of a short relative is shown in (44):

(53)

shaahad-tu r-ragul ʔalathi rabih
watched-I the- man who won
“I watched the man who won”

Therefore, it may be necessary in an Arabic study of length effects on RC attachment preferences in reading to depart from the criteria¹ that have been applied in other languages that differentiate long from short RC.

Adjectives, on the other hand, offer a better example of short post nominal modifiers in Arabic. Adjectives, like relative clauses can also be ambiguous with respect to attachment in the context of a complex NP as shown in example (45):

¹ Usual criteria used in previous experimental designs are: 1PW= Short, 2+PW= Long because (in the languages under investigation) 2PW was believed to be the minimum size for a free-standing prosodic phrase.

- (54)
- | | | |
|---|---------|----------|
| sadiiq | alwald | alfaqir |
| friend | the boy | the poor |
| “the friend of the poor boy” or “the boy’s poor friend” | | |

In example (54), “*alfaqir*” (the poor) can either modify N1 “*sadiiq*” (friend) or N2 “*alwalad*” (the boy). Experimental data showing a tendency for readers to attach the adjective low to “*alwalad*” (the boy) will be presented in the following chapters.

4.10 Other Post-Nominal Modifiers in Arabic

Like the relative clause, other post-nominal modifiers are also ambiguous in a complex NP context. First we will look at adjectives in more detail.

4.10.1 Adjectival Modifiers

Adjectival modification in Arabic is illustrated in example (55) below:

- (55)
- | | |
|-----------------------|---------------------|
| alwald-u | al-zaki-u |
| the boy-nom | the intelligent-nom |
| “the intelligent boy” | |

Arabic adjectives occur in post-nominal position¹. They agree in definiteness, case, number and gender with the head noun they modify. Fehri (1999) studying the distributional properties of adjectival modification in Arabic employs a distinction between *attributive*

¹ Fehri (1999) gives a detailed analysis of how post-nominal adjective ordering in Arabic observes a mirror image ordering of that found in pre-nominal A-N languages.

adjectives and *predicative* adjectives¹. Different ordering restrictions of adjectives are associated with different interpretations (an attributive restrictive reading vs. a predicative non-restrictive reading).

The distributional distinction between the two classes that Fassi-Fehri presents is a distinction regarding the placement of these two types of adjectival modifiers with respect to the complement of the head noun they are modifying: “attributes must be placed before that complement, whereas predicatives occur after it.” (Fassi-Fehri, 1999:67). The N–complement construction used by Fassi-Fehri to illustrate this is the analytic genitive N1 *li* N2 with an adjective after N1 or after N2. In 56(a), the complement of the noun “*ʔalmudiir*” is “*l-maktabi*” and the adjective is “*s-saabiḡ*”. Note that the adjective is understood to modify N1. The attributive adjective must precede the complement. The example in 56(b) in which the adjective “*s-saabiḡ*” is after the complement “*l-maktabi*” is unacceptable:

(56) From [Fassi-Fehri, 1999]:

- a. al-mudiir-u s-saabiḡ-u li-l-maktab-i
the-director-nom the-former-nom of-the-office-gen
‘The former director of the office’

- b. *al-mudiir-u li-l-maktab-i s-saabiḡ-u
the-director of-the-office-gen the-former-nom
‘The former director of the office..’

¹ Fehri (1999) notes that the attributive vs. predicative distinction of adjectives is one that is classical in the literature (eg. Bolinger 1967, Hawkins 1983). Fehri also refers to other equivalent terms used in the literature such as direct vs. indirect and restrictive vs. non-restrictive.

Predicative adjectives must follow the complement as shown in the following examples in (57) from Fassi-Fehri (1999):

(57)

- a. muhaarabat-u l-hukuumat-i l-muntatharat-u li-l-irtshaa?-i
 fighting-nom the-government-gen the expected-nom of-the-corruption
 “The expected fighting of the corruption by the government”
- b. muhaarabat-u l-hukuumat-i li-irtishaa?-i l- muntatharat-u
 fighting-nom the-government-gen of-the-corruption-gen the-expected-nom
 “The fighting of the corruption by the government, which is expected.

In (57a), the adjective ‘*l-muntatharat-u*’ has only an attributive reading, while in (57b) it has only a predicative reading. Fassi-Fehri describes the interpretation of (57b) as being close to that of a reduced non-restrictive relative clause. Note that (57) contains both a possessor (the government) which is a CS and a complement (the corruption) which is a FS.

In analytic possessive constructions as illustrated by Fassi-Fehri, attributive adjectives must precede both the possessor and the complement, whereas predicative adjectives follow them both. The following are examples of other post-modification of nouns in Arabic.

4.11 Correlates of Boundary Strength in Arabic

4.11.1 Strength of Prosodic Boundary

Any two adjacent words may vary in the degree of their prosodic cohesiveness¹. Juncture² is a term used to denote the transition or temporal spacing between speech sounds or between a speech sound and silence³. Beckman and Pierrehumbert (1986) associate juncture with intonational phrasing. They identify juncture as being cued in part by intonation contour⁴. Values of perceived boundary strength at the juncture between any two words are expressed by the *break indices* within a proposed transcription system for boundaries and prosodic groupings. A break index is a number indicating the perceived degree of boundary strength. In its simplest form there can be two types of juncture: with and without a break. The Tone and Break Indices (ToBI) scheme of Beckman & Ayers (1997) (see also Hirschberg & Pierrehumbert (1986), Grosz & Hirschberg (1990) and Terken & Hirschberg (1994)) defines 5 types of juncture: all junctures are assigned an index on a scale from 0-4.

ToBi has been used as a transcription system to describe the prosodic system of various languages; primarily devised for American English and then applied to German, Korean and Japanese (see Jun (2005) for a typology of the prosody of more than 20

¹ Grosjean, Grosjean and Lane (1979) discuss considerable evidence which shows that speakers organize their speech with reference to such an internal concept of cohesion between different segments of an utterance.

² The use of this term in the literature is confusing since it is sometimes used to mean a “pause” (i.e., *maximum* temporal spacing).

³ Prince et al. (1991) have discussed earlier phonetic work on the relationship between juncture and syntax, as well as discourse level effects on duration and pitch range (Lehiste 1960; O’Malley, Klokner and Dara-Abrams 1973; Cooper 1976; Nakatani, O’Conner and Aston 1981; Gee and Grosjean, 1983), also (Selkirk 1978; Nespor and Vogel 1986).

⁴ Zellner (1994, 2000) has criticized this approach which she argues has reduced prosodic modeling to the description of accentual and tonal phenomena while temporal issues such as pausing have not been exhaustively examined. Furthermore, Zellner’s observations in French are in contradiction to the presumed priority of accentual structures. Zellner (1996) found that occurrences of pauses and syllable lengthening in French were often inadequately predicted by such accounts. “There exists no valid theoretical argument” insists Zellner “that motivates the entire derivation of temporal structures from accentual structures in languages such as French.”

languages using the ToBi system). ToBi mainly uses hierarchical prosodic structure and patterns of prominence to annotate the intonation of a language. Jun (2005) describes the various phonological aspects used in this transcription as being realized by “suprasegmental features such as pitch, duration, and/or amplitude as well as segmental properties of consonants and vowels.” (Jun 2005, p.431).

There is no Arabic ToBi transcription that has been devised as Arabic prosody has received little investigation using recent empirical analytical tools. In the following section, however, I will present a break index scheme for Arabic which is cued mainly by post-lexical segmental phonological processes at word edges. In future studies it would be of considerable interest to correlate these segmental properties with the intonational properties of the language to reach a detailed annotational description of Arabic prosody.

4.11.2 Pausal “*waqf*”, Post-Pausal “*ibtidaa?*” and Linking “*wasl*” Rules

A salient feature of the phonology of Arabic is post-lexical re-syllabification across word boundaries (see discussion in § 4.4.7). In Arabic, the beginning and/or the end of a word may differ according to whether or not they are in immediate contact with an adjacent word. A word that is sentence-final or is followed by a pause is said to be in *pre-pausal* position; one that is sentence-initial or is preceded by a pause is said to be in *post-pausal* position; while a word that follows a word in continuous speech is said to be in *contextual/continuum* position.

Within the literature of Arabic grammar, the contextual form is called “*wasl*” (connection or linking). The pre-pausal form is called “*waqf*” (stopping or breaking), and a post-pausal form is

called “*Ibtidaa?*” (beginning). It is suggested in this dissertation that these forms are morphophonological indications or correlates of prosodic phrasing in Arabic. These phonological processes act as phrase-level prosodic boundary cues.

Pausal forms in Arabic are constrained by phonotactic rules. As mentioned in §4.4, it is not possible to pause after an open syllable i.e., a vowel; a phonological phrase has to end with a closed syllable (a consonant). For example morphophonological processes that involve case, tense, mood and indefinite feature markings are blocked at phrase boundaries or pause positions, since the relevant suffixes end in a vowel (see §4.4). The following section is a description of these different forms in more detail.

4.11.3 Pausal Forms

4.11.3.1 Final vowel deletion and *Sukuun*

The final short vowel which marks case, tense or mood (/u/, /i/, and /a/) is omitted in pausal form as shown for the word *ʔal-kitaab* in example (58b):

(58)

a-	qaraʔtu ʔal-kitaab-a l-gadiid read-I the-book-ACC the-new “I read the new book”	[contextual form]
b-	qaraʔ-tu ʔal-kitaab read - I the-book “I read the book,”	[pausal form]

In 58(a) the vowel /a/ which is the accusative marker cliticized to the word *ʔal-kitaab* is omitted in 58(b) as it is in pausal position. Here, a *sukuun* (-V) is associated with the final

consonant in pausal position (see § 4.4.2) and is a cue that indicates a prosodic phrase boundary.

4.11.3.2 Taa Marbuuta *H*-Form

The change from the contextual *t*-form in the word *ʔal-madrasat-a* “the school” in 59(a) to the pausal *h*-form *ʔal-madrasah* in 59(b) is a process that happens at a prosodic phrase boundary:

- (59)
- | | | |
|----|---|-------------------|
| a. | dakhala-t Zeinab ʔal-madrasat-a ʔal-gadeedah | [contextual form] |
| | entered-she Zeinab the-school-ACC the-new | |
| | “Zeinab entered the new school” | |
| b. | dakhala-t Zeinab ʔal-madrasah | [pausal form] |
| | entered-she Zeinab the-school | |
| | “Zeinab entered the school” | |

4.11.3.3 Deletion of Tanwiin

When the indefinite word *khitaab* “a letter” is in pausal position, both the short vowel marking case and the indefinite tanwiin marking /n/ are omitted as shown in 60(b).

(60)

a.	katab-tu khitaab- a- n yawm ul-khamiis.	[contextual form]
	wrote-I letter- ACC-INDEF day Thursday	
	“I wrote a letter on Thursday”	
b.	katab-tu khitaab	[pausal form]
	wrote- I letter	
	“I wrote a letter.”	

4.11.4 Contextual forms

4.11.4.1 The t-consonant liaison

Liaison is an example of an external sandhi phenomenon: a phonological process occurring across word boundaries (see §4.). It is a form of paragoge (see §4.4.9.3): the addition of a sound to the end of a word. In French for example the /s/ in the word *les* (the) is generally silent, but it is pronounced /z/ in *les amis* (the friends). Liaison is normally produced with enchainement. However, liaison without enchainement is also found. Enchainement is the phenomenon whereby a word-final consonant sound is realized as the onset of the following syllable. Enchainement is also a sandhi phenomenon, occurring in many languages, by which words in the speech chain are linked with one another into larger constituents. As Encrevé (1988:24) notes, *enchainement* is a general phonetic phenomenon whose interest relies on the fact that it related to a central point in prosodic theories, namely, the syllabification of the speech chain. In the process of *enchainement*, word final coda consonants are said to be resyllabified with following word initial vowels. An example of liaison in Arabic is the t-consonant liaison.

In Arabic, the suffix of the feminine singular noun is called *taaʔ marbuutah*. In Arabic script *taaʔ marbuutah* is written with the basic letter [ه] which is the Arabic grapheme for the sound /h/ but with the two dots belonging to the letter [ت] /t/ added to the /h/. This gives the following grapheme [هت]. It is written like this whether it is in the contextual form /t/ or the pausal form consisting of just /h/. This compound grapheme H/T is called “taaʔ marbutah”. The ordinary /t/ is called “taaʔ tawiilah”.

4.11.4.2 T-consonant Liaison with enchainement

In pausal form, *taaʔ marbuuta* (t-consonant liaison) in conjunction with its case endings is not pronounced, and this eliminates a syllable from the word and stress shift occurs as shown in table 3:

Table 5: Examples of Contextual and Pausal forms in SA

	Contextual	Pausal
university	jaamiʕat-un	jaamiʕah
school	madrasat-un	madrasah
lecture	muhaadarat-un	muhaadarah

The shift in stress occurs because when the *taa marbuuta* and the case endings are deleted, the third syllable from the end becomes the second syllable from the end, and because it is weak (CV), it cannot receive the stress, so the stress shifts back to the previous syllable.¹ An example of t-consonant liaison with enchainement is illustrated in (61):

(61)

- a. xa:dimat almumathilah ʔallati...
servant the actress who...
- b. xa:dimat almumathilatillati...
servant the actress who

¹ There are cases however when the deletion of *taa marbuuta* and case endings does not alter the stress pattern because the syllable that originally has the stress is a strong syllable: madiinat-un - madiinah “city”.

In 61(a), N2 *almumathilah* “the actress” has the pausal form “h”, not the contextual form “t”, and the definite article which begins the following relative marker retains its glottal stop consonant. The use of the pausal form indicates a break between N2 and the relative marker. In 61(b), N2 has the contextual form “t” which forms a liaison with the relative marker (no break) causing a deletion of the glottal stop and an assimilation of the definite article of the relative marker.

4.11.4.3 T-consonant liaison without enchainement

There are cases in SA where liaison is present without enchainement. This is observed in indefinite nouns in the construct state. The example in 62(b) is an illustration of this (cf. (61) above). The construct state in 62(a) below in which N1 is indefinite with an *n-tanwiin* marker is judged as ungrammatical. This ungrammaticality could have two independent reasons. The first is a syntactic reason where N1 which is in a construct state cannot carry (in)definiteness features i.e., it cannot carry (in)def marking (see §4.6.2.1 for details on definiteness spread in the CS). The second reason could be evidence for tanwiin having a break 3 index as will be discussed in §4.9.5. Recall that the n-tanwiin marker is a contextual form not a pausal form, however the /n/ is a consonant and a consonant in coda positions of syllables define the syllable as “closed”. The absence of a vowel after the /n/ creates one level of boundary that is not compatible with the prosodic requirements of the construct state construction (which requires a break index of 0 between N1 and N2). In 62(c), however, when an adjective follows the noun *khaadimatan*, the phrase is grammatical.

In (62b) the n-tanwiin marker is deleted and only the t-liaison + vowel case marker is retained. Note however that there is no re-syllabification of the t-liaison and vowel with the initial consonant of N2. This kind of liaison without enchainement has been observed in French (Encrevé, 1988) and here in SA in examples like 62(b):

(62)

a- *khaadimat-u-n mumathilat-i-n mashhuurah
 servant-NOM-INDEF. actress-GEN-INDEF. famous
 “a servant of a famous actress”

b- khaadimat-u mumathilat-i-n mashhuurah (liaison without
 enchainement)
 servant-NOM actress-GEN-INDEF famous
 “a servant of a famous actress”

c- khaadimat-u-n miskiinah
 servant-NOM-INDEF poor
 “a poor servant”

4.11.4.3 Tanwiin (nunation)

The definite article is visible in Arabic script whereas the indefinite marker normally is not. Indefiniteness is not marked with a separate word in Arabic. It is marked with a suffix /n/ sound that comes at the end of a word. Orthographically, this suffixed /n/ sound is not written by using the Arabic letter for /n/. It is indicated, however, in vowelized text, by writing the final inflectional vowel diacritic on a word twice. This is called “tanwiin” or “nunation”. Nunation is not pronounced in pausal form as shown in the word *kitaab* “book” in the following example:

(63)

- a. qaraʔ-tu kitaab [pausal form]
 read -I book
 “I read a book”
- b. qaraʔ-tu kitaab-a-n gadeed-a-n [contextual form]
 read-I book-ACC-INDEF. new-ACC-INDEF.
 “I read a new book”

Evidence that tanwiin indicates a distinct boundary index which is weaker than the *t*-consonant liaison is that tanwiin cannot be used on N1 in construct state as illustrated in (64) as this position necessitates a certain degree of strong prosodic merge as defined by a 0 break index.

4.11.4.4 Deglottalization or Deletion of “*Hamzatul-wasl*”

The constraint on consonant clusters at syllable onsets requires that no form may begin with a cluster of two or more consonants. These conditions are met when a cluster that would otherwise be initial is preceded in certain grammatical forms and a few individual words by *hamzah* “glottal stop” + vowel e.g. ʔVCC. This *hamzah* is known as *hamzat-ulwasl* “the glottal stop linker”. An example of this is shown in (64):

(64)

bti.daaʔ ʔib.ti.daaʔ “beginning”

Hamzat-ulwasl is omitted, together with the following vowel, when it comes after a word ending in a vowel: $C_1V_1+C_2V_2C_3$ becomes $C_1V_1C_3$ (where C_2 is *hamzatul-wasl* and V_2 is called the “prop” vowel). This is illustrated in the following examples (65):

(65)

- a. ζ inda **ʔ**ibtidaaʔ “during the beginning”
 $d a \text{ } ʔ \text{ } i \text{ } b$
 $C_1V_1+C_2V_2C_3$
- b. ζ ind**ab**tidaaʔ
 $d a b$
 $C_1V_1C_3$
- c. qaraʔ**tu** ʔalkitaab “I read the book”
qaraʔ**tul**kitaab
- (d) ʔalkitaabu ʔalathii “the book which”
ʔalkitaab**ul**athii

In reading, Arabic rhythm shows the running of the final vowel of the preceding word on to the consonant following the deleted *hamzah* + vowel. Any consonant-ending word preceding *hamzatul-wasl* is given a final vowel in order to break the consonant sequence from the deletion of *hamzah* + vowel. So *hamzatul-wasl* and the following vowel are omitted when not in post-pausal position. The most important categories containing *wasl* are the article and the relative marker and all its related forms which contain the relative definite article. Glottalization or the insertion of *hamzatu-wasl* can be considered as a strengthening edge effect as discussed in Chapter 2, § 2. whereas deglottalization or the deletion of *hamzatul-wasl* can be considered as a weakening of word edges and a correlate of cohesive juncture.

The following is a summary of the syntactic contexts where a tight prosodic merger across word boundaries is obligatory. A boundary is not permitted in the following contexts:

- Construct State Genitive Construction (N1 N2) kitaab-u l-walad “the boy’s book”
- Finite Verb + pronoun raʔaytu-hu saw-1p.s.-him “I saw him.”
- Nouns or prepositions followed with a pronominal suffix:
 kitaab-u-hu book-nom-his “his book”
 il-layhum “to them”
- Particles + finite verbs li-yasharab “to drink”

4.12 Break Indices for Boundary Strength in Arabic

The following are proposed break indices for degrees of boundary strength in SA correlated with the respective phonological processe(s) discussed above:

- BI 0** = highest degree of close cohesion between two words: liaison with enchainement and deglottalization
- BI 1**= Liaison without enchainement
- BI2** = Short vowel at word ending without enchainement
- BI 3**= Tanwiin (cannot undergo enchainement)
- BI 4**= Short vowel deletion, Sukuun, deletion of Tanwiin, *h*-form.

The following is a summary of the segmental phonological cues of boundary juncture in SA as described in § 4.11.

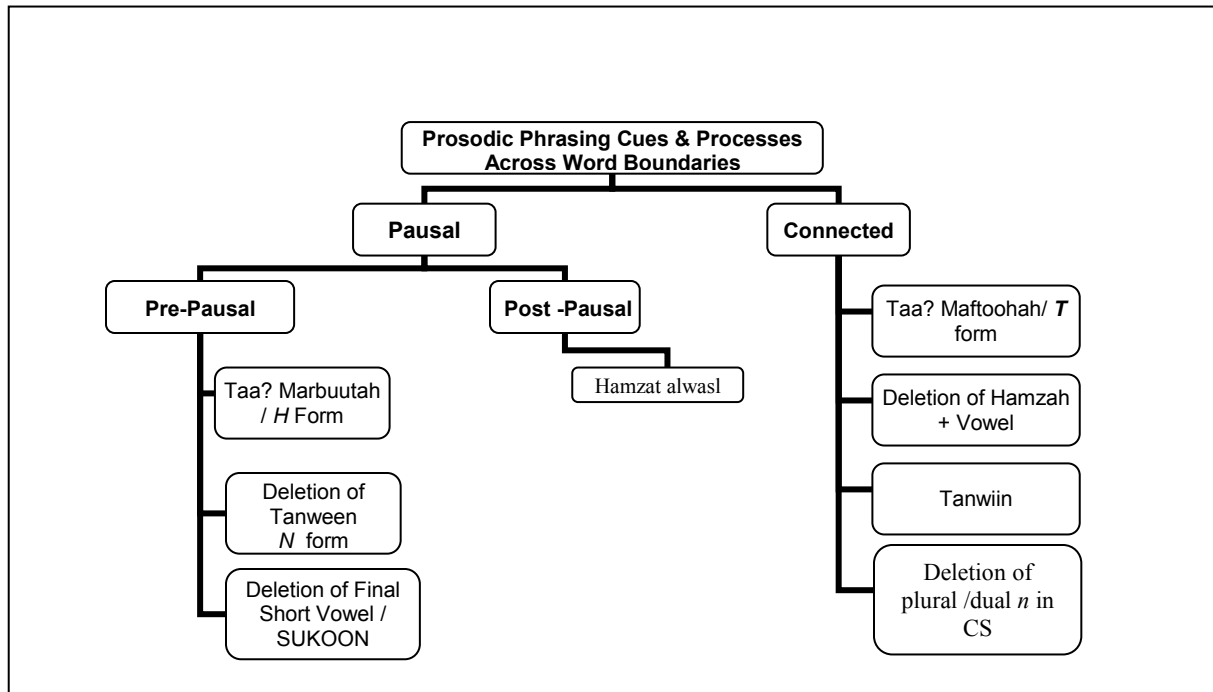


Figure 4: Overview of prosodic phrasing cues in Arabic

Most languages studied in the psycholinguistics literature to date have not been shown to have such boundary sensitive phenomena. It is important to note here that the correlations proposed here for SA have not been studied in this light before in the literature. The following section will further discuss in detail these segmental correlations of boundary strength proposed above and their relation to prosodic phrasing.

4.12.1 The Sandhi¹ Phenomenon in Arabic

Sandhi is used to describe a morphophonological processes that occurs at word boundaries. It is characterized as “the fusion of sounds across word boundaries and the alteration of sounds due to neighboring sounds or due to the grammatical function of adjacent words” (Anderson, 1986). There are two types of sandhi: *internal sandhi* which is the alteration of sounds within words and *external sandhi* which refers to changes found at word boundaries. The process of ‘liaison’ in French, and ‘raddoppiamento fonosintattico’ in Italian are examples of external sandhi. Also for Arabic, Lipiński (2001) indicates that the assimilation of words under the influence of neighboring words uttered in consecutive speech is widely attested in Arabic.

Two processes of sandhi in Standard Arabic are demonstrated in this section. The first process is deglottalization, i.e., the deletion of a glottal stop with subsequent re-syllabification which includes assimilation and enchainement. The second process considered here is that of liaison with enchainement, that is, the use of the *t*-liaison consonant with subsequent enchainement. These two processes are examples of the deletion of edge boundary effects that were mentioned in §2. . These processes are also instances where the proposed break index 0 for Arabic boundary strength is present.

¹ “Sandhi” is a Sanskrit word used in modern linguistics to describe changes undergone by the form of a word under the influence of an adjacent word. External Sandhi refers to phonological alternations across a word boundary.

4.12.1.1 Edge Deglottalization and T-liaison

In the following examples, the word “*kitaab*” (book) and “*ʔal-shaaʕir*” (poet) are placed in the context of the CS followed by a relative clause modifier. In example (66), two prosodic phrasings with two different segmental characteristics are shown:

- (66) a. qaraʔ-tu kitaab-a ʕshshaaʕir ʔalathii kaana fi l-maʕrad
 read-I book-acc. the poet who/that¹ was in/at the exhibition
 “I read the book of the poet who/that was at the exhibition”
- b. qaraʔ-tu kitaab-a ʕshshaaʕir-i ʕlathii kaana fi l-maʕrad
 read-I book-acc. the poet -gen who was in/at the exhibition
 “I read the book of the poet who/that was at the exhibition”

The form *kitaab-a* “book” in 66 (a) is a contextual form in which the short vowel “a” is the accusative marker which assimilates with the glottal stop “ʔ” of the definite article in “ʔal-shaaʕir”² (“the poet”). So after resyllabification and enchainement, the whole phonological phrase becomes “*kitaabashshaaʕir*” as shown in (67).

- (67)  ktaab ʔlshaaʕir. [Unvowelized orthography]
-   ki.taa.**bash**.shaa.ʕir. [read or spoken]

¹ There is no animacy marking in Arabic i.e. the same relative marker is used for animate and inanimate nouns.

² See §4.7.2 for assimilation of definite article and gemination rule.

In example (66) above, the relative clause is ambiguous between the N1 and N2 attachment sites. There are two possible prosodic phrasings for sentence (66): (68a) and (68b)

- (68) a. qaraʔtu kitaabashshaaʕir # ʔallathii kaana filmarad
 read-I book-the-poet # who was in-the-exhibition
 “I read the book of the poet who/that was in the meeting.”
- b. qaraʔtu kitaabashshaaʕirillathii kaana fiannadwah
 read-I book-the-poet- who was in-the-meeting
 “I read the book of the poet who/that was in the meeting.”

In (68a), there is an edge strengthening of the initial segment of the relative marker as well as the devowelling (deletion of the short vowel “i” of the genitive marker) of the final edge segment on N2 “*shaaʕir*”, which is a correlate for break index 4 as proposed in §4.8. These edge strengthening processes are described here as being weakened or deleted in (68b), where there is assimilation and resyllabification, which are correlated with break index 0 (see § 4.8).

4.13 Obligatory and Optional consonant liaison

There are two kinds of liaison domains in Arabic:

Obligatory Domain:

The construct state construction in Arabic is the domain of obligatory liaison. Therefore it is obligatory to pronounce a construct state construction containing a feminine noun with a [t] liaison reading in Arabic as in (69a):

- (69) a. tabiibatalamiirah
 physician the princess

The following, where there is no liaison [t], is ungrammatical:

- b. * tabiibah ʔal-ʔamiirah
 physician the princess

Optional Domain

In syntactic contexts other than the construct state construction (such as a single noun + modifier construction), the absence of the [t] will not make the construction unacceptable. So the absence of [t] liaison between the noun and modifier in example (70a) is acceptable.

(70)

- a- qaabal-tu lmumathilah ʔalati kaanat fi l-film [without liaison]
 met -I the actress who was in the-film
 “I met the actress who was in the film.”
- b- qaabal-tu lmumathilatulati kaanat fi l-film [with liaison]
 met-I the actress who was in the-film
 “I met the actress who was in the film.”

Optional liaison is subject to a wide variety of stylistic factors. A given speaker might show different frequencies of optional liaison in different registers, with distinct tendencies for liaison for particular words, or particular constructions. This is an area that

has not been given any attention in the literature on Arabic and would be new ground to investigate in future studies.

4.14 Conclusion

This chapter has served multiple aims. It has delineated relevant properties of the language that is under investigation in the subsequent experimental chapters. Issues pertaining to the orthographic system and the syllabic structure of Standard Arabic were given a detailed analysis. The syntactic/semantic phenomena of modification, possession, relativization and definiteness in Arabic were discussed as these are all relevant to the construction type of interest. The chapter then proceeded to outline the distinctive features of pausal and contextual forms in Arabic which will be integral diagnostic tools in the experimental section of this dissertation.

CHAPTER 5

MODIFIER ATTACHMENT TENDENCIES IN CORPUS DATA

5.1 Introduction

The aim of this chapter is to look within real language corpora (written text and spoken newscasts¹) at patterns of prosodic phrasing of sentences that include the target construction, and the attachment choices that accompany them. The aim is to gather evidence of possible usage constraints that may be responsible for phrasing regularities in the language, and which may shed light on the patterns found in the experimental data reported in Chapter 6. The present chapter includes the analysis of three sources of data from three genres of corpora:

- The Quranic Text and Overt Quranic Recitation Data.
- Television News Broadcasting from *Al-Jazeera* Television News.
- Broadcasting from *Al-Bernaamag Al-aam* Egyptian Radio Station.

¹ Radio and TV news broadcasts are one of the few non-religious arenas where we find an oral variety of SA *fushah* (see chapter 4), more specifically a variety of SA *fushah* which is read from a written text.

5.2 Quran Corpus Data

5.2.1 Nature of the text

The Quran is the most widely read text by speakers of Arabic. The Quran is written in Classical Arabic¹ and is divided into thirty equal parts with approximately 100,000 words in total. One part takes approximately twenty four reading minutes, and the whole Book requires approximately twelve reading hours.

The Quranic text is a fully vowelized text with all vowel diacritics present, as well as reading rule diacritics which convey information such as where to pause, what kind of pause to make and where to assimilate, etc. (for a detailed description of these *tajweed* rules or Quranic recitation rules see Czerepinski (2006)).²

5.2.2 Method of data collection

A search engine in the *Holy Quran* Version 6.3 software was used to search for the occurrence of the relative marker (individual searches were done for each type of relative marker: masculine singular, feminine singular, masculine plural, feminine plural, and dual in the whole of the Quranic text). 1137 tokens of the relative marker were extracted from the search. For each token that was found a documented file description was created of the type of noun phrase that the relative clause modified. This description included the length of the relative clause (in PWds), the structure of the sentence, the type and number of nouns in the NP as well as the attachment height if applicable. The

¹ Classical and Standard Arabic differ in stylistic and lexical structure whereas the syntactic and morphological structure is basically the same (see Chapter 4, §4.2.1 for a discussion).

² Also see <http://quran.aislam.com/Ahkam/Tree.asp?ID=1&t=TreeSub&l=eng&RecNo=2> for a more detailed description of tajweed rules.

description also included marking the occurrence of a boundary on perceiving a pause in the recitation (the software included an audio recitation) as well as on the basis of explicit diacritic marking of a break in the orthography.

5.2.3 Findings

Only 3% (30 out of 1137) of the relative clauses found in the Quran occurred within a complex NP (N1 N2). Among the remaining items containing a relative marker, 62% (711 out of 1137) were headless relatives and 35% (396 out of 1137) were headed by a single noun. For complex NPs containing an RC, there was a 17% (5 out of 30) tendency to place a break before the RC, while for sentences with a single noun + RC there was a 10% (41 out of 396) tendency to break before the RC. Figure 5 and 6 below show a summary of the findings of the corpus search.

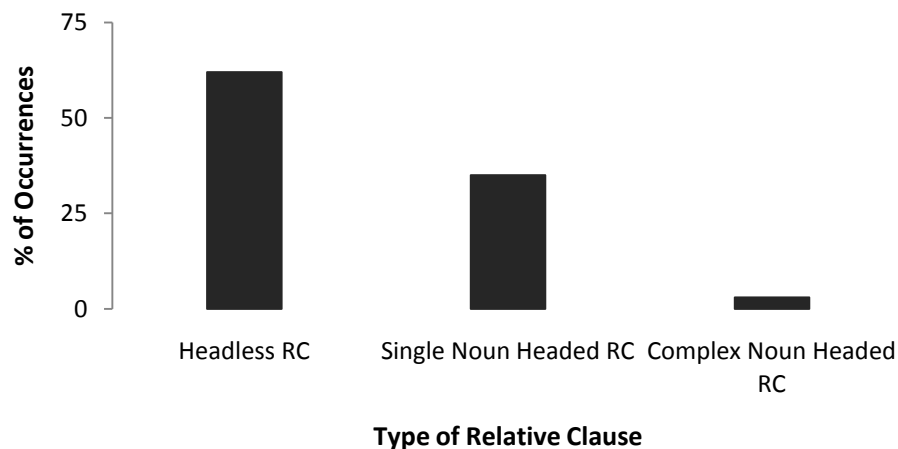


Figure 5: Mean percentage of relative clause occurrence in the Quran text in relation to type of RC. Figure shows a low occurrence of the RC modified complex NP. It is important to note here that statistics is inappropriate for this small number of items

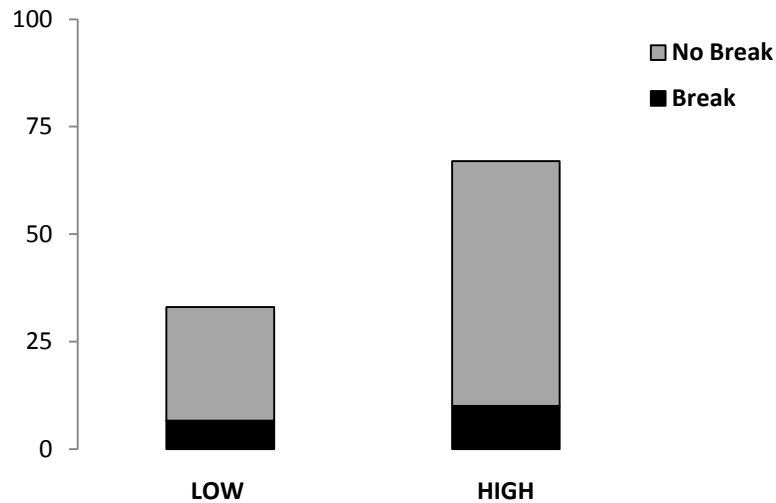


Figure 6: Quranic text search findings for mean percentage of RC low and high attachments.
Figure also shows proportion of pre-RC breaks and no breaks within each attachment.

Figure 6 shows that, for a complex NP containing an RC, the Quran shows a preference for high attachment of the RC, despite the fact that there is a low percentage of breaks in the corpus. Although the number of items in this corpus is considered insufficient to draw significant results, it could be suggested that semantic and discourse factors, which might have overridden prosodic phrasing, were in play for attachment preferences.

Although the construct state is very common in Standard Arabic, a complex NP which includes a construct state followed by a modifier is however not common in this kind of text which is a widely conventional authority for speakers of Arabic. In order to

further explore the occurrence of the target construction in other corpora, a set of two news data, reported in the next sections, were analyzed.

5.3 Al-Jazeera TV News

This corpus was collected from Al-Jazeera TV, an Arabic language news channel. The news is read by different newsreaders, male and female. The total duration of the recordings was 420 minutes (7 hours) of news time, between November 2003 and February 2004.

5.3.1 Method of Data Collection

A Sony tape recorder and a video recorder were used to record the news reading, from a Panasonic television to an audio cassette as well as a VHS tape. A process of extraction then followed in which I listened to the tapes to identify the target construction *N1 N2 RC* in the recorded material and then extracted each such sentence into a sound file using a computer microphone and the Speech Analyzer 2.0 software. There were 58 such sentences in total. A file card was created for each sentence which documented the sound file number, recorder tracking number, newsreader codename, newsreader gender, speech type, sentence structure, sentence position, attachment height, RC length, and a written version of the sentence in Arabic and an English gloss. Each extracted sentence which included the target construction was then segmented and the perceived pauses were noted. The intended meanings of the sentences were disambiguated either by

syntactic feature agreement (gender or number) where possible, and elsewhere by compatibility with the semantic context.

Some sentences in the data included a complex set of mixed modifiers. Therefore the extracted sentences were divided into two sentence types:

Sentence Type 1 = these were sentences where the target NP was of the form N1 N2 RC.

E.g. ...mushkilat al-talawuth allatii baatat tuhadid almughtamaſ...
problem the pollution which has continued threatens the society...
“the problem of pollution which continues to threaten society...”

Sentence Type 2 = these were sentences where the target NP was of the form N1 N2 ADJ RC¹

E.g. ...diraasat al-tafaaſulaat al-kimyaaſiyah allatii tatahakam fi intishaar al-ŕuzuun fi al-gaw
...study the-reactions the-chemical which controls in spread the-ozone in the-air
“...the study of the chemical reactions which control the spread of ozone in the air.”

5.3.2 Findings

Of the data collected, generalizing over both sentence types, there was an overall 38% (22 out of 58) of disambiguated high attachment sentences. Of sentences of the type N1 N2 RC, 41% (16 out of 39) were high attaching; 87% (14 out of 16) of these high attaching items included a break after N2. Of the 59% (23 out of 39) of the low attaching sentences, 13% (3 out of 23) included a break after N2. In sentences of the type N1 N2 ADJ RC, 32% (6 out of

¹ Fassi-Fehri (1999) points out that there is a fixed ordering of modifier types: relatives clauses are all located after all simple adjectives and modifiers:

(i) al-kitaab-u s-sagiir-u llathii qara?-tu-hu
the-book-nom the-little-nom that read-it-I

An order in which the relative clause precedes modifiers is ill-formed:

(ii) *al-kitaab-u llathii qara?-tu-hu s-sagiir-u
the-book-nom that read-it-I the-little-nom

19) had a high attaching RC. Of these, 83% (had a break before the RC (i.e. after the adjective). Of the 68% of low attaching sentences, 62% included a break. Generalizing over the two sentence types there was an 86% boundary placement tendency before RC for the 38% high attachment sentences, and a 31% boundary placement tendency before RC for the 62% low attachment sentences. Fig.7 below displays these findings.

With regard to the length of the modifier and the modifier type, 98% of relative clauses in the data were long (4+ PWds) whereas 99% of the adjective phrases in the data were short (1 PWd). In sentences of type 2 there were no breaks before the adjective in all cases and 98% of adjectives attached low.

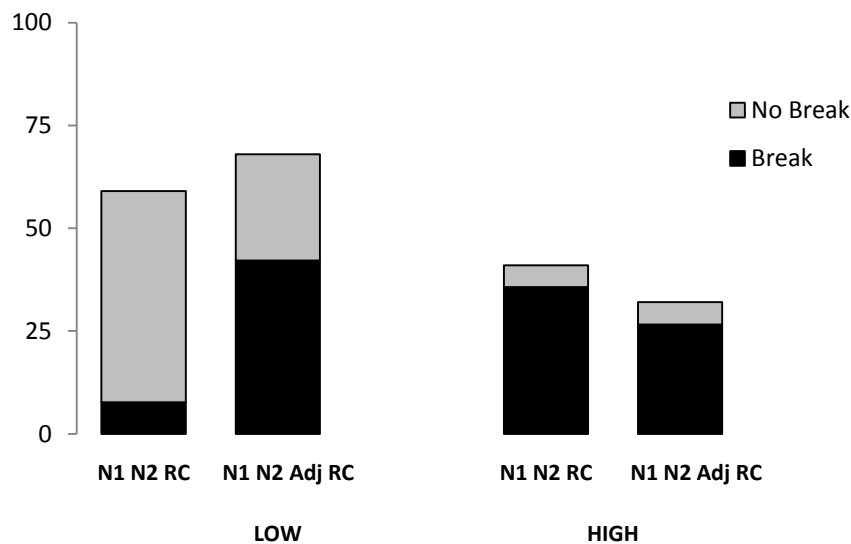


Figure 7: Mean percentage of low and high attachment in relation to type of complex NP. Figure also shows proportion of N2] Modifier boundary and lack of boundary for each height of attachment for each sentence type.

5.3.3 Discussion

There is a strong tendency in this corpus for low attachment of the RC to N2. Also there is a strong tendency not to break prosodically before the RC when attaching it low, whereas there is a tendency to break before the RC when attaching it high. In sentences of type 2 containing a pre-RC adjective, there was a clear tendency to break before the RC even when attaching low (62% break for low and 83% break for high). This could be explained as a length effect i.e., a prosodic explanation in line with Fodor's Same Size Sister (SSS) balance hypothesis. The adjective in type 2 sentences makes the NP longer than the NP in type 1 sentences. Therefore there is greater pressure to break up the NP into two prosodic phrases. This is achieved most naturally (with maximum balance) by phrasing (N1 N2 ADJ) in one phrase and the RC in another phrase. Alternatively, the pre-RC break in type 2 sentences could be due to a constraint on the number of modifiers per prosodic phrase i.e., one modifier per phrase is preferred to multiple modifiers in one prosodic phrase. Yet another explanation might be that the RC in type 2 sentences, coming after an already modified noun, is likely to be construed as a nonrestrictive RC, which in general is more likely to be preceded by a break (see §4.7.3 in Chapter 4 for discussion). An investigation of this is beyond the scope of this dissertation but is fertile ground for future research.

5.4. Egyptian Radio News Corpus

This corpus is part of Skogseth's (2000) M.A thesis on Egyptian radio Arabic. All his recordings were made between September and November 1998 in Central Cairo.

The news broadcasts are from the Egyptian Broadcast Association national radio station *al-Barnaamag al-Aamm*. The data Skogseth collected amounts to 6 hours and 52 minutes of recording time, with 161 pages of transcribed data in the appendix of his thesis. In the transcription, Skogseth marked perceived pauses with forward slashes: a short pause with a single slash; a longer pause with two and a very long break with three.

I conducted a manual search of the roman phonetic transcription of the Arabic news broadcasts documented by Skogseth, to extract all instances of the target construction of the present study. I extracted 258 occurrences of the relative marker in the corpus. The sentences were disambiguated either by gender or number markings, or by the semantic and pragmatic context. For each sentence, a note was made of the attachment height of the RC as well as the presence or absence of a break before the RC based on Skogseth's index of perceived pauses and verifying these perceived pauses and correlating them with the transcribed segmental data of word endings (vowels) as a cue of pause. Sentences were classified as follows:

Sentence Type 1 = sentences where the target NP was of the form N1 N2 RC (44 sentences)

Sentence Type 2 = sentences where the target NP was of the form N1 N2 ADJ RC (35 sentences)

Sentence Type 3 = sentences with a single noun modified by an RC (103 sentences)

Sentence Type 4 = sentences with a single noun modified by an ADJ RC (31 sentences)

Sentence Type 5 = sentences of the form N1 (N2) (ADJ) *wa* ("and") RC (45 sentences)

5.4.1 Findings

There was an overall high attachment frequency of 32% in the data for sentences type 1 and 2. Of these 32% high attachment sentences, 76% included a break before the RC. By contrast, of the 68% low attachment sentences, only 41% included a break before the RC. In type 1 sentences, there was a 34% tendency to attach high, 80% of which included a break after N2; of the 68% low attachment sentences, 24% included a break after N2. In type 2 sentences, there was a 29% high attachment tendency, of which 70% included a break before RC; of the 71% low attachment, 60% included a break before the RC. There was a 19% tendency to break before RC in type 3 (Single Noun RC) sentences. There was a 68% tendency to break before RC in type 2 sentences and a 100% tendency to break before RC in type 4 “*wa*” RC sentences.

Figure 10 and 11 below shows a summary of these findings.

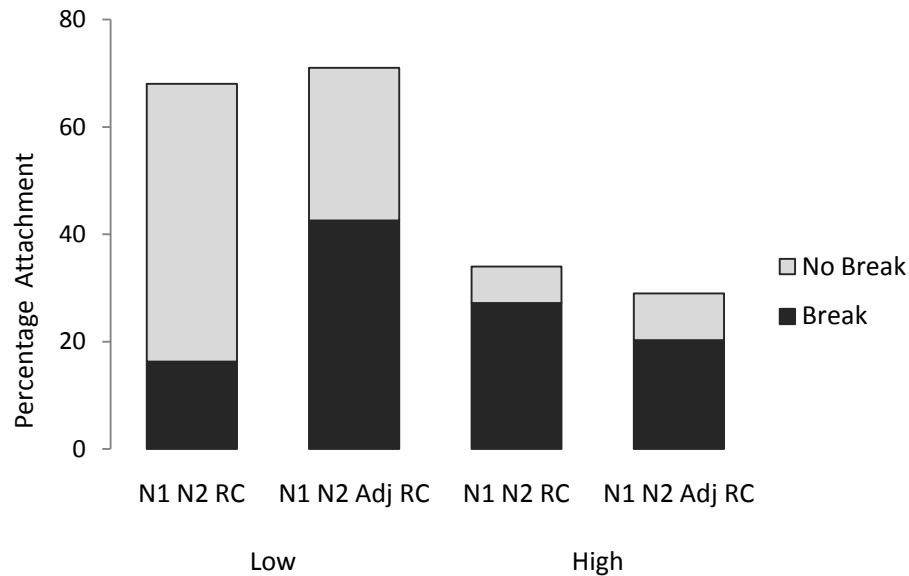


Figure 8: Mean percentage of low and high attachment of the relative clause (RC) in relation to type 1 and type 2 complex NPs. Figure also shows proportion of N2] Modifier boundary and lack of boundary for each height of attachment for each complex NP type.

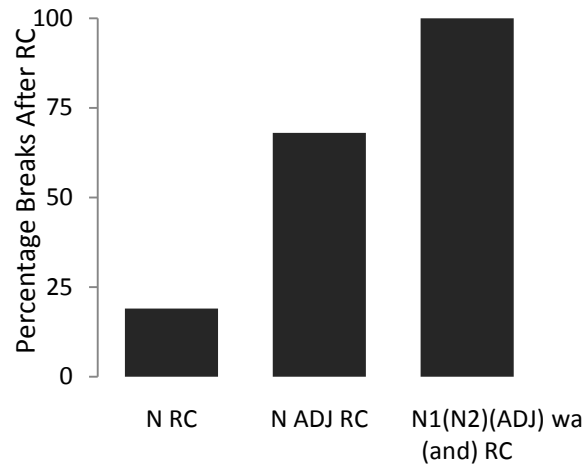


Figure 9: Mean percentage of breaks before the RC modifier in sentence type 3 (single N + RC), sentence type 4 (single N + ADJ + RC) and sentence type 5 (N1 (N2) ADJ *and* RC). Figure shows a low percentage of breaks before the RC after a single noun but a high percentage of breaks before the RC after nouns followed by an adjective or by an adjective followed by the *wa* (and) conjunction.

5.4.2 Discussion

Skogseth's (2000) news data are consistent with the Al-Jazeera data presented in § 5.3 above. In both sets of data, there are a greater number of low attachment sentences than high attachment sentences as shown in Figure10. Also in common is a high frequency of breaks before high attaching RCs. With regards to sentence type 2, both data sets show a tendency to break before an RC that follows an adjective, even when attaching the RC low as shown in Fig.11.

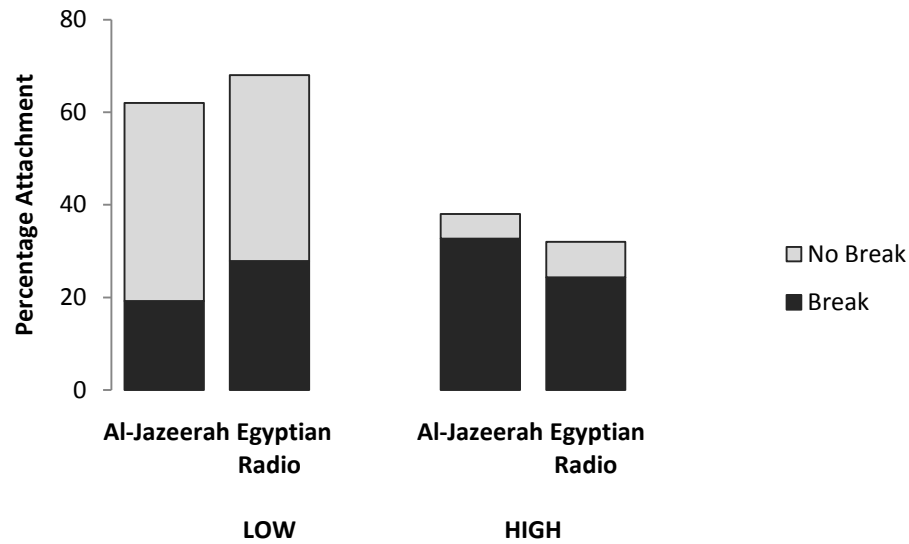


Figure 10: Mean percentage of low and high attachment of RC across both sets of news corpora. Figure also shows proportion of breaks and absence of breaks for each attachment.

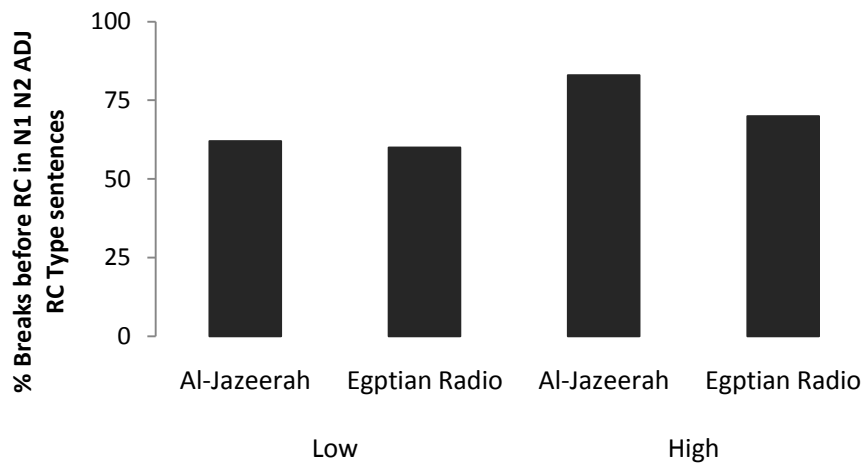


Figure 11: Mean percentage of breaks before RC modifier across two sets of news corpora for type 2 sentences. Figure shows a tendency to place a break before the RC when an adjective follows N2.

5.5 Corpus Comparison

When comparing the findings from all three sets of data as shown in Figure 12, there is an overall tendency to attach low rather than high as well as a tendency to place a break before the RC when attaching the RC modifier high in both news corpora. The Quran data shows little amount of breaks when attaching high: this however may be attributed to the lack of sufficient data found in the Quranic text to warrant such a comparison. Furthermore, there was also a tendency not to break when attaching the RC modifier low across all corpus data.

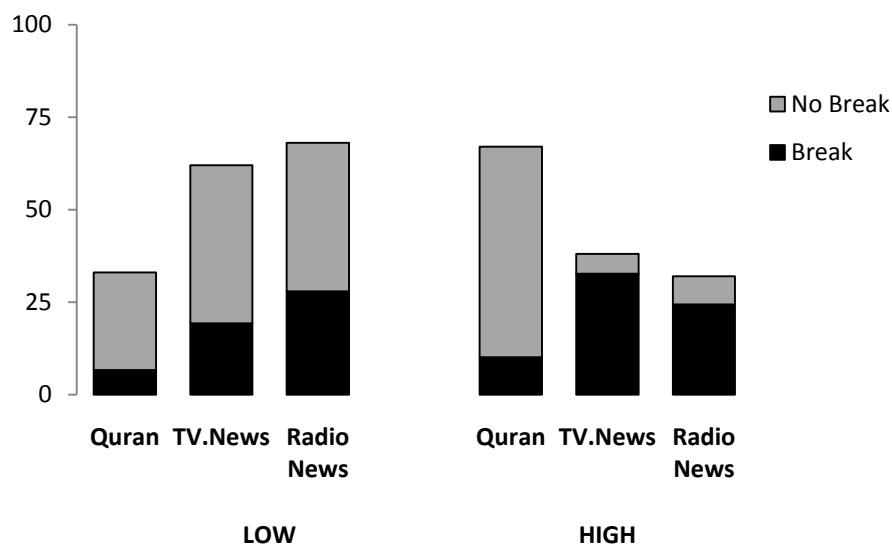


Figure 12: Mean percentage of low and high attachment across all three kinds of corpus data. Graph also shows proportion of breaks and absence of breaks for both low and high attachment.

5.6 Conclusion

The findings obtained from the data presented in this chapter point to a close correlation of modifier attachment height with certain tendencies of prosodic phrasings. The following patterns of phrasings in Standard Arabic emerge¹: a prosodic phrasing in which there is no boundary before the RC correlates more with low attachment of the modifier whereas a prosodic phrasing in which there is a boundary before the modifier correlates more with high attachment (with the exception of . These findings are in line with findings for other languages; see Chapter 2.

Having looked at the tendencies found in the different sources of corpus data, the next chapter will look at tendencies in a series of experimental studies designed to tap into the prosodic phrasing preferences of speakers of Standard Arabic in silent and overt reading.

¹ The general tendency to attach low in SA is more like English than like Spanish. This is of special interest because relatively few low-attaching languages have been identified; most languages studied to date favor high attachment. Since prosodic breaks tend to be associated with high attachment (Selkirk 2000), it is hypothesized that one shared property is a tendency toward long phrases, with relatively few prosodic breaks, as supported by the data in this study.

CHAPTER 6

MODIFIER ATTACHMENT PREFERENCES AND PROSODIC PHRASING PATTERNS IN ARABIC

Experimental Method, Materials and Design

6.1 Introduction

6.1.1 Overview

This chapter describes the goals, materials and design of two series of experiments. The first examined Arabic speakers' preference for the attachment of a modifier (relative clause, RC or adjective phrase, AP) in sentences containing a complex NP with two nouns. The second series examined Arabic speakers' prosodic phrasing preferences for the same sentences. These experiments are described and discussed in detail in Chapters 7, 8 and 9.

The aim of these experiments is to shed light on the hypothesis that there is a causal relationship between prosodic phrasing and attachment decisions in sentence processing. Six experiments are reported in the following chapters: three perception experiments (Experiments 1, 2 and 3), and three production experiments (Experiments 4, 5, and 6). To provide a preview, they can be described as in the following table:

Table 6: Overview of two experimental series

<i>Perception Series (Attachment Preference)</i>	
Experiment 1	Attachment preferences for silently read sentences presented with an unvowelized (Standard Arabic) orthography
Experiment 2	Attachment preferences for overtly read sentences presented with an orthography vowelized to block a phrasing break internal to the target construction, i.e., [N1-N2-Modifier] phrasing
Experiment 3	Attachment preferences for overtly read sentences presented with an orthography vowelized to imply a phrasing break between complex noun phrase and modifier, i.e., [N1-N2][Modifier] phrasing

<i>Production Series (Prosodic Phrasing)</i>	
Experiment 4	Prosodic phrasing patterns implied by vowelizations that participants inserted (<i>tashkeel</i> procedure) into silently read sentences presented with an unvowelized orthography
Experiment 5	Overt prosodic phrasing patterns in utterances elicited with a protocol disambiguating for low-attached modifier
Experiment 6	Overt prosodic phrasing patterns in utterances elicited with a protocol disambiguating for high-attached modifier

The findings of all the experiments, taken together, build up a hierarchy of evidence that will support an argument for the main hypothesis: that prosodic phrasing can influence modifier attachment in both overt reading and silent reading. Chapter 7 reports on and discusses experiments in the perception series. Chapter 8 reports on and

discusses experiments in the prosodic phrasing series. Chapter 9 undertakes a cross-comparison and general discussion of all the experimental findings.

6.1.2 Hypothesis

A prosodic explanation of length effects on attachment (Fodor 2000, 2002) is the chief motivation for the experiments undertaken. The claim will be that prosodic principles, taking the form of language-specific syntax-prosody alignment constraints as well as further constraints such as those on the optimal size of phonological phrases, constrain and determine the phrasing of sentences, and consequently, parsing.

It will be claimed that, in Standard Arabic, a phonological phrase can contain more than 4-5 prosodic words¹. This tolerance for long phrases is argued to be facilitated by a liaison phenomenon that holds successive words together. Also relevant prosodic constraints, which will be discussed in more detail in chapter 9, include a constraint that prohibits a prosodic break between the two nouns of a construct state. There is also a constraint that prohibits short phonological phrases.

The IPH (Fodor, 2000) claims that a default prosodic contour is projected in silent reading and this projected prosody influences attachment via its influence on syntactic structure building.

Fodor's (2002) *Structural Interpretation of Prosody Principle (SIPP)* proposes an intricate interface relationship between the production of prosodic structure and the

¹ In the long RC condition (4+ PWds), the construction [N1 N2 Modifier] adds up to 6+ PWds, the long AP condition (3+PWds) adds up to 5+ PWds, the short RC condition adds up to 4 PWds while the short AP condition adds up to 3 PWds.

perception of syntactic structure. The idea is that prosodic structure is assigned by the mediation of factors such as phrase length and syntactic category and then this projected prosodic pattern is interpreted as signaling a syntactic configuration.

The study presents a comprehension experiment conducted to investigate the attachment preferences shown by speakers of SA in silent reading as well as another silent reading experiment investigating the prosodic phrasing preferences of users of SA. A comparison of these two silent reading experiments tries to find patterns and similarities between them. To further investigate and explore the patterns between the two experiments and to try to offer an account of the data in both experiments, another 2 set of experiments were conducted in overt reading: 2 production experiments and 2 perception experiments. These experiments try to identify the syntax-prosody interface association speakers of SA make in production and perception. The results of these experiments after extracting the patterns of association are then compared with the silent reading experiments. Cross comparison of patterns found in silent and overt reading are proposed to shed light on and provide support for the Implicit Prosody Hypothesis.

6.2 Materials

The critical materials were identical across all experiments, allowing comparisons to be made across the outcomes for different experimental tasks. These materials were sentences that included a modified complex NP of the form N1 N2[Gen] Modifier, where N1 N2[Gen] was an instantiation of the Arabic “construct state” (see § 4.6 for discussion). The complex NP (plus its modifier) thus exhibited the modifier-attachment

ambiguity discussed in previous chapters. It was placed in object position and was sentence final in all target sentences. N2 was definite in every instance, since in Arabic an RC can modify only a definite noun. To ensure that modifier attachment was not disambiguated by syntactic features, the two nouns in the complex NP always matched in gender and number, and in all instances gender was feminine. Feminine gender was selected because of the potential of most feminine nouns in Arabic to induce liaison (see § 4.9.4).

The aim in material construction was to develop attachment-ambiguous sentences which were bias-neutral and especially to minimize any semantic or pragmatic content that might bias towards one or other attachment preference. The sentences used in the experiments were evaluated for naturalness and discourse neutrality by two expert judges, who were native speakers of Arabic and faculty members in the linguistics department at Cairo University. A rating questionnaire was used to assess neutrality of the target sentences and ambiguity balance. Three of the sentence sets that were originally developed were discarded as they rated high for a bias for one of the alternative readings. The responses of the judges to the remaining sentence sets indicated that they were appropriately natural, that both interpretations of the modifier were plausible, and that there was no discernible semantic or pragmatic content to notably bias towards one or other interpretation.

6.2.1 Modifier Category

In some other studies of modifier attachment, where RC was the main focus of study, a length manipulation employed “short RCs” that were just one prosodic word (PWd) in length. However in a language like Arabic, the shortest RC possible is two PWds: the relative marker itself is a PWd (see §4.7, Chapter 4 for details). So it was important to find another modifier that could fulfill this minimum length requirement of shortness. The adjective phrase in Arabic fits this requirement because the shortest AP modifier in Arabic, a single adjective, may be one PWd in length, and because an AP in Arabic, like an RC, is a post-nominal modifier¹.

Modifiers belonging to two different syntactic categories were therefore included in the materials design: a clausal modifier (relative clause, RC) and a non-clausal modifier (adjective phrase, AP). Modifiers of both types were constructed to be Long and Short, where the former was at least two PWds longer than the latter.

Therefore the two “short modifiers” differed in the number of prosodic words: a short AP was 1 PWd while the short RC was 2 PWd, but each was short compared to its long counterparts. Thus, what was constant in the Short and the Long modifier conditions was not the actual length of the modifying phrase but rather their difference in length.

This is an important point that will bear on the interpretation of the results.

In designing the materials, the notion of length in play was associated with prosodic *heaviness*. Fodor (1998) takes ‘heaviness’ to be a function of both length and

¹ Kremers (2000, 2003) discusses the similarity between the syntax of adjective phrases and that of relative clauses in Arabic.

syntactic category where a clause for example is taken to be heavier than a noun phrase even if they contain the same number of prosodic words (Fodor 1989 p.298).

6.2.2 Modifier Length

As noted above, the length of modifiers in the experimental series to be reported was assessed at the level of the prosodic word. Both a maximum length for short modifiers and a minimum length for long modifiers were set. The maximum length for Short RCs was 2 PWds, and for the Long RCs it was required to add at least a further two PWds. The maximum length for short APs was 1 PWd, and similarly, the Long-AP condition lengthened this by at least two further PWds (3+PWds).

In summary, then, the length contrast in APs was constructed to be between phrases that were 1 versus 3+ PWds, while the same contrast in RCs was between phrases that were 2 versus 4+ PWds.

Short RCs had only a verb after the relative marker as in example 1(a), while in Long RCs there was either a complement following the verb as in example 1(b) or a prepositional phrase following the verb as in example 1(c) (the verb used was the same one used in the respective short condition). Short APs had a single word adjective as in example 1(d), while Long APs had either a prepositional phrase following the adjective 1(e) or a complement following the adjective 1(f) (the same adjective used in the respective short condition).

1a. Short RC (Relative marker + Verb):

zara al-muhaafith maktabat al-madrasah **allatii gudidat**
visited the-mayor library the-school which was renovated
“The mayor visited the library of the school which was renovated.”

1b. Long RC (Relative marker + Verb+ Complement):

zara al-muhaafith maktabat al-madrasah **allatii kaanat qad gudidat tagdiidan shaamilan**
visited the mayor library the-school which was renovated renovation complete
“The mayor visited the library of the school which was completely renovated.”

1c. Long RC (Relative marker + Verb + Prepositional Phrase):

daawaa Ahmed ?agnihat al-?asfuurah **allatii ?usiibat bi- guruuh baalighah.**
treated Ahmed wings the-bird that was wounded with-wounds severe
“Ahmed treated the wings of the bird that was wounded with severe wounds.”

1d. Short AP (Adjective)

qatala shakhs khaadimat al-mumathilah **al-mariidah.**
shot someone the servant the actress the-ill
“Someone shot the (sick) servant of the (sick) actress.

1e. Long AP (Adjective + Prepositional Phrase)

daawaa Ahmed ?agnihat al-?asfuurah **al-musaabah bi- guruuh baalighah.**
treated Ahmed wings the-bird the wounded with- wounds severe
“Ahmed treated the (wounded with severe wounds) wings of the (wounded with severe wounds) bird ”

1f. Long AP (Adjective + Complement)

qatala shakhs khaadimat al-mumathilah **al-mariidah maradan shadiidan.**
shot someone the servant the actress the-ill illness grave
“Someone shot the (ill with a grave illness) servant of the (ill with a grave illness) actress.

The four versions of each sentence were designed to have similar semantic content to the extent possible, compatible with the variation in syntactic category and the addition of material for the length manipulation. A sentence quadruple (four variants of one basic item) illustrating the properties of the critical material is shown in (2):

- (2) zaara al-muhaafitth maktabah ʔal-madrasah
 visited the mayor library the school
 “The mayor visited the library of the school ...”
- a. **Short RC** ʔallatii gudidat
 which was renovated
 “The mayor visited the library of the school which was renovated.”
- b. **Long RC** ʔallatii kanat qad gudidat tagdiidan shaamilan
 which had been renovated a renovation complete
 “The mayor visited the library of the school which had been completely renovated.”
- c. **Short AP** ʔal-gadiidah
 the new
 “The mayor visited the (new) library of the (new) school.”
- d. **Long AP** ʔalgadiidah fii nithaam binaaʔ-haa
 the new in way construction its
 “The mayor visited the (new in the way it was built) library of the (new in the way it was built) school.”

The critical experimental materials (see Appendix I for a full list) were therefore constructed to fill out a design utilizing two fully crossed factors: Modifier Length contrasted sentence items which were short versus long (by count of prosodic words), and Modifier Category contrasted sentence items that included Relative Clauses versus

Adjective Phrases. A set of 8 basic sentences fulfilling these criteria was constructed. Each basic item had 4 variants and thus a total of 32 (8x2x2) targets constituted the critical material set. The table below summarizes the properties of item subtypes in these materials.

Table 7: Length of complex NP modifier in prosodic words relative to modifier category.

Short RC	N1 N2 RC	2PWs
Long RC	N1 N2 RC	4PWs
Short AP	N1 N2 AP	1PW
Long AP	N1 N2 AP	3PWs

Diagnostics and Assessment: Prosodic boundary placement was assessed by the following orthographic and phonetic correlates of prosodic phrasing:

Phonetic indicators of no-boundary: [N1 N2 PWd ...]

- Insertion of case marking vowels on N1 [ACCUSATIVE] and N2 [GENITIVE].
- Presence of “t” sound at the end of each feminine noun.
- Liaison, enchainment and resyllabification¹ across word boundaries (N2 and following modifier).

¹ Resyllabification is a result of liaison in Arabic so they are considered together here as a diagnostic tool for phrasing.

- Deletion of glottal stop on modifier following N2.

Orthographic indicators:

- Insertion of genitive marking short vowel diacritic “i” under the last letter of N2.
- Insertion of the accusative marking short vowel diacritic “a” under the last letter of N1. In the case of long adjectives there is insertion of a case marking short vowel on the last letter of the adjective word.

Demarcative Marking: Boundary placement

The following were markers of a boundary placement: (N1 N2) (PWd ...)

- No overt case marking on N2¹.
- “h” sound on N2 followed by a pause.
- No liaison on N2, no syllabification across N2 and modifier word boundaries.
- Glottalization of initial sound of relative marker or adjective at post-boundary position.

Orthographic indicator: Absence of vowel diacritic under the last letter of N2.

Phonetic indicator: “h” sound on N2, perceived pause after “h” sound, no liaison with first word of modifier and the presence of the glottal stop¹ on the first word of the modifier.

¹ It is of interest to note here that syntactic case marking is deleted when there is a boundary, therefore it could be suggested that prosodic processing overrides syntactic case marking faithfulness in this context. Case marking is rendered opaque by the process of boundary placement.

6.3 Experimental Design

It was decided to adopt a within subjects design which has the advantage of reducing response variability. That is, in these experiments, each subject saw all the 4 variants of each sentence. Unfortunately in implementing this design the distribution of sentence versions in the presentation list was not ideally controlled. However, in presenting the results in Chapter 7 and 8, it will be argued that this design property did not undermine the interpretation of the data.

A yet more important point is that the resulting size of the list in the one list design adopted in this study permitted only 8 sentence groups to be used as materials whereas a 4 list design could have permitted a much larger sentence set data base that could have greatly enhanced the study. The ideal design would have been to have 4 separate presentation lists with each list containing one variant of each sentence; 4 groups of subjects would each see a different list.

This preferred model design was not the design that these experiments presented. Instead, each subject saw all four versions of each sentence. In an attempt to investigate the extent to which the subjects' repeated reading of the four versions may or may not have biased the results, there will be a discussion at the end of the report of each experiment where this design factor will be addressed.

Pseudo-randomization and list ordering schemas are outlined below. The target sentences were interleaved among 72 filler sentences (see Appendix (#) for a full list).

¹ The glottalization of the left edge of a prosodic word or the presence of a glottal stop might here be considered the default where a deletion rule can then apply. However this might also be analyzed in such a way where the default is for the glottal stop to be absent and insertion rule can then apply.

The fillers were included in the materials in order to distract attention from the target structures being tested. In addition, error rates on the questions in the filler items were used as an indicator of reading accuracy, and were treated as criterial in determining whether a subject was included in the final analysis of the data. A portion of the fillers included a disambiguated N1-N2-Modifier construction in versions with an equal number of short and long RCs and APs. The majority of fillers, however, contained only structures unrelated to the target construction. The materials were arranged in a fixed pseudo-randomization order, subject to the condition that the probability of occurrence of any version was roughly uniform throughout the list sequence. The four versions of any one item were separated by least 4 other sentences.

Two different pseudo-randomization schemas were used across the 6 experiments. One ordering of items was used in the materials of experiments 1, 4, 2, and 3; another order was used was in experiments 5 and 6 (see Appendix C for a detailed table of ordering).

CHAPTER 7

MODIFIER ATTACHMENT PREFERENCES IN STANDARD ARABIC

Experiments 1, 2 and 3

7.1 Introduction

This chapter presents three perception experiments examining Arabic speakers' attachment preferences for sentences in which a relative clause (RC) and an adjective phrase (AP) followed a complex NP containing two nouns, in the construct state. Experiment 1 is a silent reading questionnaire with unvowelized sentences whereas Experiments 5 and 6 are overt reading questionnaires with vowelized sentences,

7.2 Experiment 1

Experiment 1 was designed to obtain basic data about Standard Arabic speakers' overall modifier attachment preference in silent reading, and to investigate in more detail whether modifier length and modifier category affect attachment preference. Since prior research in many languages has shown that attachment preferences vary with modifier length, the materials design contrasted long and short modifiers in each category. Fodor's (2002) Implicit Prosody Hypothesis (IPH) predicts that differences in prosodic phrasing (here, a consequence of length, and possibly of category) indirectly affect silent reading:

even in silent reading, long modifiers should be more likely to attach high than short modifiers; similarly, clausal modifiers should be more likely to attach high than non-clausal modifiers.

7.2.1 Method

Materials and Procedure: The 32 target sentences were presented in written form, using unvowelized orthography with no marking of pausal or contextual forms that would indicate prosodic grouping which might disambiguate the modifier's attachment. These fully ambiguous materials were interleaved among 72 filler sentences, which carried no ambiguity (see Appendix A2 for a full list.) The fillers were included to distract attention from the target structures being evaluated; additionally, error rates on the comprehension questions following filler items were employed as an indicator of reading accuracy, and were treated as criterial in determining whether the data of any participant were to be included in the final analysis. A small proportion of the fillers (10%) included a disambiguated N1-N2-Modifier construction, inversions with an equal number of short and long RCs and APs. The majority of fillers, however, contained only structures unrelated to the target construction. The materials were arranged in a fixed pseudo randomized order, subject to the condition that the probability of occurrence of any exemplar of each item type was roughly uniform throughout the list sequence. The four versions of any one item were separated by at least 5 other sentences.

Three unambiguous practice items (see Appendix B1) preceded the presentation of the questionnaire proper, and participants could discuss these with the experimenter if

necessary to ensure they understood the task. Three additional fillers served as further covert practice items, before the first target sentence was encountered.

The sentences were presented in a folder, one sentence per page, typed on a single line in the middle of the page. On the reverse side of the each page, a question was presented together with two answer choices; this arrangement meant that when participants turned over the page to read the associated question, they could no longer see the previous sentence. Target sentences were always followed by a question about the attachment of the modifier, and the answer choices offered were always N1 and N2 (see example (1) below). The position of N1 and N2 in the choices was pseudo- randomly varied so that N1 was sometimes to the left, and sometimes on the right.

(1)

zaara al-muhaafith maktabat al-madrasah alatii gudidat
visited the-governor library the-school that was renovated
“The governor visited the library of the school that was renovated.”

maa alatii gudidat ?
what that was renovated
“What was renovated?”

- al-madrasah	- al-maktabah
- the school	- the library

Practice and filler items were followed by a question about some aspect of the meaning of the sentence, for which the answer-choices represented one correct and one incorrect response; an equal number of correct choices appeared on the left and on the right.

Participants were tested in Cairo, Egypt, individually, in a quiet room. They were first given a sheet of instructions (see Appendix B1) providing guidelines on how to complete the questionnaire. After a short practice session (three sentence-and-question pairs), they were encouraged to ask any questions they might have about the procedure. In the experiment, for each item, the subjects read the sentence silently as many times as they wanted. Then they turned the page, read the associated question and the two offered answers silently, and circled their choice. The questionnaire took approximately 35-45 minutes to complete.

Participants: Thirty volunteers, naïve with respect to the purpose of the experiment, participated successfully in the experiment. All were Egyptian native speakers of Standard Arabic. An additional 6 participants were excluded from the analysis because they failed to meet the reading accuracy criterion, which was a maximum of 2 errors in answering questions following the filler items.

Data Treatment: In the preparation of a summary data matrices, values for each item and for each subject were recorded in terms of the proportion of responses, within conditions, for which the answer-choice was one indicating high attachment. Data were arranged for two-way analyses of variance in accord with the Modifier Category x Modifier Length design of the materials. (The analysis of variance for Experiment 1 is provided in Appendix E)

7.2.2 Results

A summary of the data for Experiment 1 is presented in Figure 13:

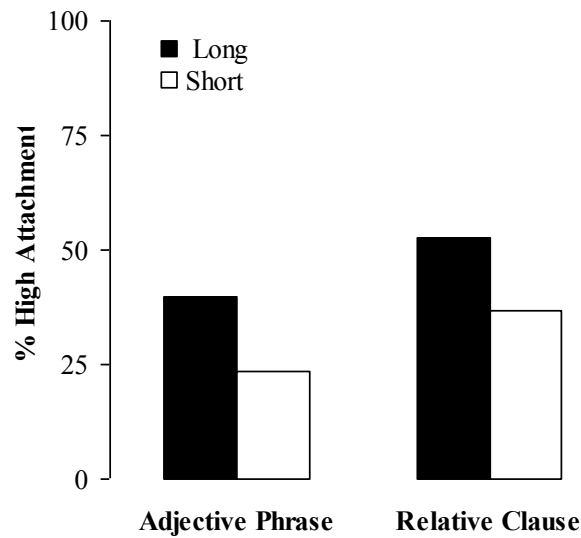


Figure 13 Experiment 1, silent reading. Mean percentage of interpretations that attached the modifier high, as a function of Modifier Category and Modifier Length.

Two-way analyses of variance with factors Modifier Category (AP, RC) and Modifier Length (long, short) were conducted on subject- and item-based data. The analysis showed a main effect of modifier category: high attachment was more likely for RCs (44.6%) than for APs (31.5%), $F_1(1, 29) = 32.88$, $p < .001$, $F_2(1, 7) = 17.64$, $p < .005$. There was also a main effect of modifier length: high attachment was more likely for long modifiers (46.0%) than for short (30.0%), $F_1(1, 29) = 28.75$, $p < .001$, $F_2(1, 7) = 15.45$, $p < .01$. There was no evidence of any interaction between these factors: $F < 1$ in both subject and item-based analyses.

A t-test collapsing over both modifier type and modifier length showed that, overall, the mean rate of high attachment was 38.0%; this is reliably less than 50%: $t_1(29)$

= 3.85, $p < .001$; $t_2(7) = 5.61$, $p < .001$. In the data for RCs, collapsing over length, the mean rate of high attachment was 44.6%, which does not differ reliably from 50%: $t_1(29) = 1.58$, $p > .10$; $t_2(7) = 1.82$, $p > .10$. For APs, collapsing over length, the mean rate of high attachment was 31.5%, reliably less than 50%: $t_1(29) = 5.81$, $p < .001$; $t_2(7) = 8.21$, $p < .001$.

7.2.3 Discussion

In this silent reading experiment, the results show that overall there is a preference for low attachment of modifiers, when generalization is over category and length. An effect of modifier length on attachment was also observed: as predicted, the modifier was attached high on a greater proportion of occasions when the modifier was long than when it was short. The reliable effect of RC length on attachment preference shown in Experiment 1 is consistent with results found in many other languages, e.g., Kamide and Mitchell (1998) for Japanese; Walter, Frazier, Clifton, Hemforth, Konieczny and Seelig (1999) for German; Pynte and Colonna (2000) for French; Fernández (2000, 2003) for Spanish; Wijnen (2001) for Dutch; Lourenço-Gomes (2002) for Brazilian Portuguese; Bradley, Fernández, and Lovrić (2003) for English; Fernández (2000/2003) for Spanish and Lovrić (2003) for Croatian.

With regards to modifier category, the data of Experiment 1 suggest that adjective phrases in Standard Arabic are less likely to attach high than are relative clauses. But it must be borne in mind that in Experiment 1's materials, the APs are systematically prosodically lighter than the RCs. It is important to reiterate here that APs are shorter than

their corresponding RCs by one prosodic word (see § 6.5 in Chapter 6). They may also be prosodically “more adjacent” to their modifiees than RCs by several criteria discussed in Chapter 6, being subject to grammatical adjacency constraints and agreement in number, gender, definiteness and case (see Chapter 4, §4.8.1 for further discussion on noun-adjective agreement in Arabic). The data available in Experiment 1 do not allow a decision to be made about what underlies the effect of modifier category on attachment, which could be attributable to the category difference itself or to another manifestation of prosodic weight (as counted in PWds), or to the combination of these characteristics.

Comparing the present results for RC attachment with those reported for a pilot study by Abdelghany & Fodor (1999), a number of points arise. The earlier study used a different material set (with no non-clausal modifiers), and employed different criteria in setting the RC length contrast: short RCs were 2-3 PWds, and long RCs were 5+ PWds (cf. the present study in which, short RCs were 2 PWds uniformly and long RCs were 4+ PWds). Abdelghany & Fodor’s overall data (collapsing over lengths) showed a high attachment preference of only 37.2% (i.e., 62.8% low attachment), falling significantly below 50%, $t_1(17) = 3.73$, $p < .01$, $t_2(15) = 2.42$, $p < .05$. However, the effect of length on attachment preferences was not reliable, and failed to reach significance in an item-based analysis. But the general pattern was broadly similar to that of the present Experiment 1, if allowance is made for the smaller number of subjects in the pilot study (18, cf. 30 in Experiment 1) and to a difference in the materials design of the pilot, which did not use the same basic items in its long and short RC comparison.

The rationale behind Experiment 1 was to infer the syntactic structure that a reader had assigned to a target sentence from the interpretative choice that was made by the subject. It was of interest to discover an effect of modifier length as in previous studies with other languages, especially as an entirely plausible explanation for this apparently universal effect attributes it to optimal length constraints on prosodic phrases. The main claim of the prosodic account of length effects on attachment is that language-specific phonological constraints on prosodic phrasing constrain the distribution of prosodic boundaries which in turn affect syntactic phrasing (parsing) due to interface constraints.

Previous studies that have evaluated phrase-length effects on RC attachment have utilized different length manipulations. What is varied may be the length of the modifier, the lengths of N1 and N2 or the length of the subject. Other studies have investigated whether there is a modifier length effect that differs with the position of the complex NP-RC construction in the sentence (Fernandez et al., 2003). These different length manipulations of non-local regions in the sentence will be an interesting area of investigation in future research that assesses the effect of global sentence prosody on attachment patterns in Standard Arabic.

Experiment 1 involved no overt prosody in either the written input or in participants' responses. Implicit prosody was invoked to offer an explanation for the relation between observed attachment preferences and variations in modifier length and category. It was taken for granted on the basis of prior findings for other languages and in the corpus study of Chapter 5, that a prosodic break before the modifier would promote high attachment, while absence of such a break would promote low attachment.

Experiments 2 and 3, reported in the following sections of this chapter, were explicitly designed to check the validity of this assumption, which is integral to the implicit prosody explanation of the findings of Experiment 1¹.

7.3 Experiment 2

Experiment 2 was designed to test whether the orthographic presence of the short vowel diacritic on N2, which is phonetically realized with a “t” consonant liaison, has any effect on attachment preference. This experiment was an overt reading questionnaire experiment.

The hypothesis is that liaison and the resulting enchainement of N2 with the modifier creates an absence of any prosodic boundary between N2 and the modifier; the lack of prosodic separation of the (N1 N2) complex from the modifier would then favor low attachment of the modifier. Liaison, which is seen as a word edge deletion² tool, thus has phrasal implications; if this hypothesis is correct, it serves to strengthen the cohesion constraint on prosodic phrasing proposed for SA.

7.3.1 Method

Materials: The stimuli in this experiment consisted of a fully vowelized presentation of the materials in experiment 1 (see §7.2.1) with orthographically marked vowel diacritics indicating the absence of prosodic breaks, that is, both morphological diacritics and syntactic

¹ Experiment 2, to be reported in Chapter 8 was designed to investigate the prosodic phrasing that is assigned during silent reading, in a different way.

² See §2.7.1.1, Chapter 2 and §4.12.11, Chapter 4 for a discussion of word edge effects.

(inflectional) short vowel diacritics were marked (see §4.3.4, Chapter 4 for a discussion of the different kinds of diacritics in SA.). The example in (2) shows the diacritic on N2.

(2)

N2

زَارَ الْمُحَافِظُ مَكْتَبَةَ الْمَدْرَسَةِ الَّتِي كَانَتْ قَدْ جُودَتْ تَجْدِيداً شَامِلاً
زَارَ الْمُحَافِظُ مَكْتَبَةَ الْمَدْرَسَةِ الَّتِي كَانَتْ قَدْ جُودَتْ تَجْدِيداً شَامِلاً

“the governor visited the library of the school which was completely renovated.”

Each sentence was followed by a question about the attachment of the modifier, as in Experiment 1. This fully vowelized version of the materials included the orthographic genitive marker “i” on N2, which triggers the presence of a phonetic “t” as a liaison element between N2 and the modifier. The phonological tool of liaison in Arabic, which is closely linked to case assignment and end vowel insertion, makes possible the cohesive binding of prosodic words within one stretch of speech. Moreover the liaison and enchainement of N2 with the modifier is claimed here to create a strong prosodic bond that encourages a low attachment reading of the modifier, that is, encourages the modifier to attach to N2 rather than N1.

Participants could see that the texts were vowelized in general, so the absence of a vowel would be a significant cue for a prosodic break, unlike in experiment 1 where all the text was clearly not vowelized.

It is important to mention here that as a result of childhood training, adult speakers of Arabic have internalized the competence to read unvowelized text and have automatized the projection of vowels onto the unvowelized text as they read. The absence of orthographic

vowelization on standard written text has created in readers a competence that is automatic, fast and efficient namely that of prosodifying the unvowelized text. This automaticity may however have a somewhat negative consequence in that adult readers of SA may sometimes, when presented with a vowelized text, disregard or override the diacritics, since attending to the diacritics would be more effortful than reliance on a less costly automatic processing strategy. A detailed discussion of this will be given in Chapter 9.

Drawing attention to the diacritics and asking readers to explicitly and effortfully attend to the vowelization was a task that needed to be constantly reinforced by the experimenter. Having participants read the sentence more than once before actually giving a final oral rendition of the sentence was important to ensure close attention to the orthography. Then the participant would turn the page and answer the comprehension question.

The goal of this experiment was not to test on-line spontaneous speech processing strategies but to find out what the preferred syntactic analysis is when speakers of Arabic read a particular vowelized version of a sentence that represented a particular prosodic phrasing.

The practical problem concerning neglect of the diacritics was not foreseen before running the experiment. Apparently a more effective approach would have been to perform a listening experiment, where the phrasing is already done for the reader. Nevertheless, the reading study produced some reliable data that are informative about the

relationship between prosodic phrasing and attachment preference when the prosody is clearly the cause, not the effect.

Procedure: Participants were instructed to read the sentence with close reference to the vowel diacritics marked on the words (see Appendix B2 for the instruction sheet given to subjects). They were asked to read the sentence silently first and then to read it aloud. Some subjects had to be asked to read the sentence aloud a number of times to ensure the correct conformity to the diacritical markings. The experimenter monitored the final output to check it was the required phrasing. The sentence was recorded using a Sony tape recorder. The subject then turned the page and answered the related question by circling his/her chosen answer.

Participants: Thirty volunteers, naïve with respect to the purpose of the experiment, participated successfully in the experiment. All were Egyptian native speakers of Standard Arabic. None had participated in Experiment 1. An additional 3 subjects were excluded from the analysis because they failed to meet the reading accuracy criterion which was a maximum of 2 errors in answering the questions following filler items. Two other subjects were excluded for failing to follow the orthography, that is, in their reading aloud they were extremely inconsistent in producing prosody conforming to the orthography.

Data Treatment: Responses to target items were coded in terms of the attachment site (high or low) implied by the choice of noun answer (N1 or N2). In the preparation of a summary data

matrix, values for each item and for each subject were recorded in terms of the proportion of responses indicating high attachment. Data were arranged for a 2 x 2 x 2 analysis of variance in accord with the N2][Modifier Boundary (Absent, Present), Modifier Category (RC, AP) and Modifier Length (Long, Short) design. The analysis of variance for Experiment 5 is provided in Appendix D.

7.3.2 Results

A summary of data for Experiment 2 is presented in Figure 14:

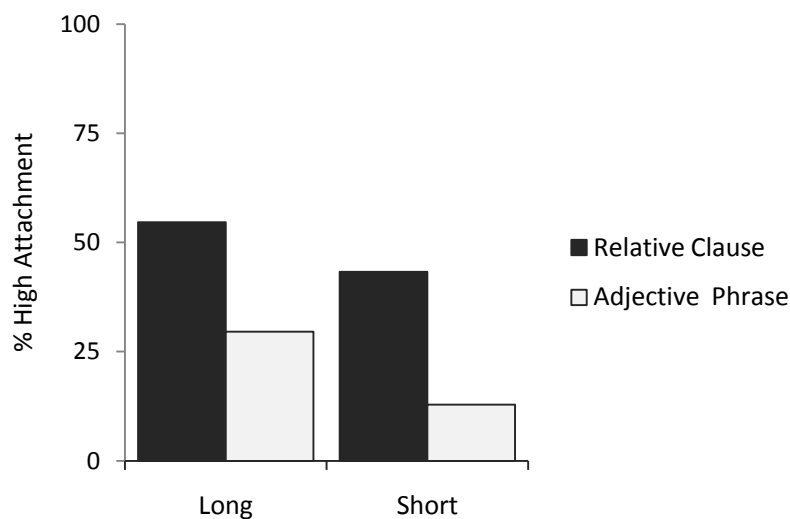


Figure 14: Summary of data for experiment 2: vowelized / forced no-boundary questionnaire. Figure shows mean percentage of interpretations that attached the modifier high, as a function of Modifier Category and Modifier Length.

The intended effect was to block a prosodic break between the N2 and the RC. The question of interest was whether this would promote low attachment, as predicted. Differences due to modifier category and modifier length were also predicted.

Two-way analyses of variance with factors Modifier Category (AP, RC) and Modifier Length (long, short) were conducted on subject- and item-based data. The analyses showed a main effect of modifier category: high attachment was more likely for relative clauses (49.0%) than for adjective phrases (21.3%), $F_1(1, 29) = 58.69, p < .001$, $F_2(1, 7) = 168.40, p < .001$. There was also a main effect of modifier length: high attachment was more likely for long modifiers (42.1%) than for short (28.1%): $F_1(1, 29) = 22.21, p < .001$, $F_2(1, 7) = 34.48, p < .001$. There was no evidence of any interaction between these factors, $F < 1$ in both subject- and item-based analyses.

7.3.3 Discussion

This was an experiment where there was a forced prosodic phrasing of the sentence materials. The presence of a short vowel diacritic on N2 forced speakers to phrase the complex NP + modifier in one prosodic unit. This absence of an N2][Modifier boundary phrasing was predicted to favor low attachment. As predicted the data shows that there is an overall low attachment preference in this experiment (only 35% high attachment). Generalizing over conditions, speakers preferred to attach low. However, there was still a length effect on attachment. With respect to length: even though there was no break, long modifiers still attached higher than short modifiers. It will be shown, however, that this length effect is weaker than the length effect in experiment 3, to be reported in the next section, which was

designed to foster high attachment. With regard to modifier category, relative clauses still preferred to attach higher than adjective phrases.

7.4 Experiment 3

Experiment 3 was designed to test whether the absence of the orthographic vowel diacritic on N2, which is phonetically realized as a pausal “h” consonant, affects attachment preference. This experiment was an overt reading questionnaire experiment similar to Experiment 2.

The hypothesis is that word-final vowel deletion, pre-boundary final consonant strengthening¹ (pausal form) on N2, and post-boundary glottalization of the initial consonant of the modifier (relative marker or adjective) creates a prosodic boundary between N2 and the modifier. This in turn is predicted to favor high attachment in that it prosodically separates N2 from the modifier and favors a discontinuity in the syntactic structure.

7.4.1 Method

Materials: The stimuli in this experiment consisted of a fully vowelized version of the materials in experiment 1, with orthographically marked vowel diacritics except that at the end of N2 there was no short diacritic of the kind that triggers liaison; the absence of this diacritic should be a trigger for a pausal reading at the N2 word boundary.

Subjects could see that the texts were vowelized in general, so the absence of a vowel would be a significant cue for a prosodic break, unlike in experiment 1 where all

¹ See Chapter 2 as well as Chapter 4 for a discussion of consonant strengthening.

the text was clearly not vowelized. Each sentence was followed by a question about the attachment of the modifier as in Experiment 2.

Example:

زارَ المُحَافِظُ مَكْتَبَةَ المَدْرَسَةِ التي كَانَتْ قَدْ جُددَتْ تَجْدِيداً شَامِلاً .

N2

زارَ المُحَافِظُ مَكْتَبَةَ المَدْرَسَةِ التي كَانَتْ قَدْ جُددَتْ تَجْدِيداً شَامِلاً .

Procedure: Participants were instructed to read the sentence with close reference to the vowel diacritics marked on the words (see Appendix B3 for the instruction sheet given to subjects). Participants were asked to read the sentence silently first and then to read it aloud. Some participants had to be asked to read the sentence aloud a number of times to ensure the correct conformity to the diacritical markings. Here as in experiment 2, the experimenter monitored the final output to check that it was the required phrasing. The sentence was recorded using a Sony tape recorder. After reading the sentence aloud, the subject then turned the page and answered the related question, by circling the chosen answer.

Participants: Thirty volunteers, naïve with respect to the purpose of the experiment, participated successfully in the experiment. All were Egyptian native speakers of Standard Arabic. An additional 4 participants were excluded from the analysis because they failed to meet the reading comprehension accuracy criterion, which was a maximum of 2 errors in answering questions following the filler items. Also an additional 6 participants were excluded from the analysis because in their reading aloud they found it difficult to follow the orthography.

7.4.2 Data Treatment

Responses to target items were coded in terms of the attachment site (high or low) implied by the choice of noun answer (N1 or N2). In the preparation of a summary data matrices, values for each item and for each subject were recorded in terms of the proportion of responses indicating high attachment. Data were arranged for two-way analysis of variance in accord with the Modifier Category x Modifier Length design of the materials. (The analysis of variance for Experiment 3 is provided in Appendix E).

7.4.3 Results

A summary of the data for Experiment 3 is presented in Figure 15.

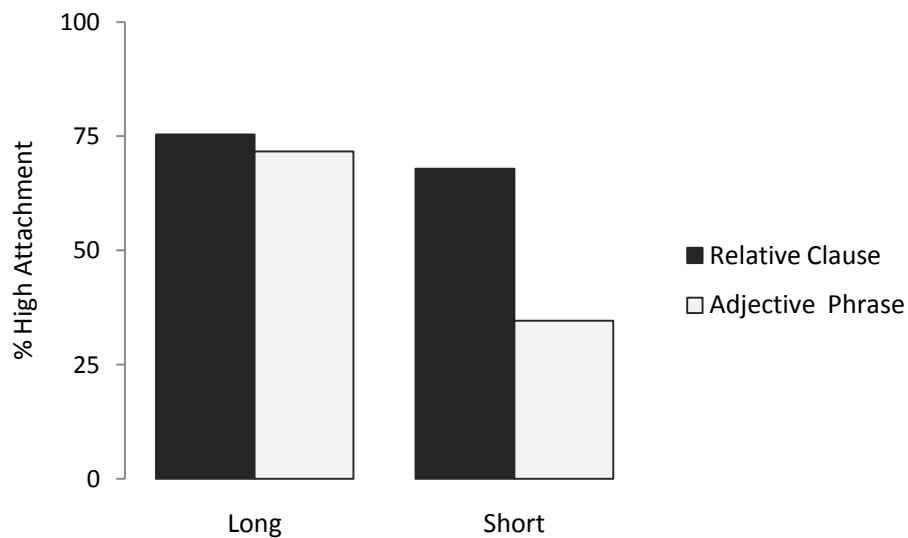


Figure 15 Summary of data of Experiment 3 (forced boundary prosody). Mean percentage of interpretations that attached high, as a function of Modifier Category and Modifier Length.

Two way analyses of variance with factors modifier category (AP, RC) and modifier length (Long, Short) were conducted on subject- and item-based data. The analyses showed a main effect of modifier category: high attachment is more likely for relative clauses (71.7%) than for adjective phrases (53.1%), $F_1(1, 29) = 38.48, p < .001$, $F_2(1, 7) = 6.40, p < .05$. There was also a main effect of modifier length: high attachment is more likely for long modifiers (73.5%) than for short (51.3%), $F_1(1, 29) = 82.98, p < .001$, $F_2(1, 7) = 35.53, p < .001$. There was a significant interaction by subjects but only a trend by items: $F_1(1, 29) = 31.45, p < .001$, $F_2(1, 7) = 4.41, .05 < p < .10$.

7.4.4 Discussion

This was an experiment where there was a forced prosodic phrasing of the materials. The absence of a short vowel diacritic on N2 required speakers to phrase the complex N1 N2 as one prosodic unit and the modifier as another prosodic unit. As discussed in previous chapters, this phrasing is standardly associated with high attachment. It was predicted, therefore, that attachment would be higher overall than in Experiment 2, with the usual effects of modifier category and length. The data shows that there is an overall high attachment preference in this experiment compared with Experiment 2. Generalizing over conditions, speakers here, preferred to attach high: overall 62% high attachment.

However, there was a length effect as in experiment 5. With respect to length: short modifiers attached lower than long modifiers. With regard to modifier category: adjective phrases preferred to attach lower than relative clauses.

In the case of short adjectives there was a consistent resistance to attach high even though the orthography signaled a boundary after N2. As an explanation of this, it can be suggested that this boundary was treated as a prosodically awkward boundary by the speakers. Even though there was a physical orthographic and phonetic boundary, that boundary violated the very strong language-specific optimal size constraint against short prosodic phrases of 1PWd.

The fact that speakers found it difficult to prosodically follow the orthography offers a strong indication of the strength of this violation of the prosodic constraint and strongly suggests (by contrast with Experiment 2) that “high attachment prosody” (i.e. a break between N2 and RC) is contrary to default prosodic tendencies in SA.

7.5 Cross-Comparison of Experiments 2 & 3

In comparing the data of experiments 2 and 3, a 2 x 2 x 2 analysis of variance was conducted on subject- and item-based data, the factors for which were N2][Modifier boundary (absent/present), Modifier Category (Adjective Phrase, Relative Clause) and Modifier Length (Long, Short).

The analysis showed a main effect of boundary: high attachment was more likely when the N2][Mod boundary was present (62.4%), than when it was absent (35.1%): $F_1(1,58) = 45.63, p < .001$, $F_2(1,7) = 78.26, p < .001$. There was also a main effect of modifier category: high attachment was more likely for RCs (60.3%) than for APs (37.2%): $F_1(1, 58) = 97.16, p < .001$, $F_2(1,7) = 35.59, p < .001$. Furthermore, there was a main effect of length: high attachment was more likely for long modifiers (57.8%) than for short

(39.69%): $F_1(1, 58) = 89.03, p < .001, F_2(1,7) = 92.18, p < .001$. There was a near three-way interaction of N2][Modifier Boundary, modifier category, and modifier length by subjects but analyses showed only a trend by items: $F_1(1,58) = 9.50, p < .005, F_2(1,7) = 3.89, .05 < p < .10$. Figure 16 below shows a cross-comparison between the results of experiment 5 and 6.

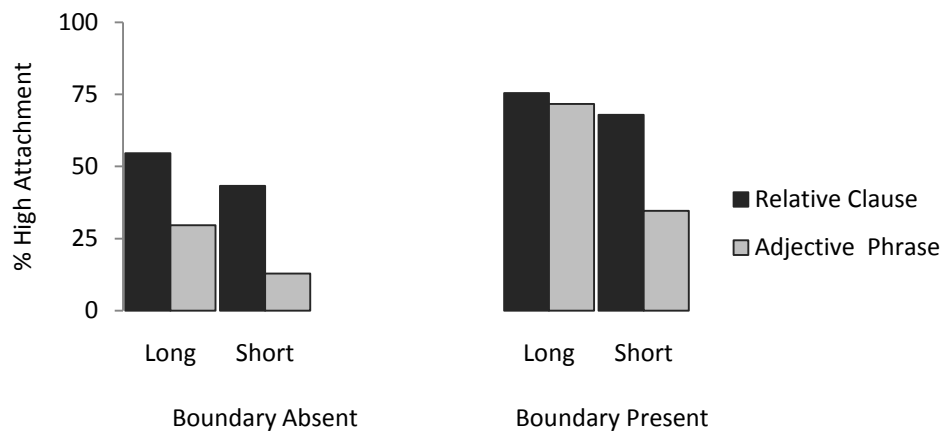


Figure 16 Cross-comparison between data in experiment 2 (no boundary) and 3 (boundary).

7.5.1 Modifier Length Effect across Experiments 2 and 3

Across Experiments 2 and 3 and within each modifier length, the following was observed: there was a two-way interaction when the modifiers were long, but no such interaction when they were short.

For long modifiers, there was a main effect of boundary: high attachment was more likely when N2][Mod boundary was present (73.5%) cf. absent (42.1%): $F_1(1,58) = 53.34, p < .001, F_2(1,7) = 183.29, p < .001$. There was also a main effect of modifier category: high attachment was more likely for relative clauses (65.0%) than for adjective

phrases (50.6%): $F_1(1,58) = 21.28, p < .001, F_2(1,7) = 5.95, p < .05$. Interaction of boundary x modifier category was not significant: $F_1 < 1$ and $F_2 < 1$.

For short modifiers, there was a main effect of boundary: high attachment was more likely when N2[Mod boundary was present (51.3%) cf. absent (28.1%): $F_1(1,58) = 24.90, p < .001, F_2(1,7) = 20.46, p < .005$. There was a main effect of modifier category: high attachment was more likely for relative clauses (55.6%) than for adjective phrases (23.8%): $F_1(1,58) = 113.12, p < .001, F_2(1,7) = 19.23, p < .005$. Interaction of boundary x modifier category was not significant $F_1(1,58) = 0.24, p > .5, F_2(1,7) = 0.06, p > .5$.

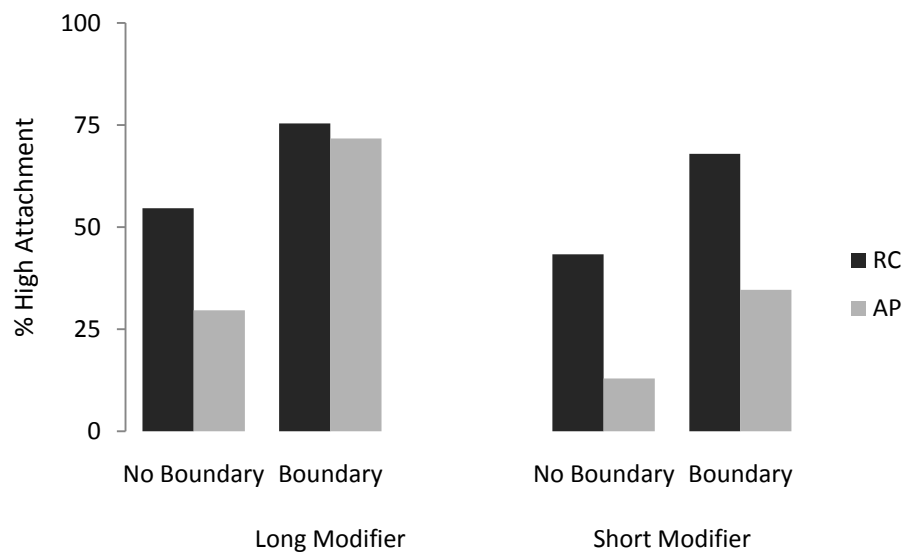


Figure 17 Summary of cross-comparison between the results of Experiment 2 (forced no boundary) and Experiment 3 (forced boundary). Figure shows the mean percentage of responses that attached the modifier high, as a function of Modifier Category and Modifier Length.

7.6 Discussion of Perception Experiments

Experiment 1 yielded data on attachment preferences where the prosodic phrasing was not determined by the task employed in the experiment. Experiment 2 and 3 used the vowelized orthography to force the prosody, and thus provide useful comparison for the data of Experiment 1. In Fig. 18, it is clear that the Experiment 1 data resemble the pattern in Experiment 2 more closely than the pattern in Experiment 3. This implies that the prosodic phrasing used by speakers in their unforced silent reading was similar to that used by the speakers in experiment 2 for forced no-boundary sentences.

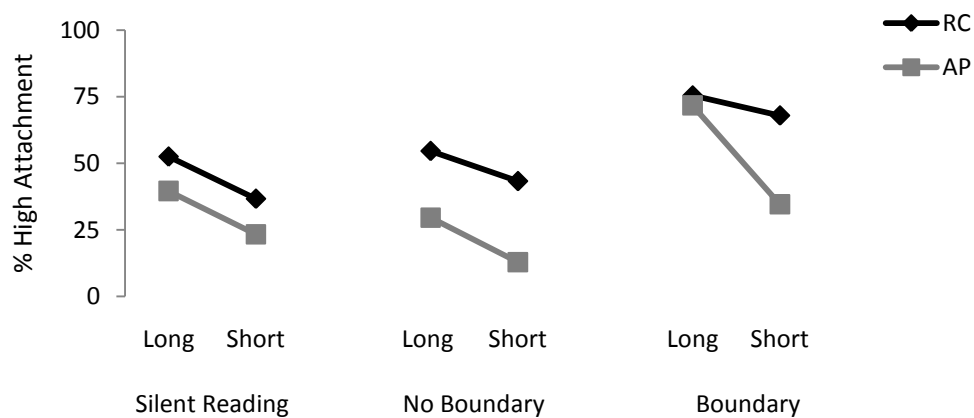


Figure 18: Comparison of attachment preferences between silent reading (Experiment 1) and the two overt reading experiments (Experiment 2 (no boundary) & Experiment 3 (boundary)). Overall data shows more high attachment (a) before pre-modifier boundary than before no boundary, (b) before long modifiers than before short modifiers, and (c) before RCs than APs.

It is important to point out that short AP shows a distinctive resistance to high attachment when preceded by a boundary, unlike the other conditions in experiment 3. Prima facie this may appear to be a counterexample to the hypothesis that prosody

influences attachment. However, it can be explained by the fact that a break after N2 in the short AP condition leaves the speaker with a prosodic unit of 1 prosodic word which is a strong violation of optimal size of prosodic constituents in Arabic, a language which tends towards long prosodic phrases. This claim is supported first by the apparent difficulty of subjects to adhere to the one prosodic unit phrasing requirement forced by the experimental material design (subjects had to be closely mentored to follow the phrasing indicated in the orthography and a total of 8 subjects were excluded because they had difficulty conforming to the orthography particularly in the short AP condition where subjects found it awkward to make a break between N2 and the short AP. It can be proposed that in this case there was an overriding mechanism at work where the subject's prosodic competence is rejecting the phonetic output given and still persistently associating the stimulus with the optimal prosodic reading, that is, a reading with no boundary after N2 and then consequently preferring a low attachment reading of the short adjectival modifier.

CHAPTER 8

PROSODIC PHRASING PATTERNS IN STANDARD ARABIC

Experiments 4, 5 and 6

8.1 Introduction

This chapter will present and discuss the results of three production experiments examining Arabic speakers' prosodic phrasing preferences for sentences in which a relative clause (RC) or an adjective phrase (AP) follows a complex NP containing two nouns in the construct state. The first experiment employs a silent reading task that aims to elicit silent prosody. The second and third experiments employ reading aloud with a sentence combination task that aims to elicit overt prosody.

8.2 Experiment 4

Experiment 4 was designed to obtain basic data about the pattern of prosodic phrasing preferred by speakers of Standard Arabic in the silent reading of sentences containing the ambiguous complex NP + Modifier construction. The hypothesis was that prosodic phrasing preferences vary with modifier length: long modifiers were predicted to have a higher incidence of N2] [Modifier boundaries than short modifiers. Also, clausal modifiers were predicted to have a higher incidence of N2] [Modifier boundaries than non-

clausal modifiers. On the basis of a previous pilot study, it was predicted that Arabic would favor long prosodic phrases, by comparison with other languages studied.

8.2.1 Method

Materials: The materials used in this experiment were the same sentences used in Experiment 1 (see Chapter 6, §6.2 for a description of the materials used).

Procedure: This experiment employed an elicitation technique specific to Arabic reading, by which the subjects indicate, indirectly, their implicit prosodic phrasing during silent reading by vowelizing an unvowelized text. The subjects' task was to orthographically add the short vowel diacritics on words as they read the sentences silently. They were instructed to mark the sounds they heard in their head as they read the sentence silently (see task instructions Appendix C). As discussed earlier, in Chapter 4, §4.3.5, this procedure (called “*tashkeel*”) is a standard task that is familiar to Arabic speakers from their schooldays.

Drawing attention to the inner voice and asking subjects to reproduce this voice orthographically by utilizing an already internalized system of diacritics imposes a complex task which involves multiple sub-tasks, namely silent reading, silent listening (to the inner voice) and reportage of the latter. First, the subject has to read the unvowelized sentence silently and, while reading, the subject has to listen to the reading voice which is the subject's projected implicit vowelization of the sentence, and then the subject has to simultaneously reproduce this inner voice orthographically as physical

markings on the written sentence on the page.¹ Throughout this compound task, all the subject is aware of is that he/she is transferring his/her sub-vocal vowelized reading onto the page using a code system that is very familiar to the subject. The joint partnership of the inner voice as well as the inner ear is crucial to this experimental elicitation procedure.²

It is important here to reiterate that marking the vowel is marking the *absence* of a prosodic break, while not marking the vowel is marking the *presence* of a prosodic break.

Presence of Orthographic diacritic on N2 = Absence of Prosodic Break

Absence of Orthographic diacritic on N2 = Presence of Prosodic Break

Marking the end of N1 or of N2 with a case marker vowel diacritic indicated the lack of a prosodic boundary at that position, while not marking a vowel diacritic indicated a boundary. As mentioned in Chapter 4, §4.8.5, a prosodic break is not permitted by the grammar of SA after N1, so it is predicted that subjects will always mark the liaison vowel on N1. The data of interest is whether they also mark the liaison

¹ There is evidence that even during normal reading for comprehension, visual sentence processing is not based on visual processing alone. Silent reading is both an articulatory and auditory act as well. Recent evidence in favor of rapid involvement of phonological information during visual processing has been obtained from several different paradigms (see Frost, 1998, for a review). Evidence suggests that phonological codes are rapidly generated during the process of visual word recognition (Ferrand & Grainger, 1992, 1993, 1994; Frost, Ahissar, Gotesman, & Tayeb, 2003; Perfetti & Bell, 1991; Ziegler, Ferrand, Jacobs, Rey, & Grainger, 2000). According to the time-course analyses provided by Ferrand and Grainger (1993) and Ziegler et al. (2000), phonological code activation lags about 20–30ms behind orthographic code activation. (See also Baddeley (1990) on the phonological loop in working memory.

² A procedure somewhat similar to this was used for French by Pynte and Prieur (submitted). They asked trained phoneticians to read a series of short texts and to indicate, on the written text, the position of prosodic breaks by inserting one, two, or three slashes, depending on the strength of the perceived break. However, this is not a familiar aspect of reading in French. The subjects were fully aware that they were marking breaks.

vowel on N2, always or sometimes, thereby indicating liaison between N2 and the modifier.

In interpreting the data, allowance must be made for the possibility that subjects were minimizing their effort, and thereby failing to add some diacritics (but not adding unnecessary ones), hence that their responses might overestimate the incidence of prosodic breaks. The data, however, show (see below) a high percentage of diacritic insertion from N2 (72.5%). Therefore the laziness issue is rendered quite improbable. Also the percentage of the presence of diacritics on N1, which is 100%, lends a reliable source of evidence that subjects were not being lazy with regards to fulfilling the task reliably. The overall 72.5% of marked vowels in this position can thus serve as a measure of subjects' accuracy.

A second point to be made is that even if subjects can perform the tashkeel task easily and accurately with respect to prosodic boundaries, this cannot be taken as evidence that readers under normal circumstances project a phonological (including prosodic) representation onto sentences that they read silently, as the IPH predicts. It can nevertheless contribute to an investigation of the IPH by cross-comparison with other reading tasks as included in this dissertation.

Participants: Thirty volunteers participated successfully in the experiment. They were all educated Egyptian native speakers of Standard Arabic. Subjects were fully aware of the task but were naïve to the purpose of the experiment. An additional 7 subjects were excluded from the analysis because they failed to meet the accuracy criterion in the

tashkeel task which was a maximum of 4 errors. Errors consisted of incorrect marking of lexical short vowels within the word as well as incorrect diacritic marking of unambiguous case marking inflections.

Data Treatment: Responses to target items were coded in terms of the absence or presence of a vowel diacritic (boundary) on N2 implied by the orthographic markings made by the subjects. In the preparation of a summary data matrix, values for each item and for each subject were recorded in terms of the proportion of occasions on which a diacritic was not inserted, which would indicate the absence of a break. Data were arranged for a two-way analysis of variance in accord with the Modifier Category x Modifier Length design. Details of the analysis of variance for Experiment 4 are provided in Appendix B2).

8.2.2 Results

Summary data for Experiment 4 are presented in Figure 19 below. A two way analysis of variance with the factors modifier type (AP, RC) and modifier length (Long, Short) was conducted on subject- and item-based data.

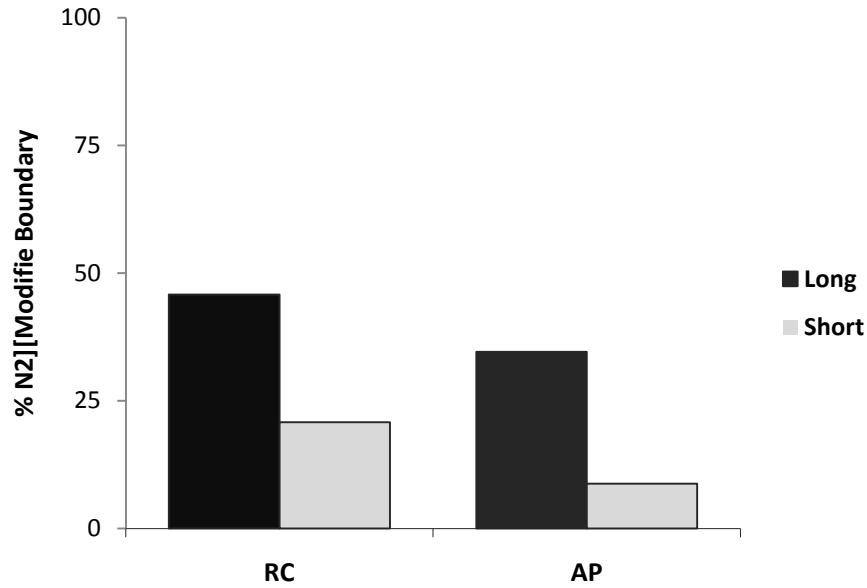


Figure 19: Experiment 4, silent reading (diacritic insertion task / elicitation of silent prosody). Mean percentage of boundary placement as a function of Modifier Category and Modifier Length.

The data analyses showed a main effect of modifier category: N2][Modifier boundary was more likely for RCs (33.3%) than for APs: $F_1(1,29) = 36.32, p < .001$, $F_2(1,7) = 18.54, p < .005$. There was also a main effect of Modifier Length: N2][Modifier boundary was more salient for long modifiers (40.2%) than for short modifiers (14.8%): $F_1(1,29) = 39.11, p < .001$, $F_2(1,7) = 81.66, p < .001$. There was no interaction of modifier category with modifier length: $F_1 < 1, F_2 < 1$.

The incidence of diacritics on N1 was 100%: the liaison diacritic was present in all cases. Fig.20 shows the overall presence of the liaison diacritic (indicating no prosodic boundary) on N1 and N2. Note that most of the time (72.5%), subjects did not mentally

project a boundary between N2 and a modifier. This is compatible with the generally low attachment of modifiers in Arabic.



Figure 20: Overall mean percentage of the presence of a genitive marker “i” on N1 and N2 which indicates a “t” consonant liaison indicating no boundary after N2 across conditions in silent reading.

An interesting source of additional information extracted from the data was the presence or absence of diacritic markings on the adjective in the long AP condition. In SA, adjectives agree with the modified noun in number, gender, definiteness and case. Case is marked as a vowel diacritic at the end of the adjective with an “a” diacritic for accusative case and an “i” diacritic for genitive case.¹ Therefore if the adjective is interpreted as

¹ In contrast, the singular relative marker in SA cannot carry a case marking vowel (see Ryding 2005 for semi-vowel *mu’atal* ending words). Therefore in the RC conditions, syntactic case marking of the relative marker is rendered opaque. Also in the short AP condition, the adjective is the last word of the sentence and therefore has a pausal form where similarly case marking is rendered opaque. Note that case marking in SA is a vowel marking at the end of a noun (see Chapter 4 for a discussion of pausal forms). Therefore the only condition where case marking can be apparent is the Long AP condition in the case where no break was made after the adjective.

modifying N1, which is accusative in all cases in this experiment, then the adjective will carry an accusative diacritic. On the other hand, if the adjective is interpreted as modifying N2 then the adjective will carry a genitive diacritic. However, when there is no diacritic marking on the adjective this signifies that there was a boundary at that point (following the adjective and preceding the complement or PP that follows) and therefore no information about the attachment preference can be extracted from that particular context. However, it does suggest that there was a boundary placement at this point. The data indicating the attachment preference and the boundary placement after the adjective, in conjunction with data showing the percentage of boundary placement after N2, point to a systematic tendency to attach the modifier high when there is a break after N2, and to attach the modifier low when a break is placed after the adjective and no break after N2.

Data obtained from adjective case markings in the long AP condition are informative in the following respects: if there was a case marking, then there was no break after the adjective; if there was a case marking, then the type of attachment preference will be clearly visible. If however there was no case marking on the adjective, then there was a boundary but there is no way of knowing what the attachment type was. So this case-marking information offers an opportunity to observe the closeness of the association between no-break before the modifier and low attachment. The data shows that there was an overall 18.3% occurrence of a boundary after the adjective word in the long adjective condition (while there was a 34.6% occurrence of a boundary after N2).

... N1 N2 # (34.6%) ADJ # (18.3%) PWd PWd

Out of the 34.6% boundary occurrences after N2, the diacritic shown on the adjective (accusative case marker) indicated a 90% high attachment of the modifier to N1. By contrast, out of the 47% of occurrences of no boundary after N2, the diacritic on the adjective (genitive case marker) indicated a 100% low attachment of the modifier. The following table gives the results for the long AP condition:

Table 8: Prosodic Phrasing Preferences for Long AP condition correlated with attachment preferences for each type of phrasing as indicated by the bracketing. Table shows that for the 47.1% of cases where there was no boundary between N2 and the AP, the modifier was attached low in all cases. In contrast, in the 34.6% of cases when there was a boundary between N2 and the modifier, there was a preference to attach the modifier high.

47.1%	...(N1 N2 ADJ PWd PWd)	100% LOW
18.3%	...(N1 N2 ADJ) (PWd PWd)	No case marker(p.225)
34.6%	...(N1 N2) (ADJ PWd PWd)	90%HIGH , 10% LOW

8.2.3 Discussion

This experiment shows that there is a significant length effect on prosodic phrasing. Boundary placement before the modifier is more likely for long modifiers than for short modifiers, in line with Fodor's Same Size Sister (SSS) hypothesis. The experiment also shows that there is an overall 28% boundary placement preference in SA. Generalizing across conditions, subjects made a break after N2 only 28% of the time, showing a substantial choice (72%) for no break there.

The optimal size of prosodic constituents in Arabic as revealed in these data seems to be able to accommodate up to 4 -5 prosodic words. The phonological rule of liaison makes possible the cohesion of prosodic words within one stretch of speech and this seems to be favored in Arabic. In particular, this experiment shows that speakers of Arabic during silent reading prefer to phrase N1, N2 and the modifier in one prosodic phrase where N1 + N2 + Modifier can include up to 4 -5 PWds.¹ Longer stretches than that do tend to require a break. When an RC is present, the break is preferred to be at the beginning of RC, while for AP the boundary can be either before the adjective word or after it, even if the adjective is part of a longer AP. The case-marking vowel data for the long AP condition shows that when subjects do choose to make a break in the long condition, they phrase long APs as N1 N2 Adj] [PWd PWd].

The overall low percentage of prosodic breaks in this experiment is indicative of a language-specific constraint at work in Arabic which prefers words to prosodically cohere as much as possible without a break.² The language has a phonetic mechanism that allows this extended phrasal patterning constraint to be overtly realized, that is, *liaison* and *case marking short vowels*. An approximate upper limit on phrase length does reveal itself in longer stretches of speech where breaks do occur, overriding these mechanisms of cohesion. It will be argued in Chapter 9 that it is these constraints that dictate prosodic phrasing and consequently affect the parsing of syntactic structure.

¹ No data for other breaks in the sentence, such as after the subject in VSO clauses were extracted. But a boundary pre-object and post-subject is quite possible in SA especially in slower speech rates. The phrasing then would be (VS) (O). Future research would profit from investigating the question of overall global prosodic phrasing preferences of sentences in SA.

²This is in line with what will be discussed in chapter 9 regarding the conclusion of Ryding (2005) that “When reading MSA aloud, the standard practice is to use pause form on the final word of a sentence, or (if it is a long sentence) wherever there is a natural “pause” for breath.”(Ryding (2005), p.29).

8.3 Experiment 5

Experiment 5 was designed to investigate Standard Arabic speakers' overt prosodic phrasing pattern(s) for semantically disambiguated forced low attachment sentences. The hypothesis is that for low attachment sentences, prosodic phrasing is predicted to disfavor a N2] [Modifier boundary. However, it is predicted that long modifiers will still have a slightly higher tendency for N2] [Modifier boundary than short modifiers, and clausal modifiers will still have a slightly higher tendency for N2] [Modifier boundary than non-clausal modifiers.

8.3.1 Method

Materials: The same set of 8 basic target items, each in 4 variants (32 experimental target sentences in all) used in Experiment 1 were used. However, as explained below, the protocol was set up to force a disambiguated low attachment reading of the sentence.

Procedure: The “Post-to-Times” elicitation protocol, devised by Bradley, Fernandez & Lovrić (2003), was administered for this experiment. In this procedure, subjects were asked to combine a pair of simplex sentences as illustrated in example (1) below (see Appendix A for full materials). Speakers were instructed to utter each simplex sentence (“New York Post” style), and then to combine them into a single complex sentence (“New York Times” style). The complex sentence, as illustrated in example (1), if correctly constructed, is identical to the target sentences in Experiments 1 and 4. Thus, it is syntactically ambiguous, though

disambiguated in the context of the Post-To-Times task. RCs were presented as restrictive modifiers and uniformly disambiguated for low attachment.

(1) Visually presented, uttered by participant:

zaara al-muhaafith maktabat al-madrasah.

visited the-governor library the-school.

“The governor visited the library of the school.”

?ayu madrasah ?

which school?

al-madrasah allati kaanat qad gudidat tagdidan shaamilan
the-school that been had renovated a renovation complete
”the school that had been completely renovated.”

To be constructed and uttered by participant:

zaara al-muhaafith maktabat al-madrasah allati kaanat qad gudidat tagdidan shaamilan
visited the-governor library the-school which had been renovated renovation complete
“The governor visited the library of the school which had been completely renovated.”

Participants: Thirty volunteers, naïve with respect to the purpose of the experiment, participated successfully in this experiment. All were Egyptian native speakers of Standard Arabic. None had participated in other experiments in this series. In addition 2 subjects were excluded for inaccuracy as they failed to consistently follow the protocol correctly.

Data Treatment: Responses to target items were coded by the presence or absence of a *t*-liaison on N2 in the utterances by the subjects. In the preparation of a summary data matrices, values for each item and for each subject were recorded in terms of the proportion of occasions on which a *t*-liaison on N2 was not present (indicating a prosodic break after N2). Data were arranged for two-way analyses of variance in accord with the Modifier Category x Modifier Length design. (The analysis of variance for Experiment 5 is provided in Appendix E).

8.3.2 Results

A summary of the data results for Experiment 5 are presented in Figure 21 below:

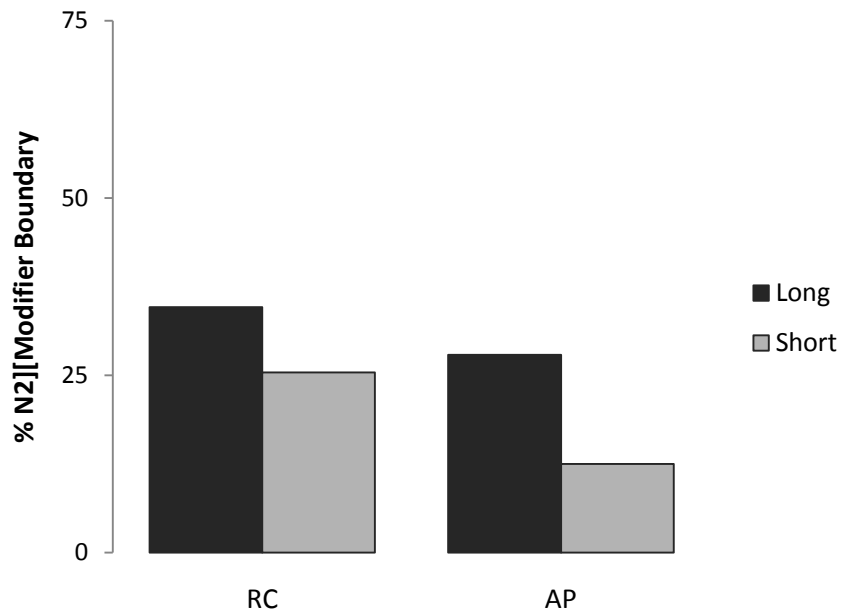


Figure 21: Experiment 5 (elicited production – forced low attachment). Mean percentage of boundary placements, as a function of Modifier Category and Modifier Length.

The data analysis shows a main effect of modifier category: N2] [Modifier boundary was more likely for RCs (30.0%) than for APs (20.2%): $F_1(1,29) = 15.32$, $p < .001$, $F_2(1,7) = 3.89$, $0.5 < p < .10$. There was a main effect of modifier length: N2][Modifier boundary was more likely for long modifiers (31.3%) than for short modifiers (19.0%): $F_1(1,29) = 25.31$, $p < .001$, $F_2(1,7) = 28.77$, $p < .005$. There was no significant interaction of modifier category with modifier length $F_1(1, 29) = 1.73$, $p > .15$, $F_2(1,7) = 0.78$, $p > .25$.

8.3.3 Discussion

In this experiment, a semantic disambiguation protocol was used to give the subject the syntactic structure ahead of building the prosodic phrasing of the whole sentence. The aim was to determine whether in Arabic, as has been shown for other languages, low attachment is realized prosodically with the relative clause (or at least its beginning) in the same prosodic phrase as N2. It was found that there was only a 25% occurrence where the RC was separated from N2 by a prosodic boundary. But, as predicted, in the majority of cases there was no boundary between them.

Furthermore there were also significant effects of Modifier Length (breaks were more frequent before long modifiers than short modifiers) and of Modifier Category (breaks were more frequent before RCs than APs).

The *Post-To-Times* forced low-attachment protocol used in this experiment was used in a study by Fernández et al. (2003), in which acoustic duration measurements for N2 showed a significant difference of 141 ms. between long and short RC in American-

English and a significant difference of 123 ms. for Castilian Spanish. In Hebrew, Shaked et al. (2004), also using the Post-To-Times forced low attachment protocol, found a significant difference in the duration of N2 between complex NPs with long and short RCs, for both the Construct State and the Free State construction in Hebrew.

For both French and English, the earlier pilot study of Quinn et al. (2001), found no evidence of a break before short RCs with forced low attachment (disambiguated by number agreement): F0 dropped between N2 and RC, and there was no N2 lengthening. For long RCs, English forced-low attachment exhibited no break. But for French forced-low attachment, there was pre-RC lengthening and no F0 fall between N2 and RC, indicative of a prosodic boundary. In French, the RC length effect was indifferent to the height of the RC in the syntactic structure, but in English the low attachment was more influential than the modifier length.

The results of Experiment 5 for Arabic are in line with previous findings for other languages that exhibit an overall preference to associate a forced low attachment syntactic structure with a no boundary prosodic phrasing.

8.4 Experiment 6

Experiment 6 exactly paralleled Experiment 5, but focused on high modifier attachment. It was designed to establish Standard Arabic speakers' overt prosodic phrasing pattern(s) for semantically disambiguated forced high modifier RC/AP attachment sentences.

The hypothesis was that forced high attachment sentences would favor a boundary between N2 and the modifier. Thus a high overall percentage of boundary placements

after N2 was predicted – higher than in Experiment 5. However, it was predicted that this would be modulated by the usual effects of Modifier Length and Modifier Category (i.e. that long modifiers would have a higher incidence of N2)[Modifier boundaries than short modifiers and clausal modifiers would have a higher incidence of N2][Modifier boundaries than non-clausal modifiers).

8.4.1 Method

Materials: The same set of 8 basic target items, each in 4 variants (32 target sentences in all) used in Experiment 5 were used. As explained below, the protocol was designed to force a disambiguated high attachment reading of the sentence. As in all experiments with these materials, the complex NP was in object position and sentence final in all the target sentences.

Procedure: The “Post-to-Times” elicitation protocol was employed in this experiment, as in Experiment 5. The only difference was that the second simple sentence (the answer to the question) implied a high attachment of the RC that the participant would produce in creating the complex sentence. Example (2) below is an illustration of the task procedure:

(2) Visually presented, uttered by participant:

zaara al-muhaafith maktabat al-madrasah.
visited the-governor library the-school.
“The governor visited the library of the school.”

ʔayu maktabah?

Which library?

al-maktabah alati kaanat qad gudidat tagdidan shaamilan
the library that been had renovated a renovation complete
”the library that had been completely renovated.”

To be constructed and uttered by participant:

zaara al-muhaafith maktabat al-madrasah allati kaanat qad gudidat tagdidan shaamilan
visited the-governor library the-school which had been renovated renovation complete
“The governor visited the library of the school that had been completely renovated.”

Participants: Thirty volunteers, naïve with respect to the purpose of the experiment, participated successfully in the experiment. All were Egyptian native speakers of Standard Arabic. None had participated in other experiments in this series. In addition, 4 subjects were excluded for inaccuracy as they failed to consistently follow the requirements of the *Post-To-Times* protocol procedure.

Data Treatment: Responses to target items were coded by the experimenter in terms of the presence or absence of a *t*-liaison on N2 in the utterances by the subjects. In the preparation of a summary data matrix, values for each item and for each subject were recorded in terms of the proportion of occasions on which a *t*-liaison on N2 was not present (indicating a prosodic break after N2). Data were arranged in accord with the

Modifier Category x Modifier Length design. (The analysis of variance for Experiment 6 is provided in Appendix C).

8.4.2 Results

A summary of the data results for Experiment 6 is presented in Figure 22 below:

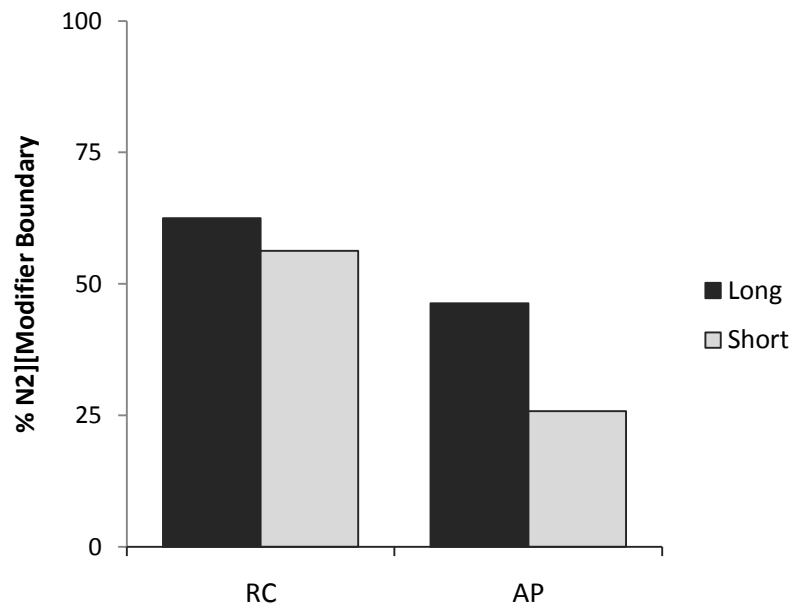


Figure 22: Experiment 6 (elicited production- forced high attachment). Mean percentage of N2][Modifier boundary placement as a function of Modifier Category (Relative Clause and Adjective Phrase) and Modifier Length (Long and Short).

Two way analysis of variance with the factors modifier category (AP/RC) and modifier length (Long, Short) was conducted on subject- and item-based data. The data analysis showed a main effect of modifier category: N2][Modifier boundary is more likely for RCs (59.4%) than for APs (36.0%): $F_1(1,29) = 79.85, p < .001$, $F_2(1,7) = 5.95, p < .005$.

There was also a main effect of modifier length: N2][boundary is more likely for long modifiers (54.4%) than for short (41.0%): $F_1(1,29) = 25.80$, $p < .001$, $F_2(1,7) = 5.95$, $p < .05$. An effect of interaction of modifier category with modifier length was found to be reliable only by subjects: $F_1(1, 29) = 5.00$, $p < .05$, $F_2(1,7) = 2.27$, $p < .15$.

8.4.3 Discussion

In this experiment as in experiment 5, a semantic disambiguation protocol was used to specify for subjects the intended syntactic structure of the RC and the AP construction. The aim was to determine whether in Arabic, as has been reported for other languages, high syntactic attachment is realized prosodically with a boundary before the relative clause.

It was found that there was an overall 48% tendency to break after N2. Though not notably high, in this experiment there was a numerically higher tendency to break after N2 in comparison with experiment 5; compare Figures 22 and 21. The 48% preference to produce a boundary for forced high attachment is much weaker than previous results reported for other languages (see Amit, 2009). The results of experiment 6 suggest that there is a reluctance for boundaries in Arabic which will be further discussed in Chapter 9 within the the model of prosodic constraints proposed for Arabic.

8.5 Cross-comparison of Experiments 5 and 6

An “omnibus” 2x2x2 analysis of variance was performed across experiments 5 and 6, the factors for which are as follows:

- Experimental Protocol (Forced Low versus Forced High Attachment)
- Modifier Category (Adjective Phrase, Relative Clause)
- Modifier Length (Long, Short)

The results of the analysis showed that there was a main effect of experimental protocol: N2][Modifier boundary is more likely when modifiers are attached high (47.7%) rather than low (25.1%): $F_1(1, 58) = 24.33, p < .001$, $F_2(1, 7) = 120.16, p < .001$. This suggests that speakers of SA are more likely to create a boundary for a high attachment syntactic structure. However the low percentage of overall breaks which is under 50% in Experiment 6 indicates that speakers of SA prefer a no boundary phrasing, as is also evident in Experiment 4.

Across experiments 5 and 6 there was also a main effect of modifier category: N2][Modifier boundary is more likely for RCs (44.7%) than for APs (28.1%). This suggests that (generalizing over low and high attachment), when inserting a boundary, speakers of SA are more likely to associate a boundary with the left edge of a relative clause than with the left edge of an adjective phrase.

Also across experiments 5 and 6, there was a main effect of modifier length: N2][Modifier boundary is more likely for long modifiers (42.8%) than for short (30.0%): $F_1(1, 58) = 51.06, p < .001$, $F_2(1, 7) = 15.08, p < .01$. This also suggests as predicted in previous studies of other languages that speakers in this study prefer overall to insert a boundary before a long modifier than a short modifier.

In the by-subjects analysis, there was a significant interaction of protocol (high/low forced attachment), with modifier category: $F_1(1, 58) = 14.02, p < .001$. The data indicates that the difference between AP and RC is more marked with high attachment (36.0%, 59.4%) than with low attachment (20.2%, 30.0%). This marked effect will be discussed in detail in Chapter 9.

There was no interaction of protocol with modifier length: $F_1(1, 58) = 0.08, p > .50$, $F_2(1, 7) = 0.04, p > .50$. This means that the difference between long and short modifiers (the length effect) is not significantly different across high or low attachment. We will discuss in Chapter 9 an account that includes the role of the length constraint BinMin in Arabic that will offer an explanation for these results.

On the other hand, the by-subjects analysis across experiments showed a significant interaction of modifier category with modifier length: $F_1(1, 58) = 6.65, p < .025$, whereas the items analysis showed no interaction: $F_2(1, 7) = 2.27, p > .10$. The data indicates that the modifier-length effect is larger for AP (long 37.1%; short 19.2 %) than for RC (long 48.5%; short 40.8%). An account of these results will be discussed in Chapter 9.

8.6 Comparing Experiments 5 and 6 with Experiment 4

In comparing Experiment 4 data with data from Experiments 5 and 6, the latter provide important comparison points, because the attachment is determined by the materials presented to the participants. In Experiment 4, the sentences were fully ambiguous and read silently, while those in 5 and 6 were contextually disambiguated and uttered aloud. The question of interest is whether the attachment preference and the

prosodic phrasing in Experiment 4 more closely resemble the low attachment pattern of experiment 5, or the high attachment pattern of Experiment 6. From Fig. 23, it is clear that Experiment 4 phrasing data more closely resembles Experiment 5 data than Experiment 6.

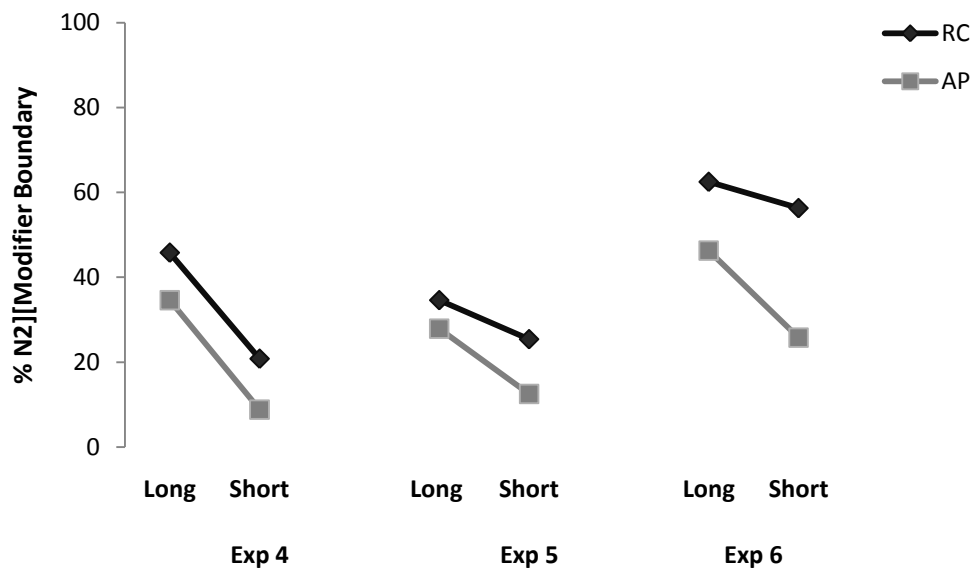


Figure 23: Comparison of data from Experiment 4 (Silent Reading / diacritic insertion task), Experiment 5 (Forced low attachment) and Experiment 4 (Forced high attachment). Mean percentage of boundary placements as a function of modifier category and modifier length across all three experiments.

This data also shows that, especially for the short RC condition, there is a marked difference in the conditions in Experiment 6 compared to the same conditions in Experiment 5 and Experiment 4. It is indicative that subjects in Experiment 6 are inserting a break so as to signal a certain meaning (high attachment) contrary to what

they would more typically do (that is, attach low which is facilitated by a no break prosody). The need to distance the modifier from N2 prosodically is achieved by means of a liaison shut-off mechanism (or a pausal form) so as to make the modifier attach to N1 and not to N2. This is especially clear in the short RC condition in experiment 6 where there is a considerable jump from a 25.4% boundary placement in experiment 5 to a 56.3% boundary placement in Experiment 4 which is a difference of 30.9%. Thus this rise for short RC is accounted for by the subjects' re-ranking of the prosodic constraints so as to accommodate the forced high attachment to N1 by the Post-To-Times elicitation protocol.

This data supports the claim that there is a strong interaction of syntactic and prosodic constraints on prosodic phrasing (Selkirk 2000). Comparing the RC data in experiment 5 to data from a comparable study in Hebrew by Shaked (2006), an important observation arises. Shaked's (2006) study shows that the constraints on prosodic phrasing in Hebrew reveal a ranking in which the need to ALIGN R XP outweighs that of Bin(MaP) [ALIGN R XP > BINMaP]. In Arabic, however, based on data from Experiments 4, 5 and 6 and as well a previous study by Hellmuth (2005), branching MaPs outweighs the need to align their edges with the edges of syntactic maximal projections [BinMaP >> AlignR XP, MaP]. Figure 26 illustrates this point:

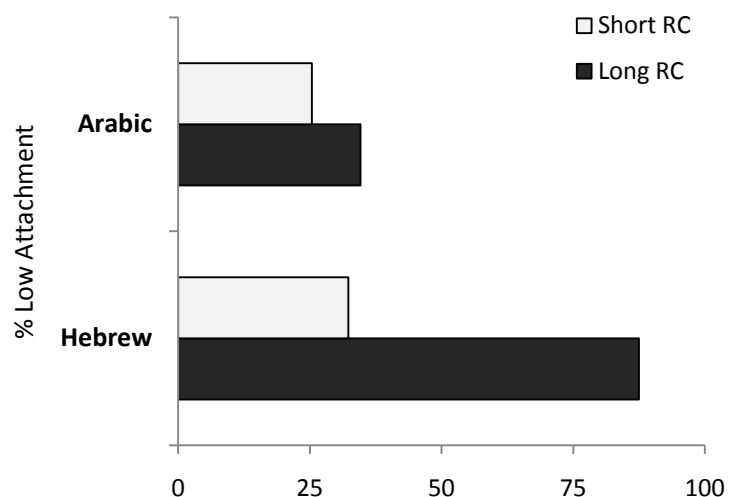


Figure 24: Experimental data comparison showing pre-modifier break preferences for forced low attachment in Arabic (Experiment 5) and Hebrew (Shaked (2006)).

It is apparent from the above figure that there is a considerable weaker tendency in Arabic to insert a break compared to Hebrew¹. I propose this should be seen as a greater resistance to place a boundary after N2 in Arabic compared to Hebrew. In the next chapter a certain ranking of various kinds of constraints will be claimed to govern prosodic phrasing across languages.

¹ For the long RC, the difference amounts to 52.9 percentage points. However, it must be remembered that this is not an exact match of materials or methods across these two studies, so numerical comparisons can only be approximate.

CHAPTER 9

MODIFIER ATTACHMENT PREFERENCES AND PROSODIC PHRASING IN STANDARD ARABIC *THEORY AND CROSS-EXPERIMENT COMPARISON*

9.1 Introduction

This chapter will pull together the results of all the experiments reported in previous chapters, and will compare and contrast them, seeking their implications for prosodic theory and for a general model of sentence processing that integrates syntactic and phonological processes. The discussion will argue in support of the claim that syntactic structure building (parsing) in silent reading is influenced by a mentally projected prosodic phrasing. A concomitant hypothesis that will also be pursued in this chapter is that prosodic phrasing is projected in a process of optimal evaluation in which a language-specific ranking of interface and prosodic well-formedness constraints is at work.

9.2 A Model of Written Sentence Processing (Silent Reading)

The claim about silent reading that will be made here is an extension of a proposal outlined by Fodor (2002) in which the syntactic analysis and the projection of prosodic phrasing by readers are viewed as interleaved. Fodor proposes a model of processing during silent reading with “prosodic processing following along in the wake

of low-level syntactic processing, and feeding later syntactic decisions” (Fodor, 2002:83).

9.2.1 Prosody before Syntax

It might be thought that, in reading, prosody is a merely a result of sentence processing and only reflects the syntactic parse.¹ In contrast however, accumulating evidence (see Chapter 3, §3.3) suggests that (*implicit*) prosody might not only reflect the syntactic structure analyzed but also influence and contribute to the building of syntactic structure during reading.

Fodor (2002) notes that this may seem paradoxical since, if prosody is the input to the same parsing process from which it is derived, the prosody would seem to be redundant, not adding any new information. However, this is reconciled by Fodor (2002), as mentioned above, by positing an interleaved process where there is first a low level syntactic processing stage which is then followed by the projection of prosodic phrasing and then a configurational interpretation of this prosodic phrasing becomes an integral part of the syntactic parse of the sentence.

A recent support of this is offered by Kentner (2009) in an empirical study of German. Kentner discusses how sub-lexical prosody such as rhythmic structure (syllables and the prosodic structure derived from the syllabic structure such as stress patterns) influences the parsing process of syntactic ambiguity resolution in reading. Kentner looks

¹ According to the structural precedence hypothesis, structural cues early in processing are used to construe a structural frame for the unfolding of the sentence, and reading prosody emerges on the basis of the early structural frame (Koriat, Greenberg & Kriener 2002).

at *implicit rhythm* and how it affects parsing decisions in silent reading. Kentner's study concludes that readers prefer a syntactic parse that is not associated with a stress clash configuration. Evidence for early activation of syllable and stress information in silent reading is also presented by Ashby & Martin (2007).

Maia et al. (2006), using a self-paced reading task with sentences containing an unambiguously attached relative clause, examine the processing of sentences in Brazilian and European Portuguese. They argue that on-line procedures tap different processes from off-line questionnaire procedures, and propose that these procedures reflect different stages in processing: "speakers of all languages prefer low attachment on a first parse but can be guided by both lexical and other non-structural factors, including ...prosody towards an ultimate high attachment interpretation." Augurzky's (2006) study with German sentences also supports the claim that in silent reading a parser initially follows structural principles such as late closure (low attachment). The study examines clause-final disambiguation and shows that the effect of implicit prosodic principles is restricted to later processing stages. Augurzky (2008) schematically outlines the different levels of processing, and maintains that "the implicit prosodic influence of balance on argument structure interpretation is superior to edge alignment".

Pynte & Colonna (2000) likewise point out that "attachment preferences have been found to vary as a function of the moment when the measure is made during the comprehension process, suggesting that different factors may be at work at different steps" (see also Heydal & Murray 2005).

Millotte et al. (2008) for French show “that prosodic cues inform the first stages of syntactic processing, either by boosting the activation of one syntactic parse over others or favoring the generation of only one syntactic parse when several are possible on the basis of the available lexical information.”

A different view is that the prosodic constraint does not merely select between two equally good syntactic analyses, nor does it contribute only when the syntax is indeterminate. Rather, certain prosodic constraints must be satisfied wherever they are relevant. Hartford & Demuth (1999) argue that Bantu languages like Chishona present a case where a syntactic constraint against movement (STAY Gimshaw 1997) is violated in order to satisfy a more highly ranked prosodic constraint against monosyllabic words (MINPW). Fitzgerald’s (1994) study of Tohono O’odham observes a prosodic preference for trochees and argues for a prosodic reanalysis of syntactic restrictions. Teeple’s (2007) study of French sentences argues that prosodic alignment constraints (McCarthy and Prince 1993) have the power to choose between morphosyntactic non-equivalents in order to avoid hiatus. This relies on the ranking of a phonological constraint (Onset) above a constraint on syntax.

Keating’s (2002) model of phonological encoding in speech production posits an initial prosodic structure which is derived directly from the syntax and then restructured on the basis of non-syntactic information. The model breaks down the process of computing the prosodic structure of a sentence into two stages: the first pass creates default prosodic constituents based on the syntax. The second pass is influenced by word-form and prosodic information. Also in the literature on speech production, it has been

claimed that the prosodic constituent structure is generated early on without knowledge of the segmental content (Ferreira 1993, 2007). According to this hypothesis (Levelt, 1989), abstract timing intervals are assigned to various sentence locations early on the speech planning process. Later segmental factors are taken into account, but words and pauses are in a trade-off relationship so as to respect the total duration of the earlier allocated intervals (see Chapter 2, § 2.13 for a more detailed discussion).

Later in this dissertation we will apply Fodor's model of processing to the interpretation of the experimental data presented in previous chapters and will argue in support of this view. The following section goes further into Fodor's model of prosody in processing.

9.2.2. Prosodic Ambiguity and SIPP

A core concept behind Fodor's model is the idea of prosodic *ambiguity* together with the ensuing resolution of such an ambiguity by what is viewed by Fodor as the configurational construal of prosodic phrasing (Fodor, 2002).¹ Fodor (2002) further suggests that this is part of a more general universal tendency or cognitive principle in human sentence processing towards the perception of congruence between syntactic structure and prosodic phrasing².

¹ This is the core theoretical argument behind the IPH (Fodor 2000). See Chapter 3, section xx for a detailed discussion.

² The original reason for a projected boundary can become opaque or blurred. Therefore a boundary which might have been posited for reasons of optimal phrase size is later interpreted as being inserted for syntactic alignment reasons.

PROSODIC AMBIGUITY

“...cases where a specific prosodic feature, such as a major phrase boundary, could have had different sources – it might be due, say, to a constraint on prosodic phrase length or to a syntax/prosody alignment constraint.” [Fodor 2002:84]

STRUCTURAL INTERPRETATION OF PROSODY PRINCIPLE (SIPP)

“... a preference for configurational interpretations is one general principle that guides the resolution of prosodic ambiguities...” [Fodor 2002, p.87]

This idea could be reworded into the interface alignment-type constraint ALIGN PB, see below. Note, however, that as a preference it would not be expected to apply in 100% of cases. Like other constraints, it would interact with others and would be reconciled with them, in terms of rankings of constraint strength.

ALIGN-PB (Prosodic Boundary):

For each projected PB, there is a construed syntactic phrase boundary, such that the projected PB coincides with the right edge of the construed XP.

This interface constraint on the *perception* of prosodic boundaries during processing is a description of the reverse process of Selkirk’s (1995) ALIGN XP constraint (see Chapter 2, §2.11).

ALIGN_RXP

The right edge of any XP in syntactic structure must be aligned with the right edge of a MaP in prosodic structure.”

This is a constraint proposed as part of the phonological/syntactic interface component of the grammar and is not processing specific. As a grammatical constraint, ALIGN R XP is primarily directed towards accounting for acceptability judgments concerning various prosodic phrasings of a sentence. We may suppose, however, that a ‘performance’ version of this competence constraint guides sentence production in speech, reading aloud and, if IPH is correct, in silent reading also.

Fodor’s (2000) SIPP (here formulated as ALIGN PB) and Selkirk’s (1995, 2000) ALIGN R XP can thus both be regarded as interface strategies to be applied by the language processing mechanisms. They reflect a general tendency toward congruence¹ at work in the human mind. This chapter will examine the strengths of these two hypothesized mechanisms and evaluate them vis-à-vis the experimental data at hand. In so doing the study will then argue for the IPH/SIPP as an explanation for modifier attachment preferences in Standard Arabic.

It should be noted that Fodor (2002a, 2002b) proposes a gradient version of the ALIGN R XP (Selkirk 2000) interface constraint. This is formulated from the perspective of production which advocates an even closer congruence between syntactic bracketing and prosodic phrasing:

GRADED ALIGN-XP, R

“The pressure to insert a prosodic break (the intensity of the acoustic realization of the break) is greater where the structural discontinuity in the tree is greater (i.e., more right brackets together)” [Fodor, 2002:86].

¹ I use *congruence* here to mean a correspondence of syntactic major phrase bracket with prosodic phrase boundaries or vice versa. Maximal congruence would exist when there is a total match between syntactic phrasing and prosodic phrasing but since other factors are also at work this is not expected.

The strength of the prosodic boundary thus mirrors the strength of the syntactic discontinuity that is reflected in the number of brackets between adjacent words in the linear string.

In the present study the insertion or avoidance of prosodic boundaries will be argued to be the result of a complex process of optimal selection by a constraint evaluation mechanism. So the pressure to insert or not to insert a break has its origin in the resolution of the competing claims of a variety of prosodic phrasing constraints. In perception, including the ‘internal’ perception of implicit prosody in silent reading, the presence or absence of produced prosodic breaks is perceived as a configurational cue which signals syntactic structure where that is not independently determinable due to syntactic ambiguity; it may also facilitate structure assignment even in unambiguous sentences.

This concept of processing presupposes a model of how interface relations are coordinated. The primary concern here, before presenting the cross-experiment analysis, is to delineate some of the properties of this interface mechanism which is responsible for mediating between hierarchical syntactic representations and their phonological expression.

9.3. The Syntax-Phonology Interface

Interface theories such as Selkirk’s (1986, 1995, 2000) End-based Theory assume a serial one-dimensional model of intermodular interaction.¹ It has been maintained that

¹See Inkelas (1989), Zec & Inkelas (1990) for the idea of the bidirectionality of information passed back and forth between syntax and prosody through the interface.

Spell-Out takes place after the completion of the whole syntactic derivation (Chomsky 1981, Chomsky & Lasnik 1993, Chomsky 1995).¹ The output of the syntax then becomes the input to the phonological component which has limited sensitivity to syntactic information: For the phrasal prosody we are concerned with here, only edges (left/right) of X-bar constituents are visible to the mapping rules². Differences in the interface mapping between languages are due to parametric variation with respect to the relevant right and left alignment edges (Selkirk & Shen 1990).

Besides the alignment constraints there are additional constraints on prosodic phrasing, all of which must be integrated in language production. The next section details some of these. The constraints discussed below are proposed as “soft” constraints, not as absolute constraints, because in the OT framework assumed by Selkirk and colleagues each constraint may be outranked by others.

9.3.1 Constraints on Prosodic Phrasing

First I will outline the different kinds of constraints on prosodic phrasing that have been proposed in the phonological literature that offer a theoretical description of variation in prosodic phrasings across languages. These constraints will be the main canvas for our explanation of the prosodic processing of sentences in SA.

¹ More recent work in the Minimalism framework proposes that spell-out occurs phase by phase. Some evidence for this is offered by Kratzer & Selkirk (2007). I will not review that work here.

² Selkirk (1995) argues that only lexical categories (not functional ones) and their projections are visible to the mapping rules.

9.3.1.1. Prosodic Alignment Constraints

According to Selkirk (1995, 2000), there are two main effects that universally influence prosodic phrasing. The first are syntax-phonology interface constraints and the second are weight related constraints on the size of prosodic phrases. Variation across languages is accounted for by the different rankings these constraints have in a language.

As mentioned above, Selkirk (1995), based on McCarthy & Prince's (1993) *Generalized Alignment* constraint, proposes the following constraint on edge-alignment of syntactic phrases with phonological phrases to explain phrasing possibilities in English:

Align (XP,R; MaP, R)

“The right edge of any XP in syntactic structure must be aligned with the right edge of a MaP in prosodic structure.” (Selkirk, 200:232)

To further explain the phrasings observed, Selkirk proposes another constraint which is the *WRAP-XP* constraint adopted from Truckenbrodt (1995, 1999):

WRAP-XP

“The elements of an input morphosyntactic constituent of type XP must be contained within a prosodic constituent of type MaP in output representation.” (Truckenbrodt 1995)

Truckenbrodt (1995, 1999) introduces *WRAP-XP* in his work on phonological phrases and their relation to syntax, focus and prominence. He claims that this constraint co-exists with Selkirk's edge alignment constraint, and that its interplay with alignment constraints can

explain the variation in phrasing found in Kimatuumbi and Chichewa. One effect of the Wrap constraint is that it blocks prosodic boundaries in certain contexts. Wrap-XP is a structure-preventing constraint as it reduces the number of phonological phrases in a sentence. Truckenbrodt claims that the effects of edge-alignment in certain positions are suppressed by the constraint Wrap-XP.

“Wrap-XP derives the unexpected absence of p-phrase edges internal to lexical syntactic projections in certain languages. Wrap-XP is seen as a plausible constraint for suppressing one or more of the internal p-phrase edges demanded by Align-XP.” (Truckenbrodt, 2000).

Cross-linguistic variation arises from different rankings of the respective constraints. Some indicative examples of various p-phrasings given by Truckenbrodt (2000) are:

- (1) [V NP PP]_{VP} *syntactic string*
- a. []_Φ []_Φ []_Φ p-phrasing due to high ranking of ALIGN-XP,L
- b. []_Φ []_Φ p-phrasing due to high ranking of ALIGN-XP,R
- c. []_Φ p-phrasing due to high ranking of WRAP-XP

Selkirk also proposes another constraint BinMaP to account for the phrasings found in English. BinMaP is related to the size/weight of prosodic phrases. It is violated when a prosodic phrase consists of more or less than two accentual phrases.

BinMaP: A major phrase consists of just two minor/ accentual phrases.

Selkirk's (2000) BinMaP is the result of bringing together two distinct length constraints, BinMin (Binary Minimum (MaP)) which states that "a major phrase must consist of at least two minor/accental phrases" and BinMax (Binary Maximum (MaP)) which states that "a major phrase may consist of at most two minor/accental phrases". The relative ranking of these two constraints would show itself in whether the language tends to have long or short phrases.

9.3.1.2. Prosodic Well-Formedness Constraints

The existence of multiple phrasing options for a given syntactic structure has long been acknowledged in the literature (Nespor & Vogel 1986, Ghini 1993, among others). Recent studies on phrasing in Romance (Sandalo & Truckenbrodt 2001; Prieto 1997, 2005; Elordieta et al. 2003, 2004; D'Imperio et al. 2005; Elordieta in press) and other languages (Hirose 1999, 2003 for Japanese; Jun 2003 for Korean) have underlined the relevance of notions such as branchingness, weight balancing, and length of phrases (also Zebrian 2004 for Xhosa (Southern Bantu); Kim 2002 for North Korean; Revithiadou 2003, 2006 for Greek; Truckenbrodt 2002a, 2002b for Brazilian Portuguese and Bengali, Hansson 2001 for Swedish; De Lacy 2002 for Māori; Féry 2003 for French; Hellmuth 2006 for Colloquial Egyptian Arabic and Shaked 2006 for Hebrew).

Whereas Selkirk (2000) describes the optimal size of a prosodic phrase in terms of how many accental phrases (BinMaP) it should contain, the studies on prosodic phrasing mentioned above have looked at the *relative* sizes of prosodic phrases. These constraints are presented as enhancing the eurhythmicity of the utterance by balancing prosodic

constituency on the basis of length, weight and branchingness. Often this, however, is at the expense of pursuing a congruent mapping between morphosyntactic and prosodic constituents.

Weight balancing and prosodic branchingness constraints constitute the driving force for the partition of sentences into prosodic units not determined by syntactic boundaries. A phrasing mechanism that assigns a primary role to purely eurhythmic well-formedness stands in rivalry with the end-based mapping that requires congruency between phonology and syntax.

9.3.2. Proposed Constraints on Prosodic Phrasing in Standard Arabic

First I present a list of the constraints proposed for Standard Arabic that includes syntactic alignment constraints, category-specific prosodic constraints, and constraints on the size of phonological phrases. It is important here to point out that there is no such compilation in the existing literature on Arabic, though I have drawn some important insights from Hellmuth (2006), Ryder (2005) and Kremers (2003). However, most of what follows is based on the analysis of corpus and experimental data in this present study (see Chapters 4, 5 and 6).

The constraints on prosodic phrasing are discussed in the following sub-sections, and it will be argued that they are at work in shaping the data provided by the experiments reported in the preceding chapters.

9.3.2.1.*P_{CSN} (No p-phrase internal to a Construct State Nominal.)

This constraint could be formulated either as a constraint against the placement of a boundary between the nouns of the construct state (*P_{CSN} : No p-phrase internal to a construct state Nominal) or as a constraint requiring an obligatory prosodic cliticization or a complete prosodic fusion of the nouns' edges (+LIAISON_{CSN}).

As documented in Chapter 4, the +LIAISON_{CSN} constraint prosodically unites N1 with N2. In the literature on the construct state in SA, discussion of this can be seen in the strict adjacency constraint on Construct State Nominals (see Shlonsky 2004 and Benmamoun 2003). Shlonsky's (2004) syntactic account states that "linear adjacency between two formatives is a direct consequence of configurational or syntactic constraints... Strict adjacency between N and its complement is one of the signature properties of the Semitic construct state nominal..." (Shlonsky, 2001:1). Adopting a phonological account, Benmamoun explains that the nouns of the CS are "phonologically adjacent elements... the merger of the elements of the CS takes place in the post-syntactic morphophonological component...merge to form a prosodic unit..." (See Benmamoun (2000), and Siloni (2000) for detailed discussion of a post-syntactic prosodic merger approach.

The constraint is claimed to be a hard categorical constraint¹ which severely penalizes a boundary of any kind between N1 and N2 and causes the derivation to be uninterpretable and ungrammatical. In other words, it is claimed that native speakers of

¹ A categorical constraint is a non-gradient constraint that must not be violated at all. (McCarthy 2003). This is equivalent to its having the highest ranking above all other constraints.

SA universally reject as ungrammatical construct state nominals in which there is a prosodic boundary between the N1 and the N2.

9.3.2.2. *Align_LAP

This is a constraint which I propose, based on prior studies as noted below, against the placement of a prosodic boundary separating an adjective (or adjective phrase) and the preceding noun that it modifies. In SA, an adjective that modifies a noun should be linearly and prosodically adjacent to it. This could be formulated as:

Avoid a p-phrase boundary between a noun and the left edge of its modifying AP.

This is a category-sensitive constraint which requires that at a left bracket labeled AP, a phonological phrase boundary is strongly avoided.

Although not emphasized in the standard literature a distinction needs to be made here between one-word adjectives and complex multi-word adjective phrases or “short” and “long” adjectives as referred to in the experimental study.

In a crosslinguistic study of adjective phrases in thirty languages, Matasovic (2001) writes that adjective phrases (APs) differ from prototypical (single-word) adjectives (A) in that APs should be analyzed as relative clauses. Matasovic notes that adjective phrases have much in common with participial clauses, of the kind observed in Latin:

- (1) *Danai dona ferentes* "Greeks bringing gifts"

Greeks gifts bringing

[from Matasovic 2001]

Matasovic maintains that such participial clauses are special kinds of relative clauses with non-finite verbal forms. In many languages they share the same position with respect to the head noun as relative clauses. In the following section we will discuss how, in Arabic, unmodified single adjectives differ syntactically from long adjective phrases.

Adjectives in Arabic agree with the noun they modify in gender, number, case and definiteness. Kremers (2003) states that the common assumption is that *concord* consists of a direct agreement relation between the head noun and its modifier. However Kremers shows data from Arabic suggesting that there is more going on than this.

- (2) li -l-gaza'ir-i -l-mutaqaddim-i dikr-u-ha
to the-islands.F-GEN the-preceding.M-GEN mentioning.M-NOM-their
'to the aforementioned islands' [from Kremers 2003]

The head of the phrase is the noun *al-gaza'ir* ('the islands'). It takes genitive case because of the preposition *li*. The noun is modified by an adjectival participle, *al-mutaqaddim* ('preceding'). However, although it is modified by the participle *al-mutaqaddim*, the noun *gaza'ir* 'islands' is *not* the subject of the participle. The subject of the participle is *dikr-u-ha* ('their mentioning'). This is a gerund-like deverbal noun, modified by a pronominal suffix *ha*. This resumptive pronoun expresses the object of the action expressed by the deverbal noun, and it refers back to 'islands'. The combination *mutaqaddim dikr-u-ha* means 'their mentioning preceding' when it is used attributively with the noun *gaza'ir*; the whole phrase has the meaning 'the islands whose mentioning preceded'. The head noun *al-gaza'ir* is feminine plural, definite and has genitive case. The subject of the participle, *dikru-ha*, is masculine singular, definite and has

nominative case. Kremers points out that the participle *al-mutaqaddim* shows a mixed set of features. It is masculine singular, definite and has genitive case. That is, its phi-features are assigned by its subject, *dikru-ha*, whereas its case and definiteness features are assigned by the noun it modifies, here *gaza'ir*. Further examples show that the construction is not limited to participles, but also occurs with lexical adjectives:

- (3) ra'aytu –mra'at-an gamil-an wagh-u-ha
 I.saw woman-F-ACC.INDEF beautiful.M-ACC.INDEF face.M-NOM-her
 'I saw a woman beautiful her face'
 'I saw a woman with a beautiful face' [from Kremers 2003]

This provides an illustration of the two agreement processes. In example (3), the modified noun, *imra'a* 'woman', is feminine, indefinite, and takes accusative case. The modifying adjective, *gamil* 'beautiful', is masculine, agreeing with *wagh* 'face', but the adjective is at the same time indefinite, agreeing with *imra'a* rather than with *wagh-u-ha*, which is definite. Note that the adjective also has accusative case, like the head noun. What these examples show is that there is not one but two agreement processes involved in adjective concord in Arabic. Agreement in phi-features is distinguished from agreement in case and definiteness. In this respect, Kremers shows that the way in which concord is established is more complex than usually assumed.

The above examples are those where a DP-internal adjective in Arabic has an overt subject. However, Kremers points out that most DP-internal adjectives in Arabic do not have such an overt subject: they usually just modify the noun.¹

The question now is: As the agreement of adjectives in adjective phrases is divided between the external subject on the left side and the internal subject on the right side, what are the prosodic consequences of this division of labor in long APs? Which agreement (internal phi-features or external case and definiteness features) necessitates more prosodic closeness or liaison? Is a prosodic boundary between the internal subject and the adjective less likely than one between the external subject and the adjective? Relevant data for this question will be discussed in the experimental findings in Chapter 9.

Although Kremers is of the opinion that APs and one word adjectives should be treated in a unified syntactic analysis, this study will show that there are syntactic differences between long adjective phrases and short unmodified single adjectives which result in differences in their optimal prosodic phrasing preference patterns.

The discussion in the following chapters of this dissertation will refer to both adjective phrases ('long adjectives') and unmodified single adjectives ('short adjectives') as AP. The next section will go on to list other relevant constraints in SA.

¹ In cases where the adjective phrase does not have an overt internal subject, Kremers posits the presence of an empty element in the DegP-internal subject position. The argument of the adjective (internal subject) is syntactically realized as *pro*. This *pro* is a resumptive pronoun that refers back to the head noun. If the internal subject is overt however, it will contain an overt resumptive pronoun.

9.3.2.2. ALIGN_R XP, (Selkirk 1995)

“The right edge of any XP in syntactic structure must be aligned with the right edge of a MaP in prosodic structure.”

See previous discussion of this constrain in § 9.3.1 above.

9.3.2.3. CONGR

This constraint that I propose applies at the syntax-prosody interface in both production and perception. It can be factored into two related constraints:

CONGR_p

Avoid a prosodic boundary in absence of a right edge XP syntactic phrase boundary.

This applies in sentence production. It penalizes the placement of a prosodic boundary when there is no major syntactic boundary in the syntactic representation.

CONGR_{SYN}

Avoid the assumption of a right edge XP syntactic phrase boundary in the absence of a prosodic boundary.

This applies in sentence perception. It would discourage the interpretation of a syntactic major phrase closure when there is no associated prosodic boundary in the input.

9.3.2.4 BinMax

It is important to mention here that in this study, BinMax (see Selkirk 2000), which is a constraint on the maximum size for prosodic phrases, is a weak constraint in SA. Unlike other languages, there is no strong maximum constraint on prosodic phrases in SA. The discussions in Chapters 4 and 5 as well as the experimental results of prosodic phrasing preferences in SA reported in Chapters 7 and 8 suggest that SA prefers long phonological phrases; therefore a constraint on maximum size is proposed to be a weak constraint in SA.

9.3.2.5 BinMin

As presented in § 9.4.1 , Selkirk (2000), in an attempt to account for patterns of prosodic phrasing in English which are not explained by the interface constraints, proposes a constraint BinMin requiring a MaP to consist of at least two Minor Phonological Phrases (MiP) (This is also incorporated into Selkirk's BinMaP constraint; see discussion above.) Hellmuth (2006), working on Colloquial Egyptian Arabic (CEA) notes the striking lack of phrasing breaks in her corpus and concludes that there is a minimum size restriction that gives rise to the large phonological phrases observed in CEA¹. She proposes that (SVO) phrasings (i.e., no prosodic break within the clause) predominate in CEA due to a phonological well-formedness constraint BinMaP. However, this constraint is slightly different from Selkirk's BinMaP.

¹ In addition to other observations of interest, Hellmuth (2006) presents compelling empirical evidence that suggests that the domain of pitch accent distribution in CEA is the prosodic word (PWd). She proposes that CEA is an intonational stress-accent language with a dense pitch accent distribution where there is a pitch accent on every content word. Hellmuth further suggests implications of this for the prosodic typology of languages.

Selkirk's BinMaP requires a Major Phrase (MaP) to consist of at least two Minor Phonological Phrases (MiP). However for Hellmuth, the MiP in EA, at normal speech rates, exhibits binarity in that it is a constituent that is itself formed of two prosodic words. Hellmuth notes a precedent for this in Japanese (Kubozono 1993) where MiP can be defined as a node that branches into two words. For Hellmuth, a MaP that meets the minimal binarity requirement that it should contain at least two MiPs, thus contains at least four PWds. This formulation of the phonological well-formedness of MaPs in EA correctly predicts the observed long phrasings in her data. She notes that the constraint BinMaP outranks ALIGN XP in CEA¹.

Futhermore, Hellmuth proposes that while the well-formedness constraint BinMaP_{MiP} holds at all speech rates but the formation of the lower level unit MiP is rate sensitive. At normal speech rates a MiP consists of two PWds, but at slower rates eurhythmy is achieved by means of smaller MiPs so that a MaP contains fewer than 4PWds; at slower rates a MaP can contain 3 PWds (but not 2 PWds).²

For the data in the present study, the minimum size requirement that best fits the data is 4PWds. This is will be referred to as BinMin for SA and will be interpreted in this study as a gradient constraint: the fewer PWds a phrase contains the more BinMin violations it will accrue. Violation(s) of the BinMin constraint will be accrued as shown:

¹ Compare with Shaked (2009) where observations about prosodic phrasing are made for Hebrew in which ALIGN XP outranks BinMin.

² An important question for future research raised by Hellmuth is what determines MiP formation in CEA at slow rates.

BinMin in SA

A major prosodic phrase must consist of at least four PWds.

4 PWds = 0 violations

3 PWds = 1 violation

2 PWds = 2 violations

1 PWs = 3 violations

9.3.2.6 *P-Phrase

Truckenbrodt (1999) points out that besides the two interface alignment constraints ALIGN-XP, R and Wrap-XP, every language has an additional constraint that can render one or both of the alignment constraints inactive if it outranks them. This additional constraint is a constraint specific to prosodic structure which minimizes the number of p-phrases:

***P** Don't form p-phrases. (Truckenbrodt, 2002:274)

This constraint was first mentioned by Prince and Smolensky (1993) as belonging to the family of constraints *STRUC (Prince and Smolensky 1993:25, fn.13). It is seen as an instantiation of a general avoidance of structure. This constraint is best satisfied by outputs containing the least number of prosodic phrases possible. If this constraint

outranks the alignment constraints, the winning candidate could show no alignment with syntax at all.

Above, we mentioned the constraint Wrap XP proposed by Truckenbrodt (1999). In his 1999 paper, in comparing the two constraints of Wrap XP and *P-PHRASE, Truckenbrodt writes that:

“Wrap-XP is a force that wants lexical projections to be phrased together, while allowing functional projections to be split up freely.”(Truckenbrodt, 1999: 229). So although both Wrap-XP and *P-PHRASE are boundary-preventers, “*P-PHRASE prefers fewer and larger p-phrases in all cases, whereas Wrap-XP selectively prefers large p-phrases around lexical projections, but not around functional ones.” (Truckenbrodt, 1999: 229).

Drawing on the findings in the literature on the intonation and prosody of SA to date and on the observations and finding in this current study, it is proposed here that the constraint *P-PHRASE is a strong constraint in SA. Ryding (2005) writes: “When reading SA aloud, the standard practice is to use the pause form on the final word of a sentence, or (if it is a long sentence) wherever there is a natural “pause” for breath.” (On the pause form, see §4.11.3). This can be reworded here as: “Don’t pause inside a sentence unless you run out of breath”.

9.3.2.7 ALIGN_LRC (Fodor 2002)

This is a category-sensitive non-graded constraint that requires that for every left bracket labeled RC there is a phonological phrase boundary at its left edge. This is claimed to apply in French, for example, but not in English (see Fodor 2002, also see Jun (2002) for a prosodic typology of language alignments). Fodor points out that this alignment constraint could be an instance of a more overarching constraint such as Align Left CP.

In right-aligning languages, any Align Left constraint goes beyond Selkirk's claim that each language aligns consistently either to the left or to the right (but see Truckenbrodt 1999:228, fn11). Other Align Left constraints have been proposed for prepositional phrases in Croatian (Lovric 2003) and German (Augurzky 2006) – at least for the prepositional phrase in the complex NP corresponding to *the servant of the actress*.

9.4. A Note on Category Typicality

In Standard Arabic, relative clauses are *typically* long constituents (more than 2PWds) whereas adjective phrases (one PWd are typically short¹). Any departure from these typicality-based expectations can be viewed as a marked instance, and is proposed here to have an effect on processing.

In close reference to this notion of typicality, Farmer, Christiansen & Monaghan (2006) conducted a series of on-line reading experiments and have presented evidence

¹ See the findings of the corpus study in Chapter 5. Also examples of relative clauses and adjectives in Arabic grammar books support this.

that the phonological typicality of a word¹, with respect to its syntactic category, affects both word and sentence processing. Tanenhaus & Hare (2007) indicate that what is striking in the Farmer et al. data is that even for skilled readers; the speed with which a word is read is influenced by the typicality of its phonology relative to other class members. An interesting related question for further study is whether this phenomenon extends to longer kinds of syntactic categories such as phrases and clauses. In relation to the present study, the question becomes: can the typical phonological properties of syntactic categories such as an RC or an AP affect sentence processing? For instance, will the more atypical an RC (or an AP) becomes, make it more difficult to process as an RC (or as an AP)?

In the present instance, we are interested in the possibility that phonological length is a relevant typical property of such phrases. In the analysis presented in this chapter, some answers to these questions will be extracted from the data for short relative clauses and long adjective phrases.

If we temporarily treat length as a prosodic feature then a prosodic feature change in the typical feature matrix of a clausal category such as *relative clause* (RC) or *adjective phrase* (AP) may affect the activation of the constraints Align_L RC or *Align_L AP in sentence processing. For descriptive purposes, we can think of a relative clause or an adjective phrase in Standard Arabic as possessing, among other things, typical prosodic features such as (+long) for RCs and (-long) for APs. The typical feature is a default overridden by the actual length. An *atypical* instantiation of this would show RC

¹ Farmer et al. (2006) define phonological *typicality* as “the degree to which the sound properties of an individual word are typical of other words in its lexical category”.

surfacing as (-long) and AP as (+long). This creates a shift in the feature matrix and it is suggested here that the processor goes through a garden-path like effect. For RC the processor expected a longer prosodic window and for AP it expected an early termination. In both instances the processor is perturbed and a stochastic ‘noise’ element is introduced into the process¹. Thus, it is suggested here that a violation of typicality by an atypical prosodic length for that syntactic category creates *noise* in sentence processing (in the sense of Stochastic OT that will be introduced below). This makes them not clear exemplars of their syntactic category, which in turn is proposed to reduce the effective workings of both the category-sensitive constraints: *Align_LAP in the Long AP condition, and Align_LRC in the Short RC condition.

9.5. Variation

A commonly observed fact about prosodic structure, from the earliest descriptions through to the most current research, is that it tends to vary from one utterance to another, even of the same sentence (the same syntactic/semantic structure). Clearly this must be addressed by any account of the relationship between syntactic and prosodic structure. The experimental results presented in both Chapter 7 and Chapter 8 have shown considerable prosodic variability. This is exhibited in the patterns of optionality in the alignment of phonological phrases with syntactic phrases within and across experiments, as well as within and across sentence variants.

¹ The theoretical constructs of Stochastic Optimality Theory will be outlined below in §9.5.3. The effect of the typicality of categories will be discussed in reference to the category-specific constraints mentioned above.

Different accounts and modeling of variation have been proposed in the literature. I will adopt ideas from two such accounts in light of which I will reanalyze and interpret the data that has been already presented in Chapters 7 and 8. The following is an outline of the different accounts found in the literature.

9.5.1 Accounting for Variation

While linguists have sometimes written off prosodic differences in the past as due merely to performance variability, theoretical linguists are increasingly inclined to embrace the variation data as indicative of the mental grammar. For instance, Anttila (2006) notes that variation is by no means a marginal “*performance*” phenomenon but is central to human language and an important source of evidence about its structure. Many researchers especially those working within the framework of Optimality Theory (OT) have started to explore ways to formalize and model variation (as in Partially Ordered Grammars, Anttila 1997; Floating Constraints, Reynolds 1994, Nagy & Reynolds 1997; Constraint Competition, Zubritskaya 1997; and Stochastic OT¹, Boersma 1997, Boersma & Hayes 2001). All of these works significantly assume that at least some knowledge of variation is located in a speaker’s grammatical competence; they therefore differ from more traditional phonological accounts that have attributed variation to performance only.

¹ Stochastic OT was originally developed by Paul Boersma as part of a theory of functional phonology that addresses learning of categories, variation, optionality, and probability (Boersma and Hayes 1997, 1998, 2000, 2001). The underlying theory of Stochastic OT includes an associated Gradual Learning Algorithm (GLA), and an implementation within the cross-platform Praat and OTSoft computer programs. See Boersma & Hayes (2001:47-50) and Anttila (2002: 231- 233) for overviews of the formalism.

In this dissertation, I use the general framework and essential ideas of the model of variation that has received the most attention in recent years, namely Stochastic Optimality Theory (StOT; Boersma & Hayes 2001 et seq.)¹, to explain the recurring variability in the experimental data at hand. The analysis I present does not commit to all of the details and algorithms of the StOT approach in its current implementation. The informal analysis presented here could, however, become the basis of a more formal StOT account in the future.

9.5.2. Stochastic OT and Standard OT

Under standard optimality theory (e.g. Prince and Smolensky 1993), grammars of individual languages are composed of categorically ranked constraints, which strictly dominate one another. Hypothetical strict domination ranking in a language X is of the following nature (where the greater-than sign indicates domination):

$$C1 > C2 > C3$$

Under this view, in a language with this constraint ranking, C1 strictly dominates C2, while C2 strictly dominates C3 (and C1 strictly dominates C3 by transitivity). This means that if C1 and C2 conflict in their effects (and similarly for C2 and C3) then in every case the output exhibits the effects of C1 rather than those of C2.

However the need to capture variability in OT has led to proposals of variable constraint ranking. Accounts of optionality in terms of variable ranking have been argued for by Anttila (1997), Itô and Mester (1997) and Elenbaas (1999) among others. These

¹ The stochastic evaluation of constraints (Boersma 1998, Boersma and Hayes 2001; Jager 2003) provides a way of formally modeling this kind of variation.

studies, to a great extent, agree on a particular way of deriving variation, by which different possible outputs result from different constraint evaluations where more than one ranking of the constraints is permitted by the grammar.

9.5.3 Stochastic OT (StOT) as a model of constraint interaction and variation

StOT is a set of assumptions about the mechanism of interaction between constraints: the choice of optimal candidates is determined by the rankings of constraint weights, but the rankings can be “perturbed” by a normally distributed “evaluation noise” (Boersma and Hayes 2001).

StOT adds two essentially different ideas to the standard OT approach. The first is that constraints are ranked on “a continuous scale of real numbers rather than on an ordinal scale”. Therefore constraints differ in *distance*, as well as *dominance*. Each constraint has a numerical ranking. This is called the constraint’s ***ranking value***. The second idea is that, at each evaluation, the rank of a constraint varies slightly. The rank it has in the grammar is the mean of a normal distribution or “bell curve” of variant values that it has when applied in evaluations.

During the course of sentence production, the moment when the linguistic form is processed (immediately before being uttered) is the ***evaluation time***. At the evaluation time of any form, a stochastic element is introduced and combined with that constraint’s ranking value to produce the actual value used to rank the constraints for that utterance. This value is called the ***selection point***. For any given ranking value, the process of calculating the selection point at evaluation time involves combining the random noise

with the ranking value. This equation illustrated here is provided by Boersma & Hayes (2001):

$$\textit{selectionPoint}_i = \textit{rankingValue}_i + \textit{noise}$$

The *noise* variable represents unknown factors that are independent of the linguistic theory embodied in the constraint set. The assumption is that there is a deterministic function from the total context, but many aspects of the context are too complex to know in detail. The random noise variable models the lack of knowledge of the total context which includes non-linguistic factors (e.g., speech style, speech rate). Figure 1, which is adapted from Boersma and Hayes (2001), provides a graphical representation of this process. Two constraints are shown, with the ranking values given in bold, **A** and **B**. Most of the time, the selection point for constraint **A** will be higher than for constraint **B**; however, variation can occur, as shown by the selection points *A*₂ and *B*₂. Noise might lower the effective ranking of *A*₂, and raise that of *B*₂.

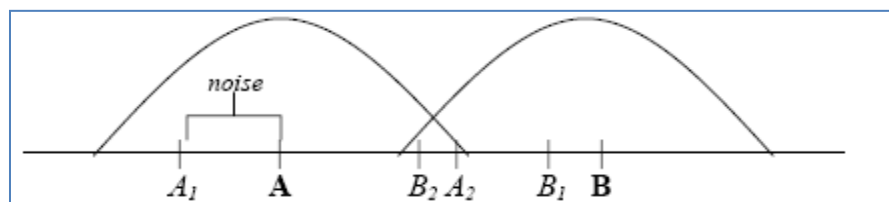


Figure 25: From Boersma & Hayes (2001): Constraint ranking on a continuous scale with stochastic evaluation

As explained by Boersma and Hayes (2001), an OT grammar with stochastic evaluation can generate both categorical and variable outputs. Categorical outputs occur

when ranked constraints are spread far apart on the continuous scale, so that the stochastic variation in ranking values has no effect. In Figure 27¹, for example, $C_1 > C_2$ and the two constraints are spread far enough apart that their ranges of variation do not overlap. As the distance between constraints increases, interactions become rare (Boersma and Hayes 2001: 50)². Variable outputs arise when ranked constraints are close enough together for the variation in their ranking values to interact with some observable frequency.

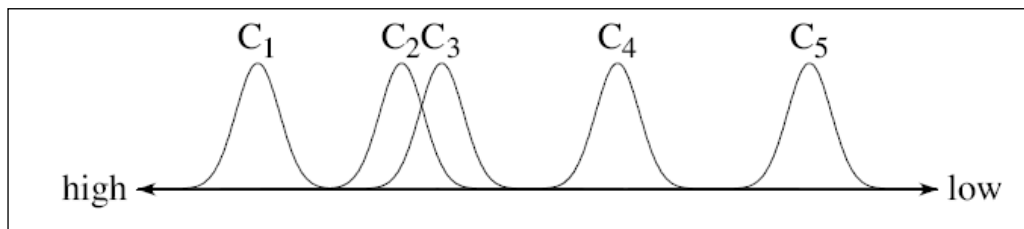


Figure 26 : From Boersma and Hayes (2001).

It is relevant here to mention that StOT has been applied recently in the analysis of prosodic phrasing. Working with speakers of Central Catalan and building on work done by Prieto (2005) and D'Imperio et al. (2005), Feldhausen (2006) investigates the role of sentential objects on the prosodic phrasing of matrix S and V within the framework of stochastic OT. Feldhausen argues that ALIGN-CP,L, MIN-N-PHRASES, and ALIGN-XP,R are very close constraints in Catalan in the sense described above. The general constraint hierarchy proposed is:

¹ Diagrams in figures 1 & 2 are adapted from Boersma and Hayes (2001).

² Units of measurement are arbitrary. With standard deviation = 2.0, a ranking distance of 10 units between constraints is taken to be effectively categorical.

MAX-BIN-END > ALIGN-CP, L > MIN-N-PHRASES > ALIGN-XP, R

Feldhausen shows from the data that the actual ranking of the constraints is sometimes the reverse of their ‘normal’ ranking.

To recap, Stochastic OT (Boersma 1998, 2000, Boersma and Hayes 2001) differs from standard OT in two essential ways:

- (i) **Ranking:** Constraints are not simply ranked on a discrete scale; rather, they have a value on the continuous scale of real numbers. Thus constraints not only dominate other constraints, but they are specific distances apart, and “these distances are relevant to the predictions made by the theory”.
- (ii) **Stochastic evaluation:** At each evaluation, the real value of each constraint is “perturbed” by temporarily changing its ranking value.

To summarize how StOT accounts for variation: given two constraints, C1 and C2, the ranks of these constraints are the means of their varying effective ranking where effective ranking = constraint ranking + noise, and are marked at the peaks of the bell curves. So although C1 is ranked higher than C2, nevertheless, on some evaluations, the effective rank of C1 will fall in the lower end of its normal distribution at the same time that the effective rank of C2 falls in the higher end of its distribution, and a ranking reversal will occur with $C2 > C1$. If C1 and C2 conflict, such ranking reversals will create an alternative output for the same input, giving rise to variation.

As a result, an OT grammar with stochastic evaluation can generate both categorical and variable outputs. Categorical outputs arise when crucially ranked constraints are distant. As the distance between constraints increases, interactions become rare. Variable outputs arise most often when ranked constraints are close together.

9.5.4. Linear Optimality Theory (LOT)

Another account of variation, distinct from StOT yet still within a general framework of Optimality Theory, is given by Keller (2005). Linear Optimality Theory (LOT), as proposed by Keller (2000), is a framework designed to account for gradient linguistic judgment data and seeks to make predictions about the relative grammaticality of linguistic structures. Theoretical constructs from the LOT theory will be used, in addition to StOT concepts, to describe and explain the data in this study.

A key idea in Keller's (2005) theory of gradience in grammar is the difference between hard constraints whose violations trigger strong unacceptability judgements and soft constraints whose violations lead only to mild unacceptability and trigger gradient judgments. *Gradience* in Keller's model presupposes that suboptimal candidates have a grammatical status which is incompatible with the 'winner takes all' accounts in general OT.

Another key idea in Keller's theory is that of "cumulativity"; Keller (2006) views constraints as ranked, and constraint violations as cumulative. Cumulativity signifies that multiple constraint violations are significantly more unacceptable than single violations.

“Cumulativity accounts for the ganging up effect ...for constraints...: multiple violations of lower ranked constraints can be as unacceptable as a single violation of a higher ranked constraint.” (Sorace & Keller 2005:20).

Like StOT, LOT assumes that constraint ranks are represented as numeric weights. In its account of gradient grammaticality, it assumes that the grammaticality of a given structure is inversely proportional to the sum of the weights of the constraints it violates.

LOT offers a way of accounting for optionality, i.e., for cases where two or more candidate outputs are equally optimal. Under this hypothesis, this means that the two candidates have the same harmony score. In LOT, the *harmony* of a structure $H(S)$ is each candidate’s harmony value which is determined by summing the weights of that candidate’s constraint violations. The total scores of the candidates are then compared and the candidate with the lowest harmony value is selected as the winner. Harmony is the degree of well-formedness relative to a given set of constraints.

In Keller’s terminology, the *violation profile* of a candidate structure tells which constraints are violated by the structure and how many violations it accrues. As mentioned above, the *harmony* of a structure $H(S)$ is the sum of the weights of the constraints it violates, which represents its degree of well-formedness. Consider an example grammar discussed by Keller with the constraints $C1$, $C2$, and $C3$, and the constraint weights ($w(C)$) given in Table 8. This table also gives an example candidate set $S1.....S4$ and gives the violation profiles for these candidates:

Table 9: An example of cumulativity and harmony scores (in Keller 2005).

$w(C)$	C_1	C_2	C_3	$H(S)$
	4	3	1	
S_1		*	*	-4
S_2		*	**	-5
S_3			*	-1
S_4	*			-4

The structure S_3 is said to maximize harmony, i.e., it incurs the least serious violation profile. It is therefore viewed as the optimal structure in the candidate set. The structures S_1 and S_4 are both less grammatical than S_3 . S_1 and S_4 receive the same harmony scores, but for different reasons; S_4 because it incurs a high-ranked violation of C_1 , S_1 because it accumulates violations of C_2 and C_3 . The structure S_2 is less grammatical than S_1 , as it incurs an additional violation of C_3 . In total, we obtain the following grammaticality hierarchy:

$$S_3 > S_1; S_4 > S_2.$$

Keller's example illustrates the three central properties of constraint interaction in his LOT model. The first property is the *ranking* of constraints. S_3 incurs a violation of C_3 , while S_4 incurs a violation of C_1 . That S_3 is more grammatical than S_4 is accounted for by the fact that C_1 has a higher weight than C_3 , i.e., the ranking $C_1 > C_3$ holds. The second property is that of the *cumulativity* of constraint violations. S_1 incurs single violations of C_2 and C_3 . The structure S_2 also incurs a single violation of C_2 , but a double violation of C_3 . As a consequence, S_1 is judged as more grammatical than S_2 .

Table 8 also illustrates what Keller calls the *ganging up* of constraint violations. The structures *S1* and *S4* have different constraint profiles: *S4* violates the constraint *C1*, while *S1* violates the two constraints *C2* and *C3*, which are both lower ranked than *C1*. However, *S1* and *S4* are equally grammatical because the two constraints *C2* and *C3* gang up against *C1*, leading to the same harmony score in both structures.

Keller further points out that a Standard optimality theoretic evaluation of the candidate set in Table 8 leads to a different harmonic ordering: $S3 > S1 > S2 > S4$. OT assumes the strict domination of constraints, and therefore fails to model what Keller calls “ganging up effects”, which he documents in data from Socrates & Keller (2005). Socrates & Keller’s study gives empirical evidence that ganging up effects occur in natural language in syntactic judgments of word order, extraction and gapping in English.

Under the Standard OT approach, there is no possibility for a joint violation of *C2* and *C3* to be as serious as a single violation of *C1*, due to the ranking $C1 > C2 > C3$. Therefore Standard OT fails to account for these observed ganging up effects. In summary, LOT differs from OT in two ways: first it represents constraint ranks as a set of numeric weights instead of partial orders. Standard OT formulates constraint ranks as binary ordering statements of the form $C1 > C2$ (i.e. constraint *C1* is higher than the constraint *C2*) which does not indicate how much higher the ranking of *C1* is compared to *C2*. Second, LOT assumes that the grammaticality of a given structure is inversely proportional to the sum of the weights of the constraints it violates. OT’s concept of strict dominance is replaced with a constraint combination mechanism.

In summary, StOT and LOT are designed to model optimal preferences within an approach that includes weighted constraints. It is this core idea that will be called upon to explain the preferences and crucially here the variation in preferences in the present data.

9.6. Analysis and Cross-Experiment Comparison

9.6.1 Hypothesis Recap

As mentioned at the beginning of this chapter, the hypothesis under consideration is that a default prosodic phrasing is projected during silent reading and a congruent syntactic interpretation is proposed to be associated with this prosodic phrasing. This process is viewed as a function of a cognitive human tendency to perceive congruence at language interfaces. It is further assumed that the prosodic phrasing projected during sentence processing is the optimal output for a set of competing language-specific and non-linguistic constraints on prosodic phrasing. What needs to be established for SA is how the specific constraints proposed apply, and how the process of interaction between competing and non-competing constraints can come into play to account for the tendencies found in the cross-experimental data. Two major questions to be considered and pursued in this regard are:

- How much of an effect does interface *congruence* have in parsing and prosodic phrasing?
- How can we describe the relationship between *default* prosody and interface *congruence*?

The experiments in this study were designed to show different types of interface relationships at work and to test the strength of congruence across these relationships. First we will review the different types of interface congruencies presented in the experiments in the present study. In light of this we will then proceed with the cross-experiment analysis, seeking an explanation of the totality of data within an optimality approach (see § 9.6).

All the data in the following sections have been presented in detail with statistical analysis in Chapters 7 and 8. The main points have been collated here preparatory to explanatory discussion. All the findings discussed in the following sections are statistically reliable except in specific cases where noted.

9.6.2 Types of Interface Congruence

In the literature on sentence processing, studies have mainly centered on the leading role of syntax and its relation to other modules of the grammar. In this study we will be looking at a bidirectional relationship between the syntactic and phonological modules. The following are the kinds of interface relationships explored in the present experiments:

A- *Syntactic Congruence* with the default/natural prosodic phrasing (IPH/SIPP):

Experiment 1 and Experiment 4. (Implicit prosody).

B- *Prosodic Congruence* with a given/forced syntactic phrasing (ALIGN XP / CONGR):

Experiment 5 and Experiment 6. (Overt Prosody).

C- *Syntactic Congruence* with a given/forced prosodic phrasing (ALIGN PB /

CONGR_{SYN}): Experiment 2 and Experiment 3. (Overt Prosody).

The central hypothesis to be examined is that the prosodic patterns found in the data for Experiment 4 (elicitation of implicit prosody) as shown in figure 27 are associated with the interpretative patterns found in the data of Experiment 1 (modifier attachment preference in silent reading in silent reading), as also shown in figure 27, given the assumption that Experiment 4 data represents the default implicit prosody of the language for this construction.

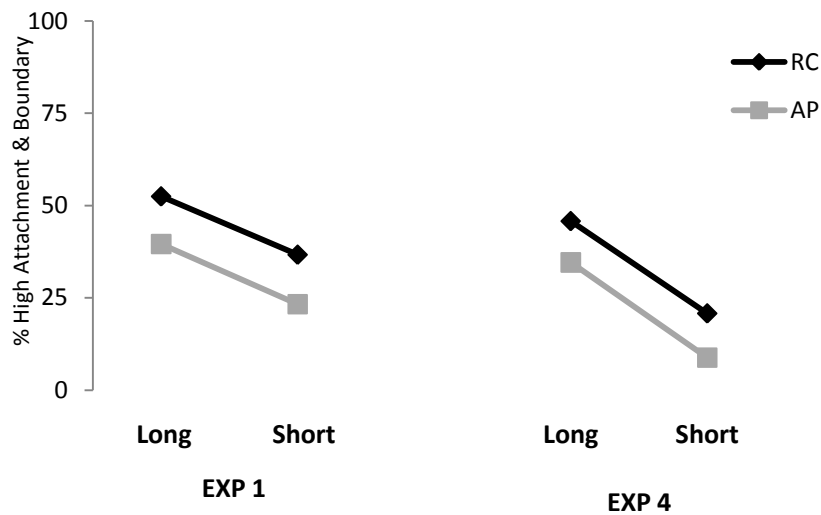


Figure 27: Comparing attachment preference data in Experiment 1 (silent /attachment) with Break data in Experiment 4 (silent prosody).

As mentioned in the beginning of this chapter, the projection of a prosodic phrasing during silent reading and the congruent syntactic interpretation of this prosodic phrasing are viewed as part of a general human cognitive tendency to perceive congruence at language interfaces. This configurational congruence with the natural prosodic phrasing will be compared to the other types of interface congruencies discussed above (configurational congruence with forced prosody, prosodic congruence with forced syntax).

With respect to the question of prosodic congruence with a forced unambiguous syntactic phrasing, we will consider to what extent syntax has an effect on prosodic phrasing. More specifically, we will assess the relative strength of the congruence constraints ALIGN XP and CONGR. In so doing, we will evaluate how these two constraints rank on the constraint scale of the language vis-à-vis other constraints.¹

Having established this, we will look at the question regarding the reverse interface relationship of syntactic congruence with a forced prosodic phrasing. Here we will explore the relative strength of the perception specific congruence constraints ALIGN PB and CONGR_{SYN}. In the light of this, we will evaluate how these two constraints rank in the language.

9.6.3 Linking Theory with Experimental Manipulation

Before discussing the data in detail, it is necessary to give a brief theoretical rationale for the overall design and methodology behind the experiments. A summary

¹ *Alignment* here refers to the placement or perception of a prosodic or syntactic boundary while *CONGR* refers to the avoidance of such a boundary in production and perception. See discussion §9.3 above.

table of this rationale is shown in table 9 below¹. First, there are three factors that were manipulated in the experiments in the present study:

- Manipulation of the syntactic category of the modifier.
- Manipulation of the length of the modifier.
- Manipulation of the attachment of the modifier.

Secondly, the rationale was that if an effect of the manipulation of the phonological lengths of modifiers or the syntactic category² of modifiers is observed in the data in the form of an attachment preference in silent reading, then the standard way to account for these effects would be by reference to an implicit projected phonological representation, matching the phonological structure that would be most naturally projected in the overt prosodic realization of the sentence under investigation.

Furthermore it is assumed that if effects of the manipulation of the lengths or categories of modifiers were observed in the data in the form of a prosodic phrasing preference during silent reading, then the way to account for the effects would similarly be by reference to an implicitly projected phonological representation, matching the phonological structure that would be most naturally projected in the overt prosodic realization of the sentence under investigation. More specifically, if a *syntactic category*

¹ Note that this summary is not intended to be interpretable out of the context of the above discussion.

² In the sentence processing literature on ambiguity and modifier attachment, there are no studies in the literature to date that I am aware of that involve manipulating the modifier category with an Adjective Phrase. However, besides RCs, Prepositional Phrases have been used in experiments of modifier attachment ambiguity (see Hemforth et al. 2005).

effect (effect of manipulation of modifier category) is observed in the data in the form of a difference in prosodic phrasing preference, then the standard way to account for this effect would be by reference to a prosodic phrasing which is produced as an output of an interaction of a set of interface constraints that include category-specific interface constraints namely, *ALIGN_LAP and ALIGN_LRC. Moreover, if a *length effect* (effect of manipulation of modifier length) is observed in the data in the form of a phrasing preference, then the way to account for this effect would be by reference to a prosodic phrasing which is projected as an output of an interaction of a set of interface constraints that include a well-formedness constraint on the size of prosodic phrases namely, BinMin and *P.

In experiment 5 and 6, if an forced attachment elicitation effect (effect of manipulation of attachment) is observed in the data in the form of an overt phrasing preference, then the way to account for this effect would similarly be by reference to a prosodic phrasing which is produced as an output of an interaction of a set of interface constraints and well-formedness constraints. These interface constraints are the syntactic Major Phrase sensitive constraints ALIGN XP, R (for the forced high attachment in - Experiment 6) and CONGR (for the forced low attachment in Experiment 3).

Table 10: Overview of Task, Effects of Manipulations and Proposed Accounts.

TASK	FACTOR	% HIGH / PERCENTAGE POINTS	ACCOUNT	RELEVANT CONSTRAINTS
SILENT READING EXPERIMENT 1	Length	16	MEDIATED BY IMPLICIT PROSODY	*P, BinMin, *ALIGN _L AP, ALIGN _L RC
	Category	13.1		
	Attachment Height	38%		
	N2][Modifier Boundary	NO DATA		
SILENT READING EXPERIMENT 4	Length	25.4	MEDIATED BY IMPLICIT PROSODY	*P, BinMin, *ALIGN _L AP, ALIGN _L RC
	Category	11.6		
	Attachment Height	NO DATA ¹		
	N2][Modifier Boundary	27.5%		
OVERT READING EXPERIMENT 5	Length	9.8	OVERT PROSODY DETERMINED BY INTERFACE CONSTRAINT	CONGR _P , *P, BinMin, *ALIGN _L AP, ALIGN _L RC
	Category	12.3		
	Attachment Height	100% FORCED LOW		
	N2][Modifier Boundary	25.1%		
OVERT READING EXPERIMENT 6	Length	13.4	OVERT PROSODY DETERMINED BY INTERFACE CONSTRAINTS	ALIGN _R XP, *P, BinMin, *ALIGN _L AP, ALIGN _L RC
	Category	23.4		
	Attachment Height	100% FORCED HIGH		
	N2][Modifier Boundary	47.7%		
OVERT READING EXPERIMENT 2	Length	14	SYNTACTIC STRUCTURE DETERMINED BY INTERFACE CONSTRAINTS	CONGR _{syn} , (*P, BinMin, *ALIGN _L AP, ALIGN _L RC)
	Category	27.7		
	Attachment Height	35.1%		
	N2][Modifier Boundary	100% FORCED 0 BREAK		
OVERT READING EXPERIMENT 3	Length	22.2	SYNTACTIC STRUCTURE DETERMINED BY INTERFACE CONSTRAINTS	ALIGN _{PB} , (*P, BinMin, *ALIGN _L AP, ALIGN _L RC)
	Category	18.6		
	Attachment Height	62.4		
	N2][Modifier Boundary	100% FORCED BREAK		

¹ Data for attachment preferences for the LAP condition in experiment 4 was presented in Chapter 8, §8.2.2.

For Experiments 2 and 3 it was assumed that, if a prosodic boundary effect (effect of manipulation of prosodic phrasing) is observed in the data in the form of an attachment preference (high or low), then the way to account for this effect would be by reference to a prosodic \ perception constraint ALIGN PB or CONGR_{syn} favoring the syntactic structure associated with that prosodic contour.

With this rationale in mind, the following is a summary and classification of the constraints that are relevant to these data, which will be followed in §9.7.1 by a discussion of the cross-experiment data analysis of Experiments 4, 5 and 6 (§9.7.2 will discuss Experiments 1, 2 and 3).

9.6.4. Classifications of Constraints

The analysis will consider evidence for the weights of different constraints as well as how these constraints interact.

Syntax-prosody interface constraints

- Syntactic/configuration sensitive constraints

ALIGN XP, R Elicitation specific forced high attach experiment 4

CONGR Elicitation specific forced low attach experiment 3

- Syntactic category sensitive interface constraints

***ALIGN_L AP**

ALIGN_L RC

Prosodic Well-formedness Constraints (Phonological Phrase size sensitive constraints)

BinMin

***P**

Another way to classify the constraints that will be used in the analysis is by whether they encourage or prevent a boundary:

Boundary-Preventing Constraints: *P, CONGR, *ALIGN_LAP, and BinMin

Boundary- Encouraging Constraints: ALIGN R XP, ALIGN_LRC

9.6.5 Classification of Experimental Constructs

The following are descriptions of the different constructs that will be used in the analysis to describe the various interface relationships. This is followed by an account of how these constructs will be used in the explanation of the experimental data.

PROSODY α : this is the term that will be given to whatever default prosody is projected by readers after low level syntactic analysis. [IMPLICIT PROSODY]

PROSODY 0: this is the term that will be given to the prosodic phrasing in which there is no N2][Modifier major prosodic phrase boundary. [OVERT PROSODY]

PROSODY 1: this is the term that will be given to prosodic phrasing in which there is an N2][Modifier major prosodic phrase boundary. [OVERT PROSODY]

SYNTAX 0: this indicates a syntactic structure where there is no major syntactic phrase division after N2 which amounts to a low attachment of the modifier to N2.

SYNTAX 1: this is a syntactic structure in which there is a major syntactic phrase after N2 which amounts to a high attachment of the modifier to N1.

9.7 Analysis and Cross-Experimental Comparison: Empirical Analysis

PRODUCTION EXPERIMENTS

9.7.1 Cross-comparison between Experiment 4, 5 and 6 - *Introduction*

Experiments 4, 5 and 6 are production experiments that elicit prosodic phrasing. Experiment 4 elicited silent prosody whereas experiments 5 and 6 elicited overt prosody. The results of these experiments are framed in terms of the percentage of boundary placement before the modifier (see §8.2.1). Figure 28 shows the results across the three experiments:

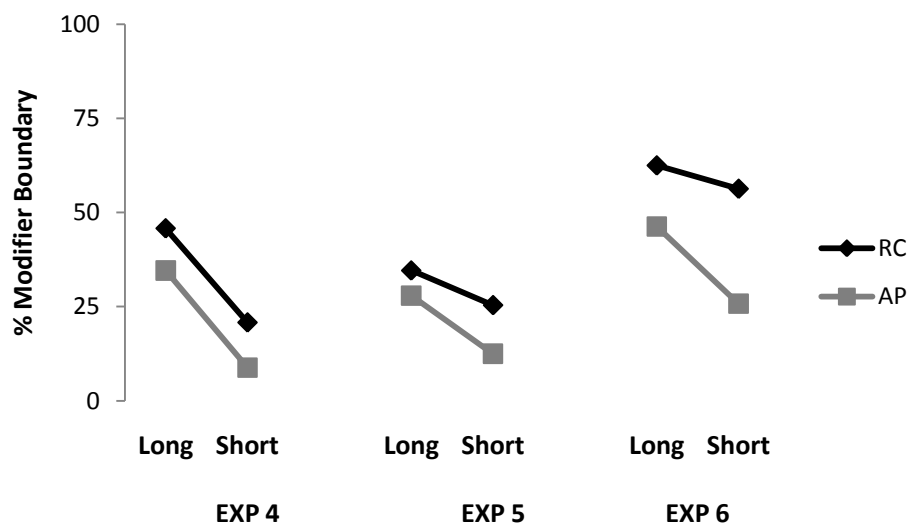


Figure 28: Comparing Data of Production Experiments (Exp 4(silent production of prosody) with Experiments 5 & 6 (overt production of prosody)).

In all three experiments, statistical analysis shows that there is a significant effect of length (with long modifiers having more breaks than short modifiers) and a significant effect of category (with RCs having more breaks than APs) (See Chapter 8, §8.2.2 for a detailed statistical analysis of variance).

Figure 29 below is a summary of the category and length effects across experiments 4, 5 and 6. Experiment 4 shows a relatively large effect of length, while experiment 6 shows a greater effect of syntactic category. An explanation of this cross-experimental variation in effects will be discussed below.

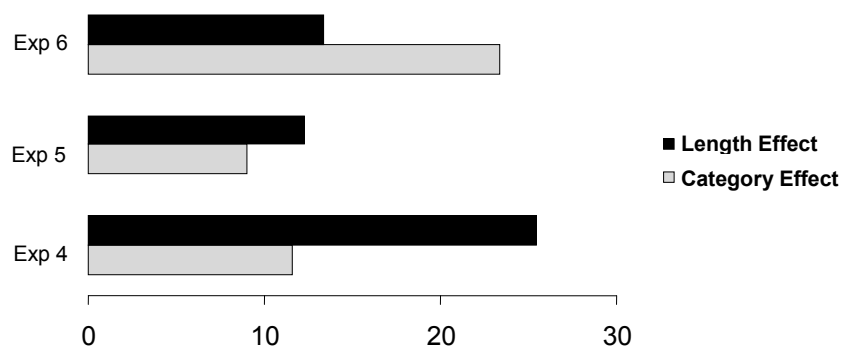


Figure 29: Category and Length Effects across production experiments

First recall that the type of interface congruence that will be analyzed in the comparison of experiment 3 and 4 is the extent of prosodic congruence with the syntax. The questions are: *Does the syntax affect the overt prosodic phrasing of the sentence? How much? What kind of prosodic phrasing do speakers of SA associate with a given*

syntactic structure? Another related question is: *What are the relative strengths/weights of the configuration-specific constraints ALIGN XP and CONGR in relation to the other proposed constraints for SA?*

From a syntactic viewpoint, Arabic is mainly a right-branching language. It is prosodically a right-aligning language. Therefore satisfying the alignment constraint would result in different phrasings for low and high attachment. In the low-attachment structure in Figure 30, there are no maximal projection edges after N2; therefore a prosodic break is predicted not to occur at this position in accord with CONGR. In experiment 5, the syntactic representation is forced to represent a low attachment i.e. N2 and the modifier (RC or AP) are forced into one syntactic phrase as illustrated in Figure 30 below.

LOW ATTACHMENT $[_{NP} Det [_{N'} N' [_{NP} Det [_{N'} N' [RC/AP]]]]]$

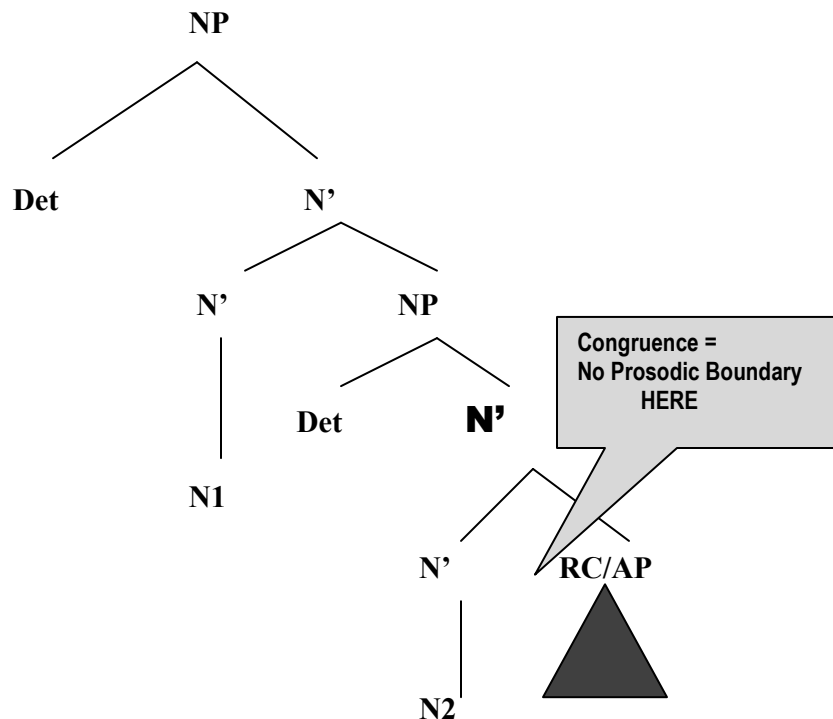


Figure 30: Syntactic structure representing Low attachment of the Modifier.

Here prosodic congruence with the syntactic bracketing would mean the lack or avoidance of a prosodic boundary between N2 and the modifier.

For high attachment, on the other hand, a prosodic boundary is predicted to be congruent with the right-edge of the syntactic maximal projection. In experiment 6 (forced high attachment), aligning with the syntactic representation would mean placing the modifier in a separate prosodic phrase Figure.31.

HIGH ATTACHMENT

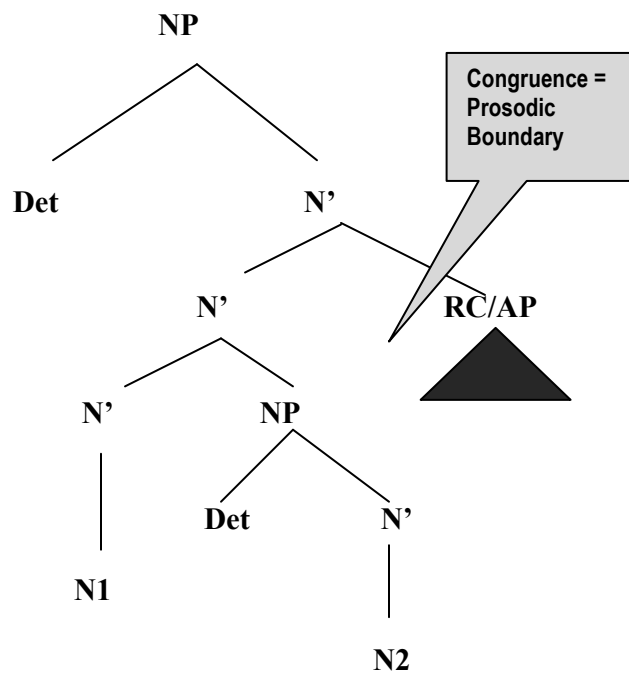


Figure 31: Syntactic structure representing High Attachment of the modifier

The following discussion will first consider the overt production of forced low attachment (Experiment 5) and then forced high attachment (Experiment 6). We will then compare the interface association of syntax-prosody extracted from the data of the two

experiments with the silent reading of ambiguous sentences in Experiment 4. The discussion will further suggest which overt prosodic phrasing (Experiment 5 or 6) is more in-line with the implicit prosodic phrasing preferred by readers in Experiment 4.

9.7.1.1 Experiment 5 – *Introduction*

Generalizing over length and category, there is an overall 25% pre-modifier boundary occurrence in experiment 3 (forced low attachment elicitation). The 75% prosody 0 phrasing in Experiment 3 which indicates a significant preference not to place a boundary before the modifier is compatible with the proposed boundary-preventing constraints CONGR and *P where the former is a configuration sensitive constraint and the latter is a general syntax-independent prosodic constraint on prosodic phrasing. Also relevant here are the effects of other boundary- preventing constraints *ALIGN_LAP and BinMin where the former is a category sensitive constraint whereas the latter is a length specific constraint.

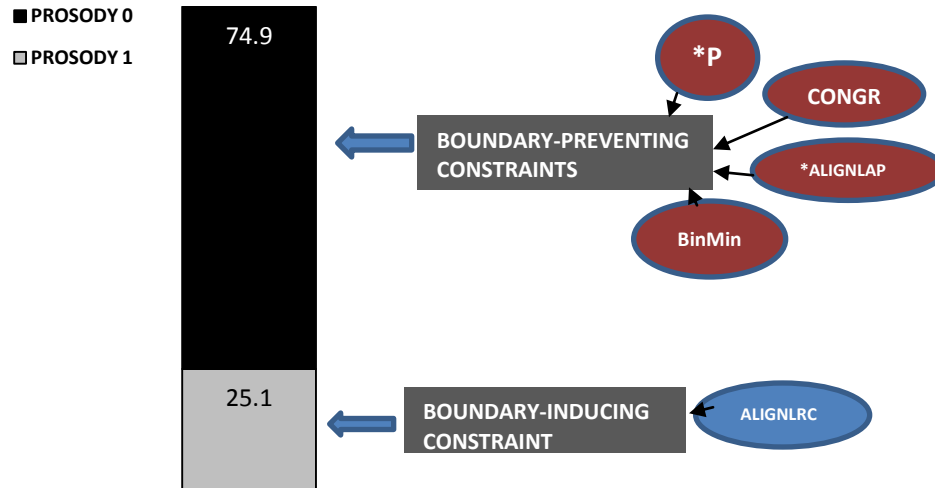


Figure 32: Percentage Pre-Modifier Boundary (prosody 1) vs. No Boundary (prosody 0) for Forced Post-To-Times Low Attachment (Experiment 5)

From the above mentioned data, we can say that, in general, the syntactic analysis of low attachment of the modifier is associated with a significant tendency not to place a boundary between N2 and the modifier. We will now analyze in more detail how the different effects mentioned earlier in this chapter (see § 9.7.1, Fig.29) are relevant to this generalization. Recall that this significant tendency in prosodic phrasing is proposed to be the output of constraint interaction.

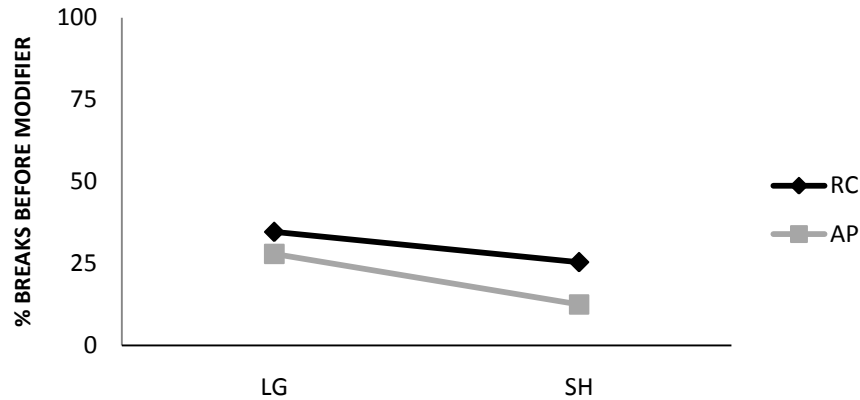


Figure 33: Experiment 5. Category and Length Effects on pre-modifier boundary placement for Post-To-Times forced low attachment (LG = long modifier; SH = short modifier).

9.7.1.1.1 Category Effect

First let us examine the category effect and the interaction of category specific constraints (*ALIGN_LAP and ALIGN_LRC) with the other proposed constraints (*P, CONGR and BinMin). Recall that the statistical data analysis for the overt elicited production task in experiment 3 (forced low attachment) shows that the main effect of *modifier category* (RC/AP) on the prosodic phrasing of stimulus sentences is such that an N2][Modifier Boundary is more frequent for RCs (30.0%) than for APs (20.2%).

The difference in effect between RCs and APs in experiment 3, which is an approximately 10 percentage point difference, is consistent with the effect of the category-specific constraints *ALIGN_LAP and ALIGN_LRC (with *ALIGN_LAP preventing a boundary before the modifier and ALIGN_LRC encouraging a boundary before the modifier).

The relative weakness of this category effect (which is significant by subjects but only a trend by items) might be accounted for by the proposed constraint interaction whereby the boundary-preventing category related constraint *ALIGN_LAP and other boundary-preventing constraints (*P, CONGR and BinMin) are compatible with 80% of the AP data. This cumulative ganging-up of boundary-preventing based constraints could be described as having more weight than the boundary inserting constraint ALIGN_LRC which is compatible with only 30% of the RC data.¹ In other words, the weight of ALIGN_LRC is in conflict with all the combined weights of the boundary-preventing constraints hence, only making a slight 10 percentage point effect. The other 70% preference not to make a break before the modifier in RC data is accounted for by the combined weights of the boundary-preventing constraints CONGR, *P and BinMin.

For the AP data, however, the 80% preference not to make a boundary before the AP modifier is compatible with the combined effects of CONGR and *P and *ALIGN_LAP. Also BinMin is relevant here as a constraint on the size of prosodic phrases which is similarly considered a boundary-inhibiting constraint. It is hard however to discern here which and how much each of these constraints is affecting the outcome. However it is safe to say for now that the combined effects of the boundary-preventing constraints have more weight than the break-inserting constraint ALIGN_LRC. We cannot infer how strong CONGR is here because we can't tell which one is doing the work *ALIGN_LAP, CONGR or *P (all are break-preventing constraints).

¹ It is relevant to recall here that the ALIGN_LRC constraint is the only break-inserting constraint proposed for SA here other than ALIGN XP, R which is not activated in experiment 3.

It is clear, however, that the slightly higher preference to make a break before relative clauses can be attributed to the only category-sensitive boundary-inserting constraint $\text{ALIGN}_{\text{LRC}}$ which is in conflict with all other proposed constraints. Also the preference not to make a break before APs is attributed to the category-sensitive boundary-preventing constraint $\ast\text{ALIGN}_{\text{LAP}}$ which reinforces (gangs-up with) the other proposed boundary-preventing constraints.

9.7.1.1.2 Length Effect

For the RC data in Experiment 5 there is an approximately 9 percentage point difference between LRC (long relative clauses) and SRC (short relative clauses) with respect to the production of a pre-modifier prosodic boundary. This can be accounted for as the effect of the length-specific constraint BinMin. BinMin is relevant for the RC data because the RCs in experiment 5 had different lengths (LRC: 4PWds and SRC: 2PWds). Recall, as mentioned in §9.3.2.5, that BinMin in SA is a constraint that proportionately penalizes phrases of less than 4 PWds so a phrasing where there is a break before SRC (2 PWds) will accrue 2 violations. However, in the LRC condition (4 PWds), BinMin is not in play because a boundary before the modifier here does not violate BinMin.

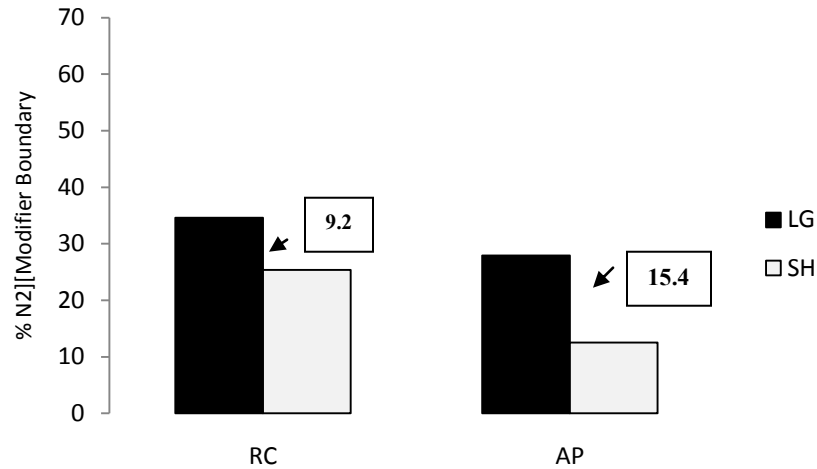


Figure 34: Experiment 5- Category and Length Effects on pre-modifier boundary placement for Elicited Production (Post-To-Times) forced low attachment.

Similarly for the AP data in experiment 3 there is a 15.4 percentage point difference between LAP (long AP: 3 PWds) and SAP (short AP: 1 PWd) which can also be accounted for as the effect of the length-specific constraint BinMin. In the LAP condition, BinMin is violated once whereas a boundary before SAP accrues 3 violations of BinMin, so this numerical difference between LAP and SAP is compatible with the number of violations of the proposed size-monitoring constraint BinMin.

The mean effect of length generalizing over RCs and APs is 12.3 percentage points which is a small difference but highly significant. In both cases (APs and RCs), the length difference amounts to two BinMin violations where the cost per violation can be assessed.

9.7.1.1.3. Summary of Constraints

The following is a recap of the findings for constraint weight and constraint interaction in experiment 3. First, the combined weight of the boundary-avoiding constraints CONGR, *P, *ALIGN_LAP and BinMin have been shown to have more weight than the boundary-inserting ALIGN_LRC constraint. The combined effect of these boundary-avoiding constraints is compatible with a significant preference not to make a major prosodic phrase boundary before the modifier.

These findings of the overall data allow us to reach a preliminary conclusion that there is a significant association between SYNTAX 0 (low attachment) and PROSODY 0 (no pre-modifier break phrasing) in SA, in line with findings of other languages. We can also possibly infer that the syntax-specific interface constraint CONGR, which is activated by SYNTAX 0, in conjunction with *P are strong constraints whose combined weights favor the production of PROSODY 0 and hence the overall 75% PROSODY 0 preference in experiment 5.

The length effect for RCs observed in experiment 5 is in line with data in Bradley et al. (2003) for English RCs using the Post-to-Times elicitation protocol with RCs forced low, where the separate phrasing of the modifier was found to be significantly more likely for LRC than SRC. However different results were obtained in Shaked (2006, 2009) using Bradley et al. Post-to-Times elicitation protocol for the Construct State in Hebrew: for forced low attachment of SRC, PROSODY 1 and PROSODY 0 were found to be equally likely while for LRC PROSODY 1 predominated. For RC attachment to a Free State nominal in Hebrew, Shaked found 40.6% occurrence of PROSODY 1 and 27.1

PROSODY 0 for forced low SRC; there was also 32.3% PROSODY 2 (i.e., (N1)(ofN2)). For forced high attachment of LRC, prosody 1 predominated.

It appears that the length effect varies cross-linguistically. The mismatch between the Arabic data and Hebrew Construct State data is particularly striking in view of the fact that Arabic and Hebrew Construct State nominals have similar morphosyntactic properties of the Construct State. The different ranking of constraint on prosodic phrasing in the two languages could be offered as the reason for this variation (see p.242). It is suggested that the cross-linguistic variation in interface constraints is a more important influence than similarities of syntax and morphology.

9.7.1.2 Experiment 6 – *Introduction*

Generalizing over length and category, there is an overall 47.7% pre-modifier boundary occurrence in Experiment 6 (forced high elicitation). This approximately 48 % preference in experiment 6, which indicates a higher tendency to place a boundary before the modifier than the 25% in experiment 5 as shown in Figure 35, is compatible with the configuration-specific constraint ALIGN XP, R which is a constraint that was inactive in experiment 3. This constraint is sensitive to the right-edge syntactic XP boundary present in the elicited stimulus sentences in experiment 6.

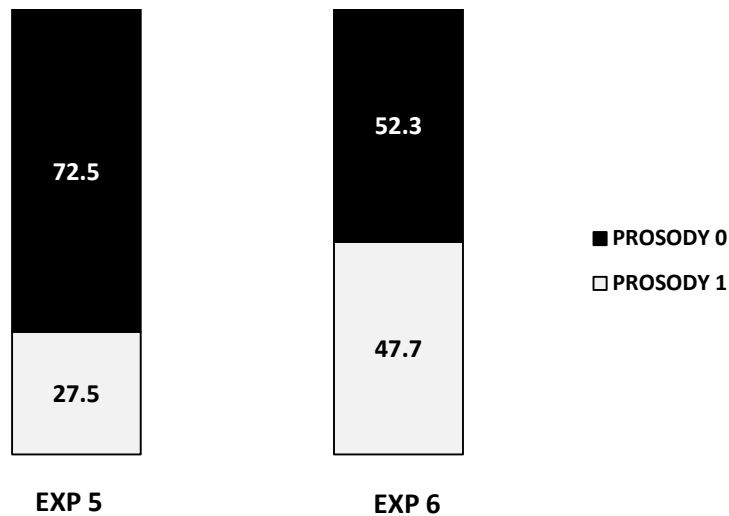


Figure 35: Comparison of Overt Prosody Production Experiments 5& 6- Overall prosodic phrasing preferences shows a stronger preference for prosody 0 (no boundary) for low attachment than for high attachment.

It is important to note, however, that ALIGN R XP does not yield a majority of pre-modifier breaks. This indicates that it is outweighed by some other constraint or a combination of constraints. In general the syntactic analysis with high attachment of the modifier is associated with an approximately 48% tendency to place a boundary after N2, greater than for low RC-attachment, yet not overall greater than chance. We will now analyze in more detail how the effects of category and length presented earlier in this chapter (see Fig.29) are relevant to this generalization.

9.7.1.2.1 Category Effect

First let us look at the category effect and the interaction of the category-specific constraints (*ALIGN_LAP, ALIGN_LRC) with the other proposed constraints (ALIGN_RXP, *P, BinMin). Recall that the statistical analysis for Experiment 4's overt elicited

production task (forced high attachment) shows a highly significant main effect of modifier category (RC/AP) on the prosodic phrasing of stimulus sentences, such that an N2][Modifier Boundary is more frequent for RCs (59.4%) than for APs (36.0%).

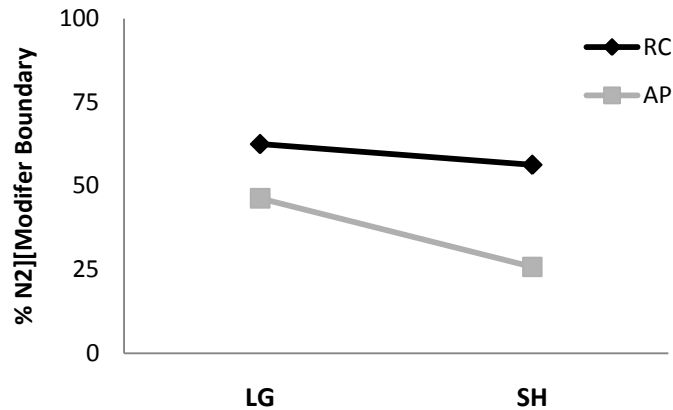


Figure 36: Category and Length Effects in Exp 6: elicited forced high attachment.

The two boundary-inserting constraints $ALIGN_{XP,R}$ and $ALIGN_L RC$ (which reinforce each other) account for approximately 60% of the overall RC data, while the other approximately 40% is accounted for by other constraints that inhibit an N2][Modifier Boundary – possibilities are *P which applies generally and BinMin which applies to and violated by SRC, LAP and SAP.

With regards to APs on the other hand * $ALIGN_L AP$, *P and BinMin account for 64% of the AP data while $ALIGN_{XP}$ accounts for 36%. It is reasonable to infer here that the combined effect of * $ALIGN_L AP$, *P and BinMin is stronger than that of $ALIGN_R XP$.

$$*P + *ALIGN_L AP + BinMin > ALIGN_R XP$$

The difference in occurrence of pre-modifier breaks between RCs and APs in experiment 6, which is approximately a 23 percentage point difference, is compatible with the effect of the category-specific constraints *ALIGN_LAP and ALIGN_LRC (with *ALIGN_LAP blocking a boundary before the modifier and ALIGN_LRC encouraging a boundary before the modifier). This category effect could be explained by the proposed constraint interaction whereby, for RCs, the category-based boundary-inserting constraint ALIGN_LRC reinforces the configuration-based boundary-inserting constraint ALIGN_R XP. On the other hand, for APs, the boundary-preventing constraint *ALIGN_LAP is in conflict with ALIGN_RXP and together with the other boundary-suppressing constraints *P and BinMin, it outweighs ALIGN_R XP.\

9.7.1.2.2 Length Effect

The 62.5% pre-modifier boundary placement preference in experiment 4 for LRC is compatible with ALIGN_RXP and ALIGN_LRC, which would counteract the *P constraint. Since the LRC is 4Pwds, no length constraint is violated. *P is shown here to have less strength than the combination of ALIGN_RXP and ALIGN_LRC. Recall however that *P and CONGR in experiment 3 were seen to have more weight than ALIGN_LRC. So the following preliminary scale emerges:

LRC only where BinMin does not apply.

34.6% pre-modifier boundary EXP 5: $\boxed{*P-PHASE + CONGR > ALIGN_L RC}$

62.5% pre-modifier boundary EXP 6: $ALIGN_R XP + ALIGN_L RC > *P-PHRASE$

The 56.3% boundary occurrence for SRC in Experiment 6, can be accounted for by $ALIGN_R XP$ and $ALIGN_L RC$ while the 43.7% no boundary is compatible with BinMin and *P.

$$ALIGN XP, R + ALIGN_L RC \approx *P-PHRASE + 2 \text{ Violations of BinMin}$$

The small difference in pre-modifier boundaries (6.3 percentage points) between LRC and SRC can be attributed to a double BinMin violation by SRC. The cost of 2 violations of BinMin was 6.3 percentage points, which is significant and which closely matches the results in Exp5, where the cost of 2 BinMin violations was 12.3 percentage points.

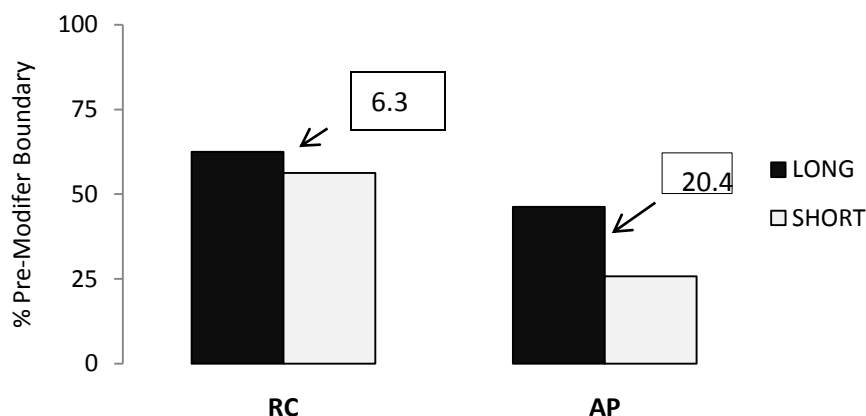


Figure 37: Length Effect in experiment 6: Elicited Production (Post-To-Times) forced high attachment. Graph shows a larger difference in length effect for APs than for RCs.

For LAP, the 46.3% presence of a pre-modifier boundary can be, accounted for by $ALIGN_R XP$ while the 53.7% no boundary is compatible with $*ALIGN_L AP$ and *P and 1

violation of BinMin. For SAP, the corresponding data are 25.8% boundary and 74.2% no boundary. The only difference in relevant constraints between LAP and SAP is 1 vs. 3 BinMin violations, so the 20.5 percentage point difference between them could be attributed to the two additional BinMin violations¹ (which is more than the estimate in Experiment 5).

In Experiment 5 (forced low attachment), the only constraint that could be encouraging a break in the LRC condition is the break-inserting constraint ALIGN_LRC which could therefore be held responsible for the 34.6% pre-break boundary, despite the boundary-preventing constraints *P and CONGR. For LRC in experiment 6 (forced high attachment) the constraints are the same except that an added break-inserting constraint ALIGN_RXP applies to LRC and the break preference rises to 62.5% (a difference of 27.9 percentage points compared to experiment 5 (forced low attachment)).

For SRC the relevant constraints are similar to those for LRC except that BinMin applies in both experiments. The cross-experiment difference to be attributed to the configuration-based constraint ALIGN_RXP in this case is 30.9 percentage points, very similar to the difference for LRC.

For APs in experiment 6, ALIGN_LRC is not applicable and *ALIGN_LAP does apply, creating a greater disparity in pre-modifier boundaries between AP and RC in experiment 6 than in experiment 5, as expected. Also BinMin constraint violations are incurred by both LAP (1 violation) and SAP (3 violations in both experiments), yielding

¹ Sorace & Keller (2005) demonstrate that “cumulatively effects do not only incur for multiple violations of different constraints, but also for multiple violations of the same constraint.” (Sorace & Keller 2005:13). So here multiple violations of BinMin (3 violations) have a higher cumulative effect than 1 or 2 violations.

fewer boundaries for SAP and LAP across the board. The cross-experiment difference due to $ALIGN_R XP$ is 18.4 percentage points for LAP and 13.3 percentage points for SAP, with the SAP apparently particularly resistant to a pre-modifier boundary. For example $ALIGN_R XP$ can largely balance $*ALIGN_L AP$ and one BinMin violation, but not $*ALIGN_L AP$ plus 3 BinMin violations.

9.7.1.2.3 Summary of Constraint interaction

The following is a recap of the findings for constraint interaction in experiment 6. The combined weights of the boundary-inserting constraints $ALIGN_R XP$ and $ALIGN_L RC$ cumulatively outweigh $*P$ and BinMin. However, the cumulative weight of $*P$, 3 violations of BinMin and $*ALIGN_L AP$ outweigh $ALIGN_R XP$ for short adjective phrases. This constraint interaction is compatible with a preference to insert a boundary before the relative clause modifier when attaching high. This indicates that there is a significant association between SYNTAX 1 (high attachment) and PROSODY 1 (modifier boundary) in SA for relative clauses, but not so much for adjective phrases. This association is accounted for by the constraint interaction which for relative clauses supports a boundary whereas for adjective phrases it discourages such a boundary.

9.7.1.3 Summary of Comparison of Experiments 5 & 6

One point of major interest is that the combined weights of the boundary-preventing constraints which include CONGR appear to have a stronger effect in SA than the constraint $ALIGN_R XP$.

The combined effects of the boundary-preventing constraints in experiment 5 yield an overall 75% tendency not to place a boundary before a modifier, while ALIGN_RXP in experiment 6 yields an overall 48% tendency to insert a boundary before a modifier. This could be offered as an answer to the question that was asked at the beginning of this discussion in §9.7.1: the data for SA indicate that the prosodic congruence with low attachment syntax is stronger than with high attachment syntax. This appears not to be the case in other constructions/languages for which data are available, such as the Hebrew Free State and Construct State nominals with RC modifiers (Shaked 2009), or Croatian complex nominals without preposition *od* with RC modification (Lovrić 2003). Those constructions show a very strong tendency to exhibit a break before a long RC regardless of attachment height, and that length-induced effect may mask a sensitivity difference between high and low RCs by creating ‘spuriously’ correct prosody for high attachment. In SA, which is evidently more tolerant of long prosodic phrases, the attachment height effect may be seen more clearly. However, differences in experimental methods and in materials (e.g., with respect to actual lengths of ‘long’ and ‘short’ modifiers) make precise cross-language comparisons difficult to draw.

9.7.1.4 Experiment 4

From the perspective of the IPH there is interest in how the implicit prosody results of experiment 4 relate to the results of the overt prosody production experiments 5 and 6. A first glance indicates that there is a closer resemblance with experiment 5 (with

a 2 percentage point difference in overall boundary preference) than with experiment 4 (with a 20 percentage points difference in overall boundary preference) (see Fig. 38). We see the usual length and category effects on break placement, with an overall pattern more similar to that for forced low attachment than for forced high attachment.

Looking more closely at the data we observe a larger effect of modifier length in Experiment 4 than in Experiment 5. The following discussion will look into this and other differences between Experiment 4 and Experiment 5, in light of the constraints that can be expected to be active in silent reading.

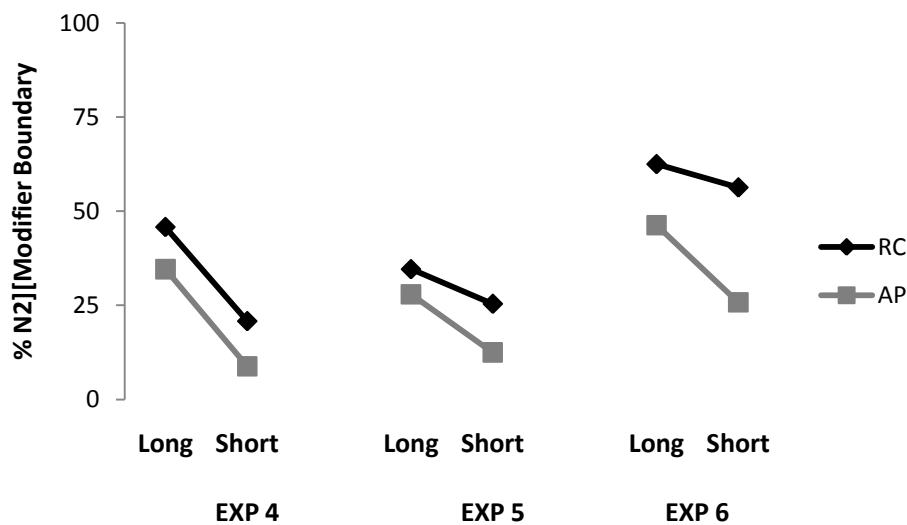


Figure 38: Cross-comparison of Exp 4, 5 and 6. Difference in lengths and category effect between Exp 4 (silent prosody) and Exp 5 and 6 (forced overt prosody).

Recall that in Experiment 4 (elicited silent prosody, with ambiguous target items), the method used did not force any particular syntactic representation, unlike the situation

in Experiments 5 & 6. It is possible that participants have some bias toward either high or low attachment based on the content of the sentences, or on language-specific parsing tendencies. However, the Implicit Prosody Hypothesis maintains that at least in some proportion of cases, the attachment interpretation is determined secondarily, as a consequence of prosody assignment on the basis of an initial low-level syntactic analysis (which does not itself include commitment to a particular attachment of the modifier; see § 9.2 above). In that case $\text{ALIGN}_{\text{R}}\text{XP}$ and CONGR will not be in play in the mental production of prosody. However, if it is true, as IPH claims, that implicit prosody projection is guided by the same ranked principles in the grammar that guide overt prosody production, then the prosodic patterns observed in Experiment 4 are predicted to be comparable to those in Experiments 5 and 6 once alignment/congruence phenomena are factored out.

The data shows an overall 27.5% pre-modifier boundary preference in Experiment 4 suggesting dominance of the boundary-preventing constraints $\ast\text{P}$, $\ast\text{ALIGN}_{\text{L}}\text{AP}$ and BinMin over the boundary-inducing constraint $\text{ALIGN}_{\text{L}}\text{RC}$. But within this general low rate of boundaries, there are significant effects of modifier category and modifier length to be accounted for.

9.7.1.4.1 Category Effect

First let us look at the category effect and the interaction of category specific constraints with the other proposed constraints. The data analysis for the elicited silent production task in Experiment 4 shows a main effect of modifier category (RC/AP) on

prosodic phrasing such that an N2] boundary is more frequent before RCs (33.3%) than before APs (21.7%).

Though small, the difference in prosody between RCs and APs is highly reliable. It is in line with the category-specific constraints $\text{ALIGN}_{\text{L}}\text{RC}$ (which encourages a boundary) and $\ast\text{ALIGN}_{\text{L}}\text{AP}$ (which discourages a boundary). However the general tendency is toward absence of breaks: in none of the conditions in Experiment 4 does the percentage of breaks exceed 50%. This is compatible with the fact that the boundary-preventing constraint $\ast\text{P}$ is also applicable in silent reading and would reinforce the effect of $\ast\text{ALIGN}_{\text{L}}\text{AP}$, whereas it is in conflict with $\text{ALIGN}_{\text{L}}\text{RC}$ which is the only break-inserting constraint proposed for SA (other than $\text{ALIGN}_{\text{R}}\text{XP}$ which we are assuming to be inactive in Experiment 4).

This category effect (which is significant by subjects and by items) might be explained by the proposed ganging-up of the boundary preventing constraints $\ast\text{ALIGN}_{\text{L}}\text{AP}$ with $\ast\text{P}$ and BinMin which are together compatible with 78.3% of the AP data. The combined weights of the boundary preventing constraints could be described as having a stronger effect than the boundary inserting constraint $\text{ALIGN}_{\text{L}}\text{RC}$ which is compatible with only 33.3% of the RC data.

For LRC (45.8%) with no BinMin violation or $\ast\text{ALIGN}_{\text{L}}\text{AP}$, it seems that $\ast\text{P}$ is more or less equally matched with $\text{ALIGN}_{\text{L}}\text{RC}$.

For LAP however, there is one unexpected finding. As proposed, a boundary before a long adjective modifier would accrue a violation of $\ast\text{ALIGN}_{\text{L}}\text{AP}$, $\ast\text{P}$ and one violation of BinMin which, cumulatively, would predict that a boundary before the long

AP modifier is a very suboptimal choice. However, it was suggested in section 9.4 that the atypical length of an AP could create “*noise*” during processing (see section 9.5.3). In light of this, the 34.6% occurrence of a boundary in the LAP condition could be viewed as a result of the categorical atypicality of the adjective phrase thereby affecting the working of *ALIGN_{LAP}. A related explanation is that long adjective phrases in SA are usually headed by a deverbal adjective which is similar to a reduced relative structure.

9.7.1.4.2 Length Effect

The effect of modifier length in experiment 4 is reliable, indicating that BinMin is at work; indeed, the length effect here is twice as big as that in Experiment 5. In the LRC condition, a boundary before N2 does not violate BinMin. However, a boundary before SRC accrues 2 violations of BinMin. So the 25 percentage point difference between LRC and SRC in number of boundaries must be attributed to the effect of two BinMin violations.

In the AP data there is a similar (25.8 percentage points) difference between LAP and SAP which can also be accounted for by the effect of two BinMin violations: in the LAP condition, a pre-boundary constitutes a single BinMin violation while a boundary before SAP accrues 3 violations.

Let us now consider the larger length effect (approximately double the size) in Experiment 4 compared with Experiment 5. It must be pointed out the following explanation is presented as a tentative one, and that the difference in question is a

numerical difference whose reliability is not known as there is no appropriate cross-experimental statistical comparisons between these two experiments.

The difference (approximately double the effect) in size of the length effect between experiment 4 and 5 could be attributed to the configuration sensitive constraint CONGR which is proposed to be at work in experiment 5. It is suggested that this constraint is not active in the elicitation task in experiment 4 whereas all the other proposed constraints are (*P, BinMin, *ALIGN_LAP and ALIGN_LRC). If we look within long modifiers, we see that a modifier boundary is more frequent for LRC in experiment 4 than experiment 5 with a difference of 11.2 percentage points.

Because BinMin does not apply for LRC and CONGR is not active in experiment 4, it follows that ALIGN_LRC is given free reign with only *P to oppose it. *P is not as strong as CONGR. In experiment 5, CONGR is active and gangs up with *P against ALIGN_LRC helping to prevent a break before LRC, but in experiment 4 *P has less power to oppose a break before LRC.

Since CONGR has a uniform effect over item types, the difference between them becomes more discernable when CONGR is taken out; for example BinMin's effect is more detectable in experiment 4. However the category effect does not increase as might have been expected. The following table 11 is presented as a summary of the interaction of constraints across all production experiments.

Table 11: Overview of constraint interaction and percentage breaks for each condition across Experiments 4, 5 and 6.

LRC		CONSTRAINT INTERACTION
45.8%	EXP 4	$*P \approx \text{ALIGN}_L\text{RC}$
34.6%	EXP 5	$*P + \text{CONGR} > \text{ALIGN}_L\text{RC}$
62.5%	EXP 6	$\text{ALIGN}_R\text{XP} + \text{ALIGN}_L\text{RC} > *P$
SRC		
20.8%	EXP 4	$*P + 2\text{BinMin} > \text{ALIGN}_L\text{RC}$
25.4%	EXP 5	$*P + \text{CONGR} + 2\text{BinMin} > \text{ALIGN}_L\text{RC}$
56.3%	EXP 6	$*P + 2\text{BinMin} \approx \text{ALIGN}_R\text{XP} + \text{ALIGN}_L\text{RC}$
LAP		
34.6%	EXP 4	$*P + * \text{ALIGN}_L\text{AP} + 1\text{BinMin} > \text{Break}$
27.9%	EXP 5	$*P + \text{CONGR} + * \text{ALIGN}_L\text{AP} + 1\text{BinMin} > \text{Break}$
46.3%	EXP 6	$*P + * \text{ALIGN}_L\text{AP} + 1\text{BinMin} \approx \text{ALIGN}_R\text{XP}$
SAP		
8.8%	EXP 4	$*P + * \text{ALIGN}_L\text{AP} + 3\text{BinMin} > \text{Break}$
12.5%	EXP 5	$*P + \text{CONGR} + * \text{ALIGN}_L\text{AP} + 3\text{BinMin} > \text{Break}$
25.8%	EXP 6	$*P + * \text{ALIGN}_L\text{AP} + 3\text{BinMin} > \text{ALIGN}_R\text{XP}$

9.7.1.5 Experiment 4 is more like experiment 5 than experiment 6

In all respects the constraints at work in experiment 4 are identical to those in experiment 3, except for the proposed added influence of the break-preventing constraint CONGR in experiment 5 which predicts that the proportion of breaks should be somewhat lower in experiment 5 than in experiment 4. This is numerically true for LRC and LAP while having very little difference in the opposite direction for SRC and SAP as shown in Fig.39 below.

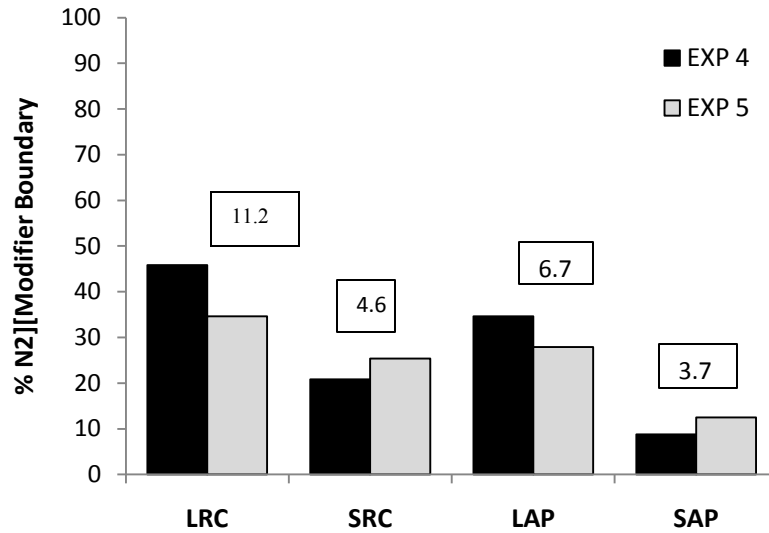


Figure 39: Effect of experimental method across Experiments 4 and 5 (percentage point differences between experiments are shown in boxes).

The constraints at work in experiment 4 and 6 are also identical except for the proposed added influence of the boundary-inserting constraint $ALIGN_{RXP}$ in experiment 6 which predicts that the proportion of breaks should be higher in experiment 6 than in experiment 4. This is numerically true across all conditions as shown in fig.40 below.

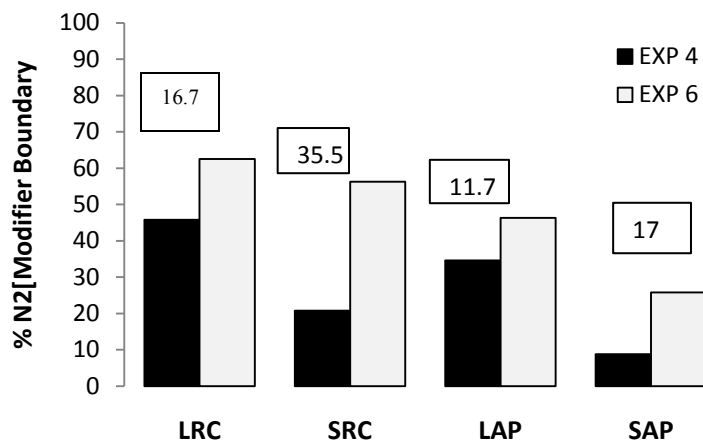


Figure 40: Effect of experimental method across Experiments 4 and 6 (percentage point differences between experiments are shown in boxes).

9.7.1.6. Conclusion

I now draw together the outcomes of the cross-comparison between experiments 4, 5 and 6. As indicated above, CONGR is a constraint that complements (gangs up with) other boundary preventing constraints in SA such as *P, *ALIGN_LAP and BinMin. ALIGN_R XP, on the other hand, although it is ranked high, only benefits or complements ALIGN_LRC; it is in conflict with all other constraints that penalize the placement of a boundary. This makes ALIGN_RXP susceptible to being cumulatively outweighed by violations of the category-specific constraint *ALIGN_LAP and/or the length-specific constraint BinMin as well as *P.

Low attachment was shown to be, overall, strongly associated with a tendency in overt prosody to avoid a boundary before the modifier across conditions whereas high attachment was shown to be associated with the tendency to make a break in overt prosody for relative clauses though less so for adjective phrases. It was also shown that the implicit prosodic phrasing preferences for ambiguous sentences in silent reading were closer to the patterns of prosodic phrasing exhibited in response to the unambiguous low attachment sentences than to high attachment. Preferences in prosodic phrasing in these experiments were presented as the workings of constraint interaction.

In theoretical terms, the conclusion of interest is that the best explanation for the data do not rest on the assumption that one constraint outranks another, thereby causing an optimal choice to be made. Rather, the data are better explained by a mechanism where the weights of a number of constraints are evaluated and combined and then sometimes affected by performance-related factors that can then influence the final

optimal selection. The data are therefore compatible with a constraint-weighting model rather than a constraint competition model.

Having presented how readers of SA produce prosodic phrasing in overt and silent reading it is now the aim of the following section to present how readers of SA perceive prosodic phrasing and how that relates to how silent reading affects the SA reader's comprehension of ambiguous sentences. We will then examine how the cross-comparison between the production experiments is related to the perception experiments and the IPH.

PERCEPTION EXPERIMENTS

9.7.2 Cross-comparison between Experimentss 1, 2 and 3

Experiments 1, 2 and 3 are pure perception experiments which elicit modifier attachment preferences. Experiments 2 and 3 (forced prosody experiments) manipulate the overt prosodic phrasing of stimulus sentences by means of orthographic conventions (vowelized orthography) in a written questionnaire. Experiment 1 is a standard silent reading questionnaire in which the same stimulus sentences are presented in non-vowelized orthography to elicit attachment preferences without imposing any particular prosody. The results of these experiments are presented, as above, in terms of the percentage of high modifier attachment. Figure 41 shows the results across the three experiments:

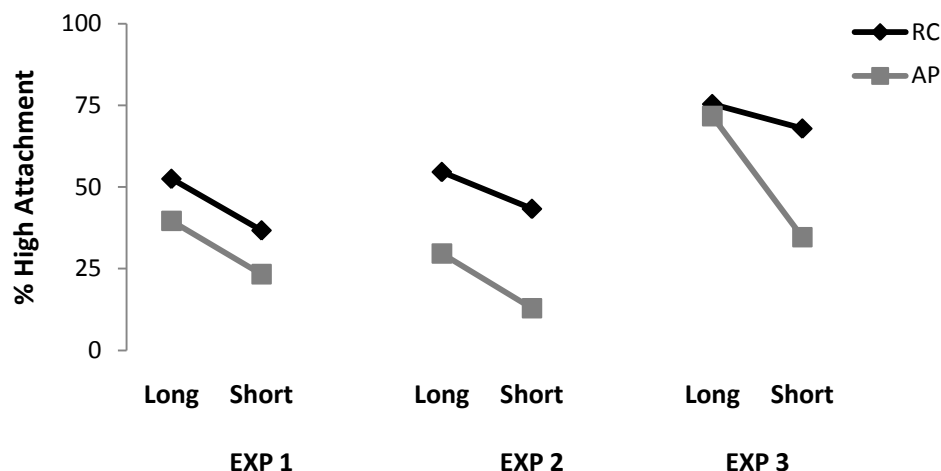


Figure 41: Comparison of perception experiments: Silent reading (Exp 1). Overt forced PROSODY 0 (Exp 2) and forced PROSODY 1 (Exp 3).

These experiments differ from the production experiments discussed above. Unlike experiments 5 and 6 where there is a forced syntactic structure and participants associate a prosodic phrasing with that syntax, in experiments 2 and 3 a prosodic phrasing is forced onto the stimulus and participants must associate a syntactic structure with it in order to interpret the sentence. Here there is no need to compute the optimal prosodic output. Rather, with prosody already set, the constraints that are relevant here are constraints on the interpretation of prosodic phrasing such as ALIGN PB and CONGR as was discussed in § 9.2.

Of particular interest are constraints of a kind that affect the configurational interpretation of the prosody. In short: the direction of the interface relationship in this case begins with a forced prosodic phrasing in the stimulus and leads to a syntactic (hence semantic) interpretation of the sentence based on that prosodic phrasing. This is of

interest in relation to experiment 1, which is a standard silent reading comprehension task in which neither prosody nor syntactic structure is enforced in the stimulus: under IPH, it is assumed that default prosody is projected, and that the syntactic interpretation can thereby indirectly reveal what the default prosody is.

However, the task in experiments 2 and 3 included the production of a forced prosody prior to the interpretation task. After a participant read the sentence in the forced phrasing determined by the orthography, they then turned the page and silently read a comprehension question presented there, and answered the question aloud. The time between overtly reading the sentence and answering the question is a span during which the participants could have had time to silently restructure the forced prosody if it was not a good fit to the sentence, and then answer the question on that basis.

A relevant point to mention here is an idea advanced by Koriat (2003) that prosody is produced “*on the fly*” as readers progress in reading. Koriat et al. (2002) investigated this in a controlled experiment. Participants were recorded while reading aloud Hebrew sentences and independent judges were presented with these recordings and were asked to rate the prosody of each recorded sentence for fluency and coherence (on a scale ranging from 1 for low to 10 for high). Participants read each sentence under three different reading instructions: In the first, unpracticed, condition they were instructed to read it as fluently and clearly as they could, immediately as it appeared on the screen. In the second, practiced, condition they were asked to read the sentence a few times before their oral reading. In the last forced condition, participants were instructed to read the sentences according to punctuation marks inserted in arbitrary positions.

According to Koriat, the latter instructions caused a disfluent and non-coherent prosody, which provided a baseline with which the other conditions were compared. The findings were that the practiced reading was rated much higher (7.95) than the arbitrary reading (2.72); the unpracticed reading was rated only slightly lower (7.38), and not significantly different, than the practiced reading.

Similarly it could be suggested that in experiment 2 and 3 in this dissertation, forced prosody is evaluated by the reader and evaluated with reference to his/her natural prosody. As Figure 42 reveals, there are both category effects and length effects in all these experiments, and also some very striking cross-experiment differences. Let us consider first the two experiments with forced prosody, experiments 2 and 3.

In experiment 2, the enforced prosody had no boundary between N2 and the following modifier. Since the absence of a pre-modifier boundary is more often associated in SA production with low modifier attachment than with high modifier attachment (see the results for the production experiments 5 and 6 above), it could be expected that the low attachment would be preferred overall in experiment 2.

In experiment 3, the enforced prosody had a boundary between N2 and the following modifier, a prosodic pattern most often associated in production experiments 5 and 6 above with high modifier attachment. In both experiments 2 and 3 (i.e., with /without a pre-modifier prosodic break), differential effects of syntactic category as well as modifier length could also be expected as usual.

In both experiments 2 and 3, the results show a significant effect of modifier length (with long modifiers attaching higher than short modifiers) and a significant effect

of modifier category (with RCs attaching higher than APs) (see Chapter 7, § 7.3.2 & §7.4.3 for statistical details). It appears, in Figure 42, that experiment 2 (with forced no-break prosody) shows a relatively larger effect of modifier category while experiment 6 (with forced pre-modifier-break prosody) shows a greater effect of modifier length but these are not statistically strong differences. Also in experiment 3 there looks to be an interaction between length and category, with the length difference largely attributable to the AP modifiers. A possible explanation of the cross-experimental variation will be discussed below. Figure 42 below shows a summary of the category and length effects across experiments 1, 2 and 3.

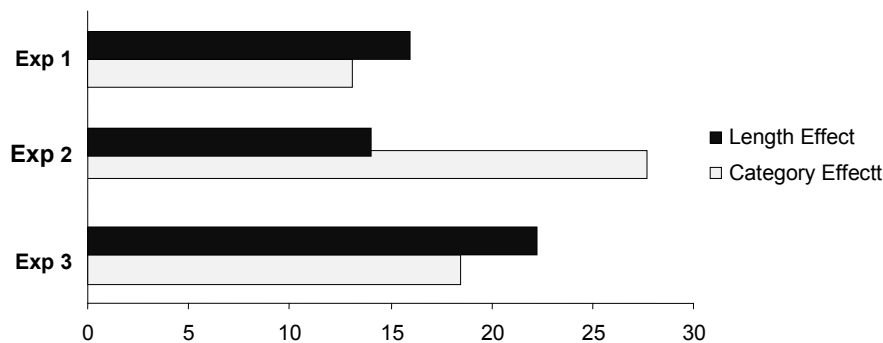


Figure 42: Effects of manipulation of Modifier Length and Category across perception experiments (Exps 1, 2 and 3).

For both experiment 2 and experiment 3, the empirical issue is the extent to which the prosody influences the syntactic analysis of the sentence. Once that is established, we can raise the theoretical question: what are the relative strengths of the relevant interface

constraints (ALIGN PB, CONGR, and/or others) that could be responsible for this pattern of influence?

In experiment 2, with a ‘no break’ prosody (PROSODY 0) held constant, the numerical results suggest that there is syntactic congruence (i.e. low modifier attachment) for APs and marginally for short relative clauses, but not for long relative clauses. On the other hand, in experiment 3 with a pre-modifier break prosody held constant, syntactic congruence (i.e. high attachment) is observed for RCs and for long APs, but very clearly not for Short APs. In experiment 6 there is an approximately 70% high attachment for RCs which is the highest for any condition in this study of SA.¹ We can now consider these findings in more detail.

9.7.2.1 Experiment 2 - Introduction

Generalizing over length and category, there is an overall 35% preference to attach high in experiment 2 (vowelized questionnaire with forced no-boundary). The approximately 65% low attachment preference in experiment 2 is compatible with syntax-prosody congruity in the constraint CONGR_{SYN}. However, there are differences between conditions which show that this isn’t an exceptionless generalization.

We can say that in general the absence of a boundary after N2 is associated with a 65% low attachment of the modifier to N2. We will now analyze more specifically how length and category effects (see Fig.42) contribute to this generalization. Recall that these

¹ Other languages (e.g., Croatian, Hebrew; see references in Chapter 3) may show higher attachment than this, at least when the prosody is in recorded sentences produced by a trained speaker.

tendencies are expected to be the output of a proposed constraint on the perception of prosodic phrasing.

9.7.2.1.1. Category Effect

The statistical analysis for experiment 5 shows that high attachment is significantly more frequent for relative clauses (49.0%) than for adjective phrases (21.3%), an overall difference of 27.7 percentage points.

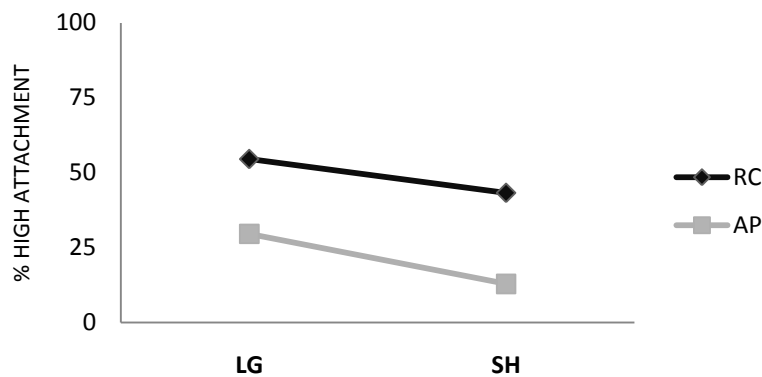


Figure 43: Perception data showing category effect for experiment 2- forced no-boundary prosodic phrasing.

This overall 49% tendency to attach high for RCs in experiment 2 shows an incomplete tendency for congruence with the no-break prosody. Evidently the proposed constraint CONGRsyn, which would prevent projection of a major syntactic phrase bracket after N2 in the absence of a prosodic boundary after N2 is not a strong constraint for relative clauses in SA. In other words there is no strong interface association between

PROSODY 0 and low attachment in this case for RCs. Recall that in production experiment 5, by contrast, there is a stronger association between low attachment SYNTAX 0 and PROSODY 0 (Exp 5: RCs: 30% boundary, APs: 20% boundary).

On the other hand, the perception of PROSODY 0 is not strongly associated with low attachment for RCs. Rather; it appears to be neutral in its relation with syntax. This suggests that perhaps where prosody is not salient as when there is no prosodic boundary in the stimulus, other factors contribute to the attachment preference. One such factor might be that SA speakers simply know that LRCs often attach high, and so they are biased towards high RC attachment quite independently of prosodic considerations. This might be so for some languages, but it is not a plausible explanation in the case of SA, because the corpus data of Chapter 5 show that, although RCs do sometimes attach high, they predominantly attach low in SA. However, we can also formulate a prosody-based version of this sort of account, which may have greater plausibility.

One possible hypothesis for this lack of strong congruence is that the experimental procedure of forced PROSODY 0 might be a suboptimal phrasing for LRCs for some subjects; recall that in experiment 4 there were two equally weighed phrasings variants for LRC (LRC: 45.8% boundary; see constraints: $*P \approx \text{ALIGN}_{\text{LRC}}$). This would predict two equally weighed attachment options in the absence of a boundary: one for low attachment and another for high attachment.

Thus a possible explanation for experiment 2's LRC data could be that speakers vary with regards to the default prosody they associate for structures with LRC. Some participants might have rejected the absence of a boundary, and have restructured the

prosodic phrasing when reading the interpretation question (i.e. participants might have reversed their mental prosody later even if they had just uttered the prosody required by the orthography).

Returning now to APs, there is a strong overall bias (72%) to attach low with a 17 percentage point difference between LAP and SAP. The association between PROSODY 0 and low attachment is strong for APs. Recall that the default prosody for APs in experiment 4 is in line and with experiment 5's association of low attachment of APs with a no-break phrasing.

9.7.2.1.2 Length Effect

Now incorporating the length factor, high attachment is a little more frequent for long modifiers (42.1%) than for short modifiers (28.1%) with an overall difference of 14 percentage points. Recall that short modifiers are strongly associated with no breaks in the default prosody (85% no break in experiment 4) whereas long modifiers are associated with a 40% tendency to make a break in experiment 4.

Intrinsic to the RC data is the difference between LRC (54.6%) and SRC (43.3%) which is 11.3 percentage points; the difference between LAP (29.6%) and SAP (12.9%) is 16.7 percentage points. These effects are in line with effects of BinMin presented in discussions of the production experiments.

9.7.2.1.3 Summary

Although there is a significant overall tendency in experiment 2 to be congruent with the prosodic phrasing and to attach low (64.9% low attachment), there are differences across category and length conditions that may initially suggest the lack of such congruence. However a hypothesis was presented pertaining to the experimental methodology of arbitrarily forcing a prosodic phrasing and it was further suggested that a mismatch between the presented prosody and the participant's preferred default prosody for the construction (for LRC and SRC) might have led to the mental restructuring of the prosodic phrasing to match the most natural default prosody of the construction and hence have influenced the final attachment interpretation.

In experiment 2, the participant is both a reader/producer as well as a perceiver/listener and it is suggested that these different processing tasks might involve different evaluation processes.

9.7.2.2 Experiment 3 - Introduction

Generalizing over length and category, there is an overall 62.4% preference to attach high in experiment 3 (vowelized questionnaire with forced pre-modifier boundary). This high attachment preference is compatible with a fair degree of syntactic congruity with the prosodic phrasing, as per the constraint ALIGN PB. The 37.6% low attachment needs to be accounted for by other factors that will be discussed below. However, there are effects of modifier length, and especially of its interaction with modifier category, which must be explained.

9.7.2.2.1 Category Effect

The statistical analysis for experiment 3 shows that the main effect of modifier category is such that high attachment is more frequent for relative clauses (71.7%) than for adjective phrases (53.1%), an overall difference of 18.5 percentage points (see Chapter 7, §7.4.3 for statistical details).

The phrasing PROSODY 1 (with a pre-modifier break) for relative clause sentences shows a strong congruence effect, in accord with the proposed constraint ALIGN PB which encourages a major syntactic phrase break after N2 in congruence with a prosodic boundary after N2.

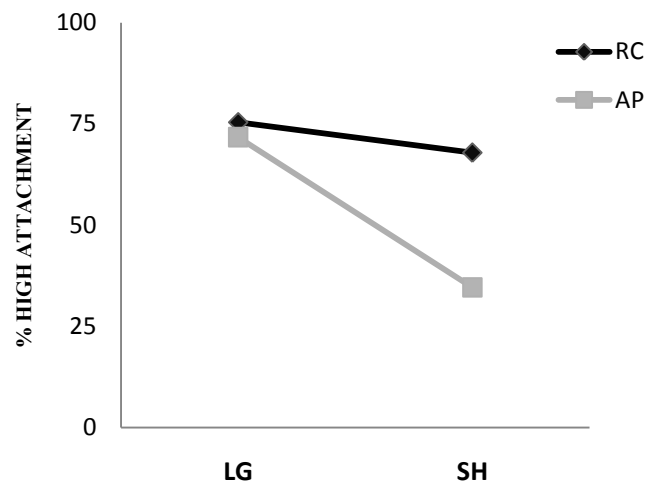


Figure 44: Length and Category Effect for Experiment 3, forced pre-modifier boundary.

For APs there is a 53% tendency to attach high which is numerically stronger compared to experiment 2 which showed a 21% high attachment for APs ; this is a difference across experiments of 32 percentage points.

9.7.2.2.2 Length Effect

For RCs there is a slight difference between LRCs and SRCs of 7.5 percentage points. On the other hand, intrinsic to the AP data is a substantial difference between LAPs and SAPs of 37 percentage points. This large difference in the length effect is out of proportion with all other effects in the six experiments reported here. It is most likely due to the fact that SAP is highly suboptimal with a break preceding the one PWd modifier. Recall from the discussion of constraint interaction in the production experiments concerning adjective phrases that a break before a short adjective accrues many violations: *P, *ALIGN_LAP and 3 violations of BinMin:

LAP: *ALIGN PB > *ALIGN_LAP, 1 BinMin, *P*

SAP: **P, *ALIGN_LAP, 3BinMin > ALIGN PB*

However, although SAP clearly tends to rebel against the orthographically imposed prosody, there is still a 34.6% high attachment occurrence in experiment 3 for SAP. What is the source of this? Recall that the procedure of the experiment involved two tasks one of production and the other of perception. In the production task, speakers might either maintain the forced prosodic phrasing, carry it over to the perception task, and interpret the break in the usual way as a cue for syntactic discontinuity, or they might restructure the orthographically forced phrasing, silently projecting their more natural prosodic phrasing of the construction and then opt for the syntactic analysis that is associated with that default phrasing. Therefore the 34.6% high attachment of SAP could be attributed to a variation or

gradiance involved in the processing of the experimental manipulation of forced phrasing in SA.

9.7.2.2.3 Summary

From the above discussion it has emerged that ALIGN PB is a strong constraint on the perception of prosodic boundaries. Participants in these perception experiments strongly associate a pre-modifier boundary with high attachment of the modifier. However, it has also been pointed out that the experimenter-controlled prosodic manipulation of the material could have met resistance on the part of speakers/readers of SA. In the overt production of a forced prosodic phrasing which comes prior to the perception task, a process of mental evaluation could be an important and relevant factor in determining the course of the perception task and thereby affecting the attachment data.

9.7.2.3 Comparison of Experiment 2 & 3

The statistical analysis of variance for experiment 2 shows that the main effect of modifier category is such that high attachment is more frequent for relative clauses (49%) than for adjective phrases (21.3), with a difference of almost 28 percentage points. Here we see that there is almost a 50/50 result for relative clauses with no clear bias in either direction, whereas, in experiment 3, high attachment is significantly more frequent for relative clauses (72%) than for adjective phrases (53%). So although in experiment 2 there is an apparent 64.9% low attachment preference overall, the category effect analysis

in experiment 2 reveals only a 54.4% low attachment for RC, as opposed to a 71.7% high attachment preference in experiment 3 for RCs.

Thus, the strength of interface congruence between PROSODY 1 and SYNTAX 1 for RCs is very low in experiment whereas the reverse (the congruence between SYNTAX 1 and PROSODY 1 as shown in experiment 5 reveals 70 % low attachment preference for RCs which is a difference of 25.4 points. This difference is a difference in the strength of association between perception and production of prosodic phrasing. In the production of phrasing in experiment 3 an interaction of constraints is at work that supports the congruence.

9.7.2.4 Experiment 1

The interest of experiment 1 in relation to experiments 2 and 3 is whether the silent reading of fully ambiguous sentences in experiment 1 shows attachment preferences comparable to the preferences in experiment 2 and 3 where the same sentences have determinate prosodic contours established by the orthography.

There is an overall 38% tendency, generalizing over length and category, to attach high in experiment 1 (see §7.2.2 for statistical details) compared with 35% in experiment 2 and 62% in experiment 3. Clearly, at this level of analysis, the data of attachment preferences in silent reading in experiment 1, without enforced prosody, most closely resembles that of experiment 2 with forced no-break prosody. But as usual there are length and category effects to be accounted for as well.

9.7.2.4.1 Category Effect

The statistical analysis in experiment 1 shows a main effect of modifier category such that high attachment is more frequent for relative clauses (44.6%) than for adjective phrases (31.5%), a difference of 13.1 percentage points. This category effect is similar to that in the prosodic phrasing production experiments where RCs are slightly higher in the scale either for a boundary (in the production experiments) or for high attachment (in the perception experiments). But recall that the category effect in experiments 4, 5 and 6, was accounted for by constraints on prosodic phrasing whereas in the case of experiment 2 and 3 what needs to be accounted for is a category effect on the interpretation of a given prosodic phrasing. The explanation of that should shed some light on the category effect in experiment 1.

9.7.2.4.2 Length Effect

There is a reliable main effect of modifier length in experiment 1 such that high attachment is more frequent for long modifiers (46%) than for short modifiers (30%), a difference of 16 percentage points. Between LRC (52.5%) and SRC (36.7%) there is a difference of 9.2 percentage points, whereas between LAP (39.6%) and SAP (23.3%) there is a difference of 16.3 percentage points. This is comparable with the proposed effect of BinMin violations in the production experiments..

9.7.2.2 Experiment 1 is more like Experiment 2 than Experiment 3

For a comparison of how readers interpret ambiguous sentences on the basis of +/-boundary placement, it is of interest that the pattern of interpretation data in experiment 1 shows a greater similarity to the data for a no-boundary prosodic phrasing in experiment 2 than for the pre-modifier prosodic break in experiment 3. I will maintain that in experiment 1 there is a perception constraint at work (ALIGN PB) and that the prosodic phrasing projected by readers in experiment 1 is predicted to be similar to that shown in the elicited implicit prosody experiment 4 (implicit prosody).

Recall that in experiment 2 it was predicted that the lack of a prosodic boundary would be associated with a preference for low attachment because of the perception constraint $\text{CONGR}_{\text{SYN}}$ requiring congruence with the forced 100% PROSODY 0 phrasing. Overall, this was indeed true for experiment 2. The data are quite similar in experiment 1, though attachment is slightly lower for RCs than in experiment 2 and slightly higher for APs than in experiment 2. See Figure 45.

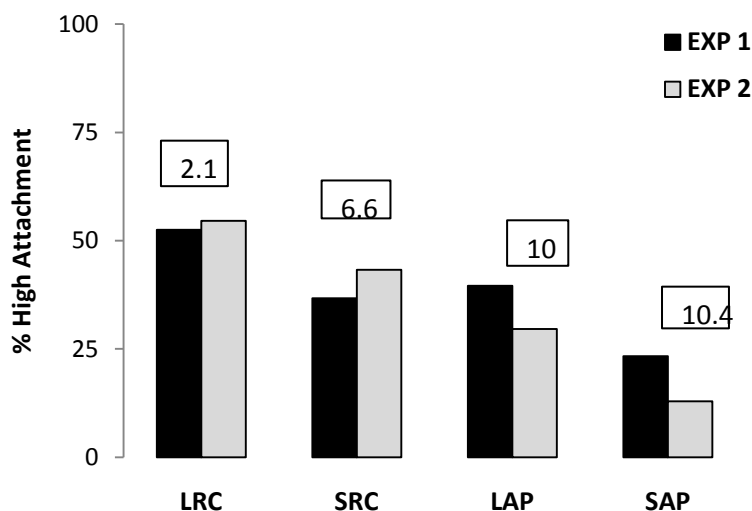


Figure 45: Comparison of data for experiments 1 and 2

In Experiment 3 a pre-modifier boundary was associated with a preference for high attachment across conditions, except for SAP. This was attributed to the perception constraint ALIGN PB applied to the forced prosody 1 phrasing. Comparing this with experiment 1, it is clear that attachment is indeed higher in experiment 3 than in experiment 1, though less strikingly so far SAP as could be expected. See Figure 46.

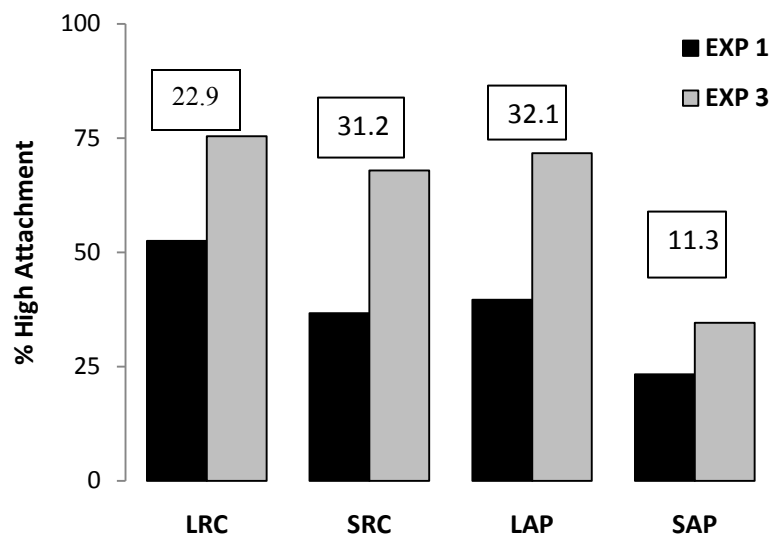


Figure 46 : Comparison of data for experiments 1 and 3

This mismatch between experiment 1 and experiment 3 indicates that ALIGN PB was not strongly in effect in experiment 1. That in turn implies that there was a low incidence of prosodic boundaries in the implicit prosody projected by participants in experiment 1. The resemblance between the attachment data for experiment 1 and 2 reinforces this conclusion that most implicit prosodic contours in experiment 1 contained no pre-modifier boundary.

9.7.3 Comparison of 1 and 4: *Discussion*

The general hypothesis under consideration is that the syntactic interpretation favored by readers in experiment 1 mirrors, at least to some extent, the configurational construal of the (implicit) prosodic phrasing projected by silent readers, which we are calling PROSODY α . Prosody α is not directly observable, but its properties may be inferable indirectly from experiment 4. Experiments 1 and 4 provide complementary data; attachment and prosody respectively, for silent reading. The following is a summary of the underlying argument that we will attempt to present here. It is based on the supposition that the prosodic phrasing registered by participants in silent reading in experiment 4 is the default prosodic phrasing for this construction, which participants in this study projected during silent reading i.e. that PROSODY α is a default pre-syntactic prosodic phrasing with minimal syntactic processing affecting it during projection¹.

Therefore it is proposed here that **PROSODY α** in experiment 1, was mostly similar to prosody 0, and this is why **SYNTAX 0** was the more frequently preferred syntactic analysis in experiment 4. It can also be explained why the overall high attachment rate of 38% in silent reading in experiment 1 is somewhat greater than the overall high attachment rate of 35.1% in experiment 2. While the numbers cannot be predicted exactly, a difference in this direction is compatible with the fact that there was a 27.5% pre-modifier boundary rate in silent reading experiment 4, compared with a zero pre-modifier boundary rate in experiment 2.

¹ See §9.2.2 in the present chapter for a discussion of establishing the prosody before the syntax.

9.8 Discussion of the Congruence Hypothesis for Silent Reading

The IPH claims congruence between the syntactic parse of an ambiguous sentence projected prosody and the syntactic parse of an ambiguous sentence in silent reading. In its strongest form, the proposal for the current study is that the attachment preferences as revealed in experiment 1 are caused by prosodic phrasing preferences as revealed in experiment 4. In this section I draw together considerations concerning how well this general hypothesis fits the data in this study.

It is clear that in SA, a sentence-internal prosodic break such as an N2][Modifier boundary is a phonologically salient cue for hearers which leads to a tendency of syntactic alignment with this boundary. This has been proposed here to be due to the perception constraint referred to here as ALIGN PB (*Align a major syntactic phrase edge to a perceived prosodic boundary*). This can explain the significant high attachment preference in the data of experiment 3 for LRC, LAP and SRC. For short AP, however, a forced break before the AP was described as being difficult to process as the speaker's prosodic competence evaluates it as highly suboptimal or unacceptable, associated with a violation of many constraints; so ALIGN PB would be likely to be blocked in many cases if not in all.¹

Recall here that a prosodic break after N2 for short AP violates *Align_LAP and BinMin three times as well as *P. Although the participants overtly read the SAP sentence condition with a boundary (see Chapter 7 for a detailed description of the

¹ Although the participants overtly read the SAP sentence condition with a boundary (see Chapter 7 for a detailed description of the procedure used in experiment 3), they had time to then process it again mentally in the question task and reject it as suboptimal and then re-impose an optimal phrasing. I propose that happened in a significant number of cases, and that then an interpretation was made which was influenced by the implicit prosody rather than the produced prosody.

procedure used in experiment 3), they had time to then process it again mentally in the question task and reject it as suboptimal and then re-impose an optimal phrasing. I propose that happened in a significant number of cases, and that then an interpretation was made which was influenced by the implicit prosody rather than the produced prosody.

On the other hand, the lack of a prosodic break, which is claimed here to be closer to the default prosody of the language, does not have the same strong effect as the marked break. It is proposed that the perception constraint CONGRsyn is not a strong constraint in the language and that the syntactic congruence with PROSODY 0 is therefore weak or neutral. It was also noted that this is especially so for RCs, and that this is another fact that has a potential explanation in the unnaturalness of certain forced prosody/syntax pairings. That is: even though SA exhibits relatively few pre-modifier prosodic boundaries, a LRC is more likely than other modifier types in SA to be preceded by a boundary in production. Thus some participants may have found the forced no-break prosody of exp 3 relatively unnatural for a LRC, and may thus have mentally revised it in the manner explained above for SAP with a pre-modifier break. It is of interest that the two data points that are somewhat unexpected in a congruence-based model are both open to an explanation that invokes unnatural pairing of prosody and syntax imposed by the experimental method.

Given that ALIGN PB is a strong constraint that results in a strong preference for high attachment (when not blocked), as is evident in experiment 3, then it is clear from experiment 1 that the prosodic phrasing used by subjects in experiment 1 (with a free-

choice of attachment) could not have been a prosody that included a high percentage of breaks. The data in experiment 1 support instead the conclusion that subjects in experiment 1 must have used a prosody similar to that used by the subjects in experiment 4 (silent prosody).

As is evident in experiment 2 (input prosody with forced no-boundary), a *no-break* prosody does not strongly bias towards a low attachment specifically for RCs. This is explained in the following way: the congruence constraint that requires no-break prosody to be paralleled with a congruent avoidance of a syntactic major phrase is not a strong constraint for the speakers in this study. The following discussion further explains this.

9.9 Production and Perception Asymmetry

In accounting for the data we have made use of a constraint interaction-weighting model where we have employed different kinds of constraints for the two different modalities of speech namely constraints on the production of prosodic phrasing and constraints on the perception/interpretation of prosodic phrasing. However we have suggested that during the perception of prosodic phrasing in reading there is an implicit production of a default phrasing that serves as a reference point by which to evaluate the forced phrasing.

The IPH claims that silent reading includes the two processes of production and perception. The projection of a prosodic phrasing involves a silent production process and the perception of a congruent syntactic structure which is a silent perception process.

Grammar alignment theories of the interface relationship between syntax and prosody have presented theoretical models as neutral between the dual processes of production and perception. Moreover psycholinguists have traditionally studied language comprehension (input) and language a production (output) processes independently. Studies have proposed different principles and models for the production and the perception of sentences suggesting different strategies for the two modalities of language processing.

This study has suggested based on the experimental data that a theory of interface grammar cannot be neutral towards the processes involved in the two different modalities of production and perception.

An important point to mention here based on the results of the data analysis at hand is that the production of prosody in the wake of a *forced* syntactic structure is asymmetrical with the syntactic interpretation of a *forced* prosody. In the production study, the interface congruence from a low attachment syntactic structure to prosodic phrasing is closer than the inverse perception interface relationship from no-boundary prosodic phrasing to a low attachment syntactic structure interpretation.

On the other hand the interface relationship from a pre-modifier-break prosodic phrasing to a high attachment syntactic structure interpretation shows more congruence than the interface relationship from high attachment syntactic structure to a pre-modifier-break prosodic phrasing.

Thus in SA the association of producing a phrasing with no boundaries to represent a low attachment syntactic structure is stronger than the inverse association of perceiving low attachment syntactic structure in response to a no boundary prosodic

phrasing, whereas the association of producing a phrasing with a boundary to represent a high attachment syntactic structure is not as strong as the association of perceiving high attachment as in response to a boundary prosodic phrasing. This has a natural explanation on the assumption that SA is a language with a strong tendency to avoid prosodic breaks, even where the syntax or length considerations might favor them. In such a language, where there is no break, perceivers can take that to be normal and not necessarily signify absence of a syntactic discontinuity. By contrast, where a break does occur, it will be taken seriously, since it is a relatively rare occurrence. (This explanation bears some similarity to the Rational Speaker Hypothesis proposed on the basis of English data by Clifton, Carlson & Frazier, 2002 (see Chapter 2, §2.7.3), though the details differ here.

It is relevant here to point out that throughout all the experimental data in this study, as shown in Fig. 49, the highest point that is documented for any condition is 75.4% high attachment for LRCs in experiment 3 whereas the lowest point is 8.8% for pre-modifier boundary placement in experiment 4.

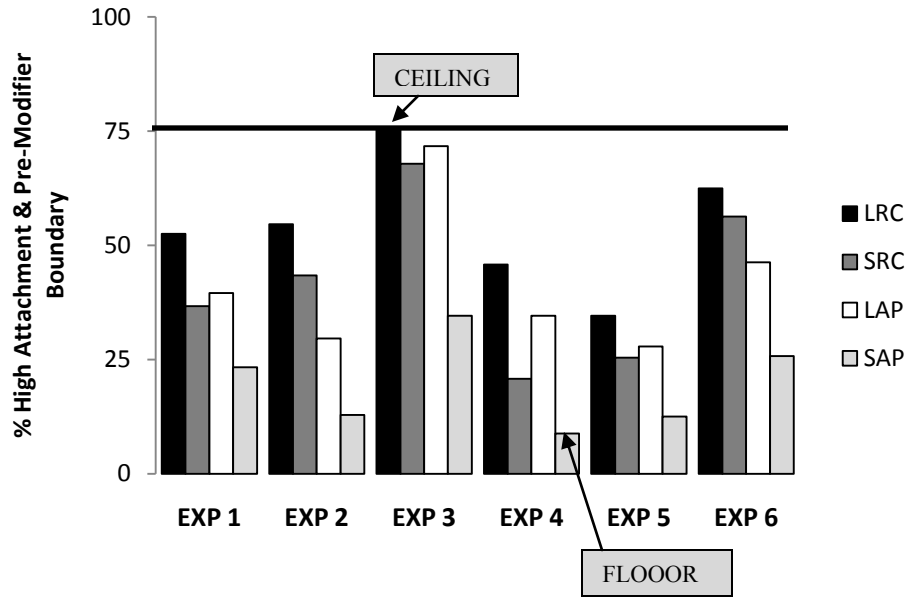


Figure 47: Overview of data range for possible boundary placement and attachment height in SA.

Keeping this overall range of potential possibilities in SA in perspective, the lowest point in the range appears to be closer to the floor than the highest possible point is to the ceiling. This supports the point that in SA there is a general preference for low attachment rather than high attachment, and also a general preference not to insert a pre-modifier phrase rather than to inserting one.

Following and producing a forced written prosodic phrasing while reading is somewhat problematic in Arabic. As discussed in Chapter 4, §4.3 of this dissertation, the process of reading in Arabic is crucially associated with a continuous prosodic projection of disambiguating vowelization in order to interpret the text. This process has been automatized by the Arabic-speaking reader and has become part of his/ her competence and skilled performance while reading. Forcing a prosody (which might at times have

been different from the default prosody associated with the sentence, which would have been a source *noise*) means asking the reader to turn off this automatized voice in his/her head and adopt at times a conflicting prosody, which might well have been difficult to do.

To reiterate, it is important to distinguish between the *production* of prosodic phrasing and the *perception* of prosodic phrasing. More importantly it is crucial to differentiate between the production of prosodic phrasing for a *forced* syntactic parse, and the syntactic interpretation of a *forced* prosodic phrasing. In the former case, the prosodic phrasing produced would be the optimal phrasing that the speaker would assign to a sentence with the syntactic structure in question. In the latter case, the prosodic phrasing is forced by the input, as is the word string, and that prosody might not be the optimal prosody that the perceiver would have associated with that particular word string, or perhaps with any such sentence.

Given the nature of Arabic reading practice, which involves the acquired literacy skill of on-line projection of prosodic phrasing to supply vowelization for disambiguation, the experimental construct of a forced prosodic phrasing could be problematic for the reader. The problem arises when the forced prosodic phrasing is associated in the reader's prosodic competence with a high constraint violation profile and is rejected by the prosodic component of the grammar as highly suboptimal and unacceptable. There would be a conflict between the objective cues in the input, which determine the prosodic phrasing intended by the producer, and the internal processing by the perceiver, whose computations on the basis of the interface constraints would be slow or fail entirely because of the number of constraint violations involved.

In this respect the natural production of prosodic phrasing for a given syntactic structure and the elicited production of a prosodic phrasing forced by the orthography are two intrinsically different processes. It is important here to reiterate that what forces the prosody is the orthography. This orthographic determination of prosody is a key aspect of SA which is not something that happens in most languages for example English (except where a comma entails a break, for instance). The orthography has allowed us to study the projection of prosody in silent reading (in experiment 4) in a more direct way than is possible in many other languages. But future experimental studies must bear in mind that in its other role of imposing prosody on written sentences (as in experiments 2 and 3) it may bring certain complications with it.

9.10 Conclusion

The tendency towards interface congruency proposed in this study is first and foremost a *tendency* not a total bias¹. Therefore the syntax-prosody interface must account for a competence that tolerates or that can accommodate a certain extent of incongruence, which is by no means random or unconstrained but is due to other factors such as other conflicting constraints. In other words the congruent configurational construal of prosodic phrasing can partially bias the resolution, but this bias carries the potential of being modulated in certain cases (when certain conditions or forces are present) by other factors that might outweigh the tendency of congruence. Incongruence in these cases is then tolerated and can even be the best optimal solution to the interaction

¹ As Hirschberg (2002:32) observes, research on prosody is more a matter of “finding likelihoods,” than of simply mapping prosodic features directly onto syntax or semantics .

of various output constraints. These constraints have been described as soft constraints which can override each other in certain circumstances and are sometimes affected by what has been characterized as ‘*noise*’ (see § 9.5.3).

The relevant question is how big a role the factors that counter *congruence* play and how strong a role *congruence* manages to sustain. It has been shown here that it cannot be expected to be the same in all experimental situations. The variation in category and length effect on both phrasing and attachment across experiments in this study has been shown to be ascribed to the different conditions created within each experiment as an effect of the method and procedure of each experiment.

In the procedure of experiments 5 and 6, the input to the prosodic component is a fixed syntactic structure which activates the configurationally-sensitive ALIGN_RXP and CONGR constraints, which interact with other constraints such as BinMin, ALIGN_LRC, *ALIGN_LAP and *P vis-à-vis the input. Sometimes ALIGN_R XP wins and sometimes it loses, depending on which of the other constraints are in play. One of the notable results in SA is that ALIGN_RXP does not win very often.

In experiments 2 and 3, an output for the prosodic component is forced by the presentation and the subject is required to respond to that stimulus by integrating it into the process of assigning a syntactic structure to the sentence. Now the subject might accept that prosodic phrasing and pass it through the interface stage of processing, where congruence is optimal but violations of congruence are possible. Or else the subject might find the imposed prosody unnatural for that word string; as a result the subject might

sometimes silently impose a more-preferred prosody on the input, regardless of the objective orthographic cues, and arrive at a syntactic structure congruent to that prosody.

In silent reading, as in experiments 1 and 4, ALIGN_RXP is inactive as the input to the prosodic component does not as yet have full hierarchical structure. The input to the prosodic component in silent reading is in a very elementary stage of syntactic processing where the information available at this stage includes syntactic category information as well as linear adjacency information. This state renders active the two category-sensitive constraints of ALIGN_LRC and *ALIGN_LAP (concerning not high-level tree configuration but local syntactic category). The output of the prosodic production component (default prosody) then acts as the input to a perception phase where the interpretation of the prosodic phrasing is now constrained by the proposed perception constraints CONGR_{syn} and ALIGN PB.

In conclusion, an interface model that characterizes the principled interaction of prosodic and syntactic derivation during sentence production and perception for users of Standard Arabic has been shown to support the view that in silent reading, mentally projected prosody significantly influences the final syntactic representation of the sentence.

APPENDICES

Appendix A: Materials

Appendix A-1: Target Items in Experiment 1

This appendix lists 32 experimental items in Experiment 1 (reported in Chapter 5). They are 8 sentences each in 4 versions. The first (1L) contains a long relative, the second (2S) a short relative, the third (3S) a short adjective and the fourth (4L) a long adjective.

In all 32 items, N1 and N2 are of the same gender: “feminine”. The first item contains the whole paradigm, including the question and two answers; for the remaining items, only the ambiguous target sentence is provided.

A1L- zaara al-muhaafith maktabat al-madrasah alatii kaanat qad gudidat
visited the-governor library the-school that been had renovated
tagdidan shaamilan.
a renovation a complete
“The governor visited the library of the school that had been completely renovated.”

A2S- zaara al-muhaafith maktabat al-madrasah alatii gudidat
visited the-governor library the-school that was renovated
“The governor visited the library of the school that was renovated.”

A3S- zaara al-muhaafith maktabat al-madrasah al-gadiidah.
visited the-governor library the-school the new
“The governor visited the (new) library of the (new) school ”

A4L- zaara al-muhaafith maktabat al-madrasah al-gadiidah fii nithaam binaa?-ihaa.
visited the-governor library the-school the new in way structure-its
“The governor visited the (new in the way it was built) library of the (new in the way it was built) school”

B1L- daawaa Ahmed ?agnihat al- ?asfuurah allati ?usiibat bi-guruuh baalighah.
 Examined Ahmed wings the bird that was wounded with wounds severe
 “Ahmed examined the wings of the bird that was wounded with severe wounds.”

B2S- daawaa Ahmed ?agnihat al- ?asfuurah allati ?usiibat.
 Examined Ahmed wings the bird that was wounded.
 “Ahmed examined the wings of the bird that was wounded.”

B3S- daawaa Ahmed ?agnihat al- ?asfuurah al- musaabah.
 Examined Ahmed wings the bird the wounded.
 “Ahmed examined the (wounded) wings of the (wounded) bird.

B4L- daawaa Ahmed ?agnihat al- ?asfuurah al- musaabah bi-guruuh baalighah.
 Examined Ahmed wings the bird the wounded with wounds severe.
 “Ahmed examined the (wounded with severe wounds) wings of the (wounded with severe wounds) bird.

C1L- qara?at faatimah ?an ?itifaaqiyat al-hudnah allati kaanat mawdi?
 read fatma about treaty the cease-fire that was center
 ?ihtimaam algamii?
 attention everybody
 “ Fatma read about the treaty of the cease fire that was the center of everybody’s attention.”

C2S- qara?at faatimah ?an ?itifaaqiyat al-hudnah allati fashilat.
 read fatma about treaty the cease-fire that failed
 “ Fatma read about the treaty of the cease fire that failed.”

C3S- qaraʔat faatimah ʕan ʔitifaaqiyat al-hudnah al-faashilah.

read fatma about treaty the cease-fire the-failed

“Fatma read about the (failed) treaty of the (failed) cease fire.”

C4L- qaraʔat faatimah ʕan ʔitifaaqiyat al-hudnah al-faashilah min kul algawaanib.

read fatma about treaty the cease-fire the-failed from all sides

“Fatma read about the (failed from all sides) treaty of the (failed from all sides) cease fire.”

D1L- shaahad alnaaqid lawhat alfanaanah allati kaanat mashhuurah bigamaal alwanihaa.

saw the critic picture the artisit who was well-known for-beauty colours-its/her.

“the critic saw the picture of the artist who/that was well known for its/her beautiful colors.

D2S- shaahad alnaaqid lawhat al-fanaanah allati ʔishtaharat.

saw the critic picture the artisit who/that was well-known

“the critic saw the picture of the artist who/that was well known.”

D3S- shaahad alnaaqid lawhat al-fanaanah al-mashhuurah.

saw the critic picture the artisit the-well-known

“the critic saw the (well-known) picture of the (well-known) artist.”

D4L- shaahad alnaaqid lawhat al-fanaanah al-mashhuurah bi-gamaal alwanihaa.

saw the critic picture the artist the-well-known for-beauty colors-its/her

“the critic saw the (well-known for its/her beautiful colors) picture of the (well-known for its/her beautiful colors) artist.”

E1L- qatala shakhs khaadimat almumathilah alati kaanat mariidah maradan shadiidan.

Shot someone servant (f) the actress who was ill an illness grave

“Someone shot the servant of the actress who was ill with a grave ill.”

E2S- qatala shakhs khaadimat almumathilah alati kaanat mariidah.

Shot someone servant (f) the actress who was ill.

“Someone shot the servant of the actress who was ill.”

E3S- qatala shakhs khaadimat almumathilah al-mariidah.

shot someone servant (f) the actress the-ill.

“Someone shot the (ill) servant of the (ill) actress.”

E4L- qatala shakhs khaadimat almumathilah al-mariidah maradan shadiidan.

Shot someone servant (f) the actress the-ill an illness grave

“Someone shot the (ill with a grave illness) servant of the (ill with a grave illness) actress.”

F1L- ?itala? al-zaabit ?alaa khitat al-mu?aamarah alatii fashala mukhatitiihaa fi tanfiithi-haa.

saw the-officer on plan the-conspiracy that failed organizers-its in carrying-it-out

“The officer saw the plan of the conspiracy whose organizers failed in carrying it out.”

F2S- ?itala? a?-zaabit ?alaa khitat al-mu?aamarah alatii fashalat.

saw the-officer on plan the-conspiracy that failed.

“The officer saw the plan of the conspiracy that failed.”

F3L- ?itala? al-zaabit ?alaa khitat al-mu?aamarah al-faashilah.

saw the-officer on plan the-conspiracy the-failed

“The officer saw the (failed) plan of the (failed) conspiracy.”

F4L- ʔitalaʕ al-zaabit ʕalaa khitat al-muʔaamarah al-faashilah min kul algawaanib.
 saw the-officer on plan the-conspiracy the-failed from all the sides.
 “The officer saw the (failed from all the sides) plan of the (failed from all the sides) conspiracy.”

G1L- takalam al-maalik maʕa gaarat al-tabiibah alatii kaanat turiid taʕweedan
 spoke the-landlord with neighbor(f) the-physician (f.) who was want compensation
 kabiiran.
 big.
 “The landlord spoke to the neighbor of the physician who wanted a big compensation.”

G2S- takalam al-maalik maʕa gaarat al-tabiibah alatii ʔutihimat.
 spoke the-landlord with neighbor(f) the-physician (f.) who was accused
 “The landlord spoke to the neighbor of the physician who was accused.”

G3S- takalam al-maalik maʕa gaarat al-tabiibah almutahamah.
 spoke the-landlord with neighbor(f) the-physician (f.) the-accused
 “The landlord spoke to the(accused) neighbor of the (accused) physician.”

G4L- takalam al-maalik maʔa gaarat al-tabiibah almutahamah fi qadiyah kabiirah.
 spoke the-landlord with neighbor(f) the-physician (f.) the- accused in case big
 “The landlord spoke to the (accused in a big case) neighbor of the (accused in a big case) physician.”

H1L- Shaahad salaah muqadimat al-masrahiyah alati hakaahaa lahu sadiiqahu mohamed.
 Saw salah introduction the-play that told to-him friend-his mohamed
 “Salah saw the introduction of the play that his friend Mohamed told him about.”

H2S- Shaahad salaah muqadimat al-masrahiyah alati hukiyaat lahul.

Saw salah introduction the-play that was told to-him

“Salah saw the introduction of the play that was told to him.”

H3L- Shaahad salaah muqadimat al-masrahiyah al-mumtiaah

Saw salah introduction the-play the-interesting

“Salah saw the (interesting) introduction of the (interesting) play.”

H4L- Shaahad salaah muqadimat al-masrahiyah al-mumtiaah fi tanaawuli-haa li-mawduui-haa

Saw salah introduction the-play the-interesting in acting out-its of-theme-its

“Salah saw the (interesting in acting out of its theme) introduction of the (interesting in acting out its theme) play.”

زار المحافظ مكتبة المدرسة التي كانت قد جددت تجديداً شاملاً

- المكتبة - المدرسة - ما التي جددت تجديداً شاملاً ؟

زار المحافظ مكتبة المدرسة التي جددت .

ما التي جددت ؟ - المكتبة - المدرسة

زار المحافظ مكتبة المدرس الجديدة .

ما الجديد التي زاره المحافظ ؟ - المكتبة - المدرسة

زار المحافظ مكتبة المدرسة الجديدة في نظام بنائها .

ما التي كانت جديدة في نظام بنائها ؟ - المكتبة - المدرسة

داوى أحمد أجنحة العصفورة التي أصيبت بجروح بالغة .

ما التي أصيبت بجروح بالغة ؟ - الأجنحة - العصفورة

داوى أحمد أجنحة العصفورة التي أصيبت .

ما التي أصيبت ؟ - الأجنحة - العصفورة

قرأت فاطمة عن إتفاقية الهدنة التي كانت موضع إهتمام الجميع .

ما التي كانت موضع إهتمام الجميع ؟ - الإتفاقية - الهدنة

قرأت فاطمة عن إتفاقية الهدنة التى فشلت.
ما التى فشلت ؟ ؟ - الإتفاقية - الهدنة

قرأت فاطمة عن إتفاقية الهدنة الفاشلة ؟
ما التى كانت فشلت ؟ - الإتفاقية - الهدنة

دأوى أحمد أجنحة العصفورة المصابة.
ما التى كانت مصابة ؟ - الأجنحة - العصفورة

دأوى أحمد أجنحة العصفورة المصابة بجروح بالغة .
ما التى كانت مصابة بجروح بالغة ؟ - الأجنحة - العصفورة

- قرأت فاطمة عن إتفاقية الهدنة الفاشلة من كل الجوانب.
ما التى كانت فاشلة من كل الجوانب ؟ - الإتفاقية - الهدنة

- شاهد الناقد لوحة الفنانة التى كان يتحدث عنها الجميع.
التى كان يتحدث عنها الجميع... - اللوحة - الفنانة ؟

- شاهد الناقد لوحة الفنانة التى اشتهرت.
التى اشتهرت... - اللوحة - الفنانة ؟

- شاهد الناقد لوحة الفنانة المشهورة.
ما أو من المشهورة ؟ - اللوحة - الفنانة ؟

- شاهد الناقد لوحة الفنانة المشهورة بجمال ألوانها.
ما أو من المشهورة بجمال ألوانها ؟ - اللوحة - الفنانة

- قتل شخص خادمة الممثلة التى كانت مريضة مرضاً شديداً.
من التى كانت مريضة مرضاً شديداً ؟ - الخادمة - الممثلة

- قتل شخص خادمة الممثلة التى مَرِضَتْ.
من التى مرضت ؟ - الخادمة - الممثلة

- قتل شخص خادمة الممثلة المريضة.
من المريضة ؟ - الخادمة - الممثلة

- قتل شخص خادمة الممثلة المريضة مرضاً شديداً.

- من المريضة مرضاً شديداً ؟ - الخادمة - الممثلة
- إطلع الضابط على خطة المؤامرة التي فشل مختطياها فى تنفيذها.
ما التى فشل مختطياها فى تنفيذها ؟ - الخطة - المؤامرة
- إطلع الضابط على خطة المؤامرة التى فشلت.
ما التى فشلت ؟ - الخطة - المؤامرة
- إطلع الضابط على خطة المؤامرة الفاشلة.
ما التى كانت فاشلة ؟ - الخطة - المؤامرة
- إطلع الضابط على خطة المؤامرة الفاشلة فى تنفيذها.
ما التى كانت فاشلة فى تنفيذها ؟ - الخطة - المؤامرة
- تكلم المالك مع جارة الطبيبة التى كانت تريد تعويضاً كبيراً.
من التى كانت تريد تعويضاً كبيراً ؟ - الجارة - الطبيبة
- تكلم المالك مع جارة الطبيبة التى إتهمت.
من التى إتهمت ؟ - الجارة - الطبيبة
- تكلم المالك مع جارة الطبيبة المتهمه.
من المتهمه ؟ - الجارة - الطبيبة
- تكلم المالك مع جارة الطبيبة المتهمه فى قضية كبيرة.
من المتهمه فى قضية رشوة كبيرة ؟ - الجارة - الطبيبة
- شاهد صلاح مقدمة المسرحية التى كان قد حكاها له صديقه محمد.
عن ماذا حكى محمد ؟ - المقدمة - المسرحية
- شاهد صلاح مقدمة المسرحية التى حكيت له.
ما التى حكيت له ؟ - المقدمة - المسرحية
- شاهد صلاح مقدمة المسرحية الممتعة.
ما التى كانت ممتعة ؟ - المقدمة - المسرحية
- شاهد صلاح مقدمة المسرحية الممتعة فى تناولها لموضوعها.
ما التى كانت ممتعة فى تناولها لموضوعها ؟ - المقدمة - المسرحية

Appendix A-2: Filler Items in Experiment 1

- 1- qaala tabiib al-asnaan an ukhtahu kaanat tamal fi al-braziil.
said doctor the teeth that sister-his was working in the- Brazil
The dentist said that the his sister was working in Brazil.
قال طبيب الأسنان أن أخته كانت تعمل في م همة في البرازيل.
من كان يعمل في البرازيل ؟ - طبيب الأسنان - أخته
- 2- yanbah kalb gaaranaa li-qitatu-naa daa?man wa ya?udu saa?ii al-bariid.
Barks dog neighbor to-cat-ours always and bites bringer the-mail
The dog always barks at our cat and bites the mailman.
ينبح كلب جارنا لقطتنا دائما و يعض ساعى البريد.
من الذى يعض ساعى البريد ؟ - القطه - الكلب
- 3- wada?a al-qursaana al-kinz daakhil kahf ?alaa al-gaziirah thuma wada?a al-khariitah fi hugrah ?alaa al-safiinah.
The pirate put the treasure in a cave on the island then he put the map in a room on the ship.
وضع القرصان الكنز داخل كهف على الجزيرة ثم وضع الخريطة فى حجرة على السفينة.
أين وضعت الخريطة ؟ - على الجزيرة - فى السفينة
- 4- ?itasala zayd bi?asdiqaahi allathiina yal?ab ma?ahum al-tinis liyukhbirahum ?an tamazuq fii qadamayhi.
Zayd called hs friends who play tennis with him to tell them about a sprain in his leg.
اتصل زيد بأصدقائه الذين يلعب معهم التنيس ليخبرهم عن تمزق فى قدمه.
من اتصل ؟ - زيد - أصدقاء زيد
- 5- takalamnaa ma?a al-musawir wa musaa?idihi.
We talked with the photographer and his assistant.
تكلما مع المصور و مساعده.
كم عدد الأشخاص الذين كلمناهم ؟ - واحد - اثنين
- 6- ?akhathnaa suuraah li?imra?ah wa ragul kaanuu yaqifaan ?alaa al-qubrii.
We took a picture of a woman and man who were standing on the bridge.
أخذنا صورة لإمرأة و رجل كانوا يقفان على الكوبرى.
كم صورة أخذنا ؟ - واحدة - اثنتين
- 7- tagaahala al-muhaadir al-mashhuur alnaas alathiina ghalabahum alnawm athnaa muhaadaratihi al-tawiilah.
The famous lecturer ignored the people who had fallen asleep in his long lecture.
تجاهل المحاضر المشهور الناس الذين غلبهم النوم أثناء محاضراته الطويلة.
من غلبه النوم ؟ - المحاضر - الناس

8- taʕarftu ʕalaa musaaʕid al-tabiibah alatii agrat al-giraaha.

I met the assistant of the physician who performed the surgery .

- تعرفت على مساعد الطبيب التي أجرت الجراحة.

من أجرى الجراحة ؟ - المساعد - الطبيب

9- qaabala al-ustaath al-taalib allathii kataba al-risaalah al-tawiilah ilaa al-waziir.

The professor met the student who wrote the long letter to the minister.

- قابل الأستاذ الطالب الذي كتب الرسالة الطويلة إلى الوزير.

من الذي كتب الرسالة الطويلة إلى الوزير. - الأستاذ - الطالب

10- baʕatha salaah lifaatimah cart min roma.

Salah sent a card to Fatma form Rome.

- بعث صلاح لفاطمة كارت من روما.

إلى من بعث الكارت ؟ - صلاح - فاطمة

11- talaba qaaʕid al-uukistrah min ʕaazif al-kamaan alathii kaana yaglis bigiwaar al-biyanu ʔan yadbit ʔiiqaʕ ʔatah

The composer of the orchestra asked the violin player who was sitting next to him to fix the rhythm of his instrument.

- طلب قائد الأوركسترا من لاعب الكمان الذي كان يجلس بجوار البيانو أن يضبط إيقاع آله.

مِمَّن طلب قائد الأوركسترا ضبط إيقاع آله ؟ -لاعب الكمان - لاعب البيانو

12- ʔitasalat Faatima bisicirtiir al-muhaamii alathii kaana fi baariis

Fatima called the secretary of the lawyer who was in Paris.

اتصلت فاطمة بسكرتيرة المحامي الذي كان في باريس.

من كان في باريس ؟ - السكرتيرة - المحامي

13- kaanat al-naafithah ghayru natheefah wa kaanaat al-madkhanah laa taʕmal wa laakin kaana al-khuukh daafiʔ wa bahiig.

The windows were not clean and the chimney was not working but the cabin was warm and bright.

كانت المنافذ غير نظيفة و كانت المدخنة لا تعمل ولاكن كان الكوخ دافئ و بهيج

ماذا كان غير نظيف ؟ - المنافذ - المدخنة

14- baʕda ʔan tatagih shamaalan ʕinda ʔishaarat al-muruur sayakuun al-malgaʕ ʕalaa buʕdi kilomitr wa nisf baʕda al-mustashfah.

After you turn north past the traffic light, the orphanage will be after a one and a half kilometers past the hospital.

بعد أن تتجه شمالاً عند إشارة المرور سيكون الملجأ على بعد كيلومتر و نصف بعد المستشفى.
أيهما أبعد ؟ - الملجأ - المستشفى

- 15- tashaagarat saahibat al-matgar maʿa musamimat al-silsilah allatii kaanat tatlub maziidan min al-maal.
The owner of the store had an argument with the designer of the necklace who was asking for more fees.

تشاجرت صاحبة المتجر مع مصممة السلسلة التي كانت تطلب مزيداً من المال.
من كان يطلب مزيداً من المال ؟ - صاحبة المتجر - مصممة السلسلة

- 16- thahaba aldabaab wa kaana al-subhu mushriq hataa an kuli shagarah alaa dufaaf al-nahr al-baʿiid kaanat thaahirah.
The fog disappeared and the morning was so bright that every tree on the bank of the distant river was visible.
ذهب الضباب و كان الصباح مشرق حتى أن كل شجرة على ضفاف النهر البعيد كانت ظاهرة.
كيف كان الصباح ؟ - مشرق - ملئ بالضباب

- 17- tahadath al-ʿustaath maa zamiil al-taalibah allatii kaanat muhtamah bigamʿi twaabinaadirah.
The professor spoke with the friend of the student who was interested in collecting rare stamps.

تحدث الأستاذ مع زميل الطالبة التي كانت مهتمة بجمع الطوابع النادرة.
من مهتم بجمع الطوابع النادرة ؟ - الزميلة - الطالبة

- 18- raʿaytu mudarib al-tulaab alathii qaadahum illaa al-fawz.
I saw the coach of the students who lead them to victory.

رأيت مدرب الطلاب الذي قادهم إلى الفوز.
من قاد إلى الفوز ؟ - الطلاب - المدرب

- 19- ʿindamaa tahdur kaamilyaa min al-ʿamal taʿkhuth qayluulah qabla ʿiʿdaad al-taʿaam.
When Kamilyah comes from work she takes a nap before preparing the food.

عندما تحضر كامليا من العمل تأخذ قيلولة قبل إعداد الطعام.
ماذا تفعل كامليا أولاً عندما تحضر إلى البيت ؟ - تأخذ قيلولة - تعد الطعام

- 20- talaba muwathaf al-istiqaal min al-suyaah haml haqaaʿibuhum ilaa al-saalah laʿan haamil al-haqaaʿib kaana mashghuul.
The reception employee asked the tourist to carry his bag to the entrance because the doorman was busy

طلبت موظفة الإستقبال من السّياح حمل حقائبهم إلى الصّالة لأنّ حامل الحقائب كان مشغولاً.
من الذى طُلب منه أن يحمل الحقائب ؟ - السياح - حامل الحقائب

21- al-bayt allathii taskun fihi hind lahu gudraan min tuub was abwaab khashbiyah
The house that Hind lives in has walls of brick and doors of wood.

البيت الذى تسكن فيه هند له جدران من طوب و أبواب خشبية.
أبواب بيت هند من ماذا ؟ - الطوب - الخشب

22- kaana dubaat al-gamaarik fi al-mataar kilaahumaa yushikuun fi saahibat al-haqiibah
allatii kaanat mutaribah.
The security officers at the airport both suspected the owner of the suitcase who was nervous.

كان ضابطا الجمارك فى المطار كلاهما يشكّون فى صاحبة الحقيرة التى كانت مضطربة.
كم عدد الذين كانوا يشكّون ؟ - واحد - اثنين

23- lam yakun al-ragul yakii qasas liawlaadih wa laakin alaan yahkii liahfaadih qisah kul
laylah.
The man didn't used to read stories to his children but now he reads to his
grandchildren a story every day.

لم يكن يحكى الرجل قصص لأولاده و لكنه الآن يحكى لأحفاده قصة كل ليلة.
لمن يحكى الرجل القصص ؟ - أولاده - أحفاده

24- talaba al-qaadii min al-muwathaf an yukarir ism al-shaahid allathii kathab.
The judge asked the employee to repeat the name of the witness who had lied.

طلب القاضى من الموظف أن يكرر اسم الشاهد الذى كذب.
من الذى طلب سماع الاسم ؟ - القاضى - الموظف

25- lam yuwafaq manduub al-mabiiʿaat fo iqnaaʿ al-thubuun bishiraaʿ gihaaz tasgiil
gadiid.
The sales representative did not succeed in persuading the customer to buy the new
recorder.

لم يُوفّق مندوب المبيعات فى إقناع الذبون بشراء جهاز تسجيل جديد.
من كان يُشجّع شراء جهاز تسجيل جديد ؟ - الذبون - مندوب المبيعات

26- nusihnaa ʿan nathal baʿiidiin ʿan haras al-safiirah allatii kaanat muraaqabah min
qibal gawaasiis alʿaduww.
We were advised to keep away from the bodyguards of the ambassador who was
being followed by the spies of the enemy.

نُصِحنَا أن نَظَلَ بعِيدِينَ عن حرس السفيرة التي كانت مراقبة من قبل جواسيس العدو.
مَنْ كَانَ مُرَقَّبٌ ؟ - الحرس - السفيرة

27- qafaza alnimr alaa la-ghazzalah ʕindamaa kaanat al-suquur tahuum fi al-samaa?
The tiger jumped on the deer as the eagles flew in the sky.

قفز النمر على الغزال عندما كانت الصقور تحوم في السماء.
ما الذي أمسك به النمر ؟ - الغزال - الصقور

28- nadia mustagidah wa laakin baqyat al-mumaridaat yaʕmalna fi mustashfah min
akthar min ʕasharat aʕwaam.
Nadia is new whereas the other nurses have worked in the hospital for ten years.

نادية مُستَجِدَّة ولكن بقية الممرضات يعملن في المستشفى من أكثر من عشرة أعوام.
ما المدة التي عملتها نادية في المستشفى ؟ - ليس بكثير - عشرة أعوام

29- raʕayatu hutaam al-taairah allatii kana alaa matnihaa miʕatu shakhsin alaa al-aqal.
I saw the wreckage of the plane that had one hundred passengers on board.

رأيت حطام الطائرة التي كان على متنها مئة شخص على الأقل.
تقريباً كم عدد الركاب الذين كانوا على الطائرة التي تحطمت ؟ - عشرون - مئة

30- Mohamed asked the driver of the train who had not slept all night about the time of
the train.

سأل محمد سائق القطار الذي لم ينام طوال الليل عن موعد قيام القطار.
من الذي لم ينام طوال الليل ؟ - سائق القطار - محمد

31- Although Khalid usually takes the bus to work, today he had to take a taxi cab.

بالرغم من أن خالد يأخذ عادةً الأتوبيس إلى عمله إلا أنه اليوم إضطر أن يأخذ سيارة أجرة.
كيف يذهب خالد إلى عمله عادةً ؟ - بالأتوبيس - بسيارة أجرة

32- The teacher gave the student who scored high on the difficult test a valuable gift.

أهدى الأستاذ الطالب الذي نجح في الإمتحان الصعب هدية قيمة.
إلى مَنْ قدمت الهدية القيمة ؟ - الأستاذ - الطالب

33- The principal met the student who wrote the long letter to the minister.

قابل الناظر الطالبة التي كتبت الرسالة الطويلة إلى الوزير.

من كتب الرسالة الطويلة إلى الوزير ؟ - الناظر - الطالبة

34- The basket had four fresh eggs, a duck and two meat pies.

إحتوت السلة على أربع بيضات طازجة ، بطة و إثنين من صوانى اللحم المطبوخ.
كم كان عدد البيض ؟ - أربعة - إثنين

35- The judge reviewed the accusations of the prisoner who wore a white shirt.

نظر القاضى فى تهمة السجين الذى كان يرتدى قميص أبيض.
من كان يرتدى قميص أبيض ؟ - القاضى - السجين

36- Samy gave the book to Adil.

أعطى سامى الكتاب لعاذل.
من أخذ الكتاب ؟ - سامى - على

37- The news critic read the book of the poet who was in the conference.

قرأ الناقد الصحفى كتاب للشاعر الذى كان فى الندوة.
من كان فى الندوة ؟ - الناقد - الشاعر

38- The rich business man sent an invitation to the beautiful princess to attend the opening celebration for the new resort.

بعث رجل الأعمال الثرى دعوة للأميرة الحساء لحضور حفل إفتتاح القرية السياحية.
من دُعِيَ إلى الإفتتاح ؟ - رجل الأعمال - الأميرة

39- The ambassador met in his office with the princess who was asking for political asylum.

استقبل السفير فى مكتبه الأميرة التى كانت تطلب اللجوء السياسى.
من كان يطلب اللجوء السياسى ؟ - السفير - الأميرة

40- The tenant asked the landlord who was asking for a compensation to go to court.

طلب المستأجر من المالك الذى كان يطلب تعويضاً كبيراً اللجوء إلى القضاء.
من كان يطلب تعويضاً كبيراً ؟ - المالك - المستأجر

41- The newspaper put a picture of the famous palyer who was taking steroids.

نشرت الصحيفة المشهورة صورة اللاعب التى كانت تتعاطى المنشطات.
من المشهورة ؟ - اللاعب - الصحيفة

42-Because his was very angry, the teacher threw the poetry book out the window and broke his glasses.

من شدة غضبه رمى الأستاذ كتاب الشعر من الشباك و كسر النظارة.
ماذا رمى الأستاذ من الشباك ؟ - كتاب الشعر - النظارة

43- Last Saturday, the minister opened the model farm that took five years to build.

إفتتح الوزير السبت الماضى المزرعة النموذجية التى استغرق بنائها خمسة أشهر.
متى أفتتحت المزرعة النموذجية ؟ - من خمسة أشهر - يوم السبت الماضى

44- Zeinab saw the movie that won first prize in the festival.

شاهدت زينب الفيلم الذى حصل على جائزة المهرجان.
ماذا شاهدت زينب ؟ - المهرجان - الفيلم

Appendix B1: Instructions for the Experimental Task

Instructions for the off-line questionnaire (Experiment 1)

English Translation

INSTRUCTIONS TO SUBJECTS

In this folder you will find sentences to read. Each one will be typed on a separate page. For each sentence, please:

FIRST: Read the sentence silently to yourself, so that you understand it.

THEN: Turn the page. You will see a question about the meaning of the sentence, with two answers. Read the question silently. Then

FINALLY: Select the answer that seems logical by circling it.

GO THROUGH THE FOLDER ONE SENTENCE AT A TIME. DO NOT GO BACK TO THE PREVIOUS PAGE. DO NOT SKIP SENTENCES – MAKE A CHOICE FOR EVERY SENTENCE.

The whole task takes no more than approximately 40 minutes.

PRACTICE SESSION: Before the experiment begins, there will be three sentences for you to practice on. After trying out these sentences, you may ask the experimenter any questions you have about the procedure.

Once the experiment begins, it is best to go through it without interruption.

Relax and try to enjoy yourself. This is not a test.

The experiment isn't difficult, and we don't score answers as right or wrong.

We are interested in your intuitions about what the sentences mean. It will help us best if you read naturally, at whatever is your comfortable pace, and answer the questions spontaneously without thinking too long or hard.

You may begin the practice session now. Stop when you get to the blue page.

Appendix B2: Instructions for the Experimental Task

Instructions for Silent Prosody Elicitation (Experiment 4)

English Translation

INSTRUCTIONS TO SUBJECTS

In this folder you will find sentences to read. Each one will be typed on a separate page. For each sentence, please:

- Start reading the sentence silently to yourself.
- As you are silently reading the sentence, you will simultaneously place the diacritic marks you are using as you silently read the sentence.

GO THROUGH THE FOLDER ONE SENTENCE AT A TIME. DO NOT GO BACK TO THE PREVIOUS PAGE. DO NOT SKIP SENTENCES – MARK ALL DIACRITIC MARKS ON EVERY SENTENCE.

The whole task takes no more than approximately 45 minutes.

PRACTICE SESSION: Before the experiment begins, there will be three sentences for you to practice on. After trying out these sentences, you may ask the experimenter any questions you have about the procedure.

Once the experiment begins, it is best to go through it without interruption.

Relax and try to enjoy yourself. This is not a test.

The experiment isn't difficult, and we don't score answers as right or wrong.

We are interested in your intuitions about reading the sentences. It will help us best if you read naturally, at whatever is your comfortable pace, and read spontaneously without thinking too long or hard.

You may begin the practice session now. Stop when you get to the blue page.

Appendix B3: Instructions for the Experimental Task

Instructions for the “Post –To-Times’ Forced Attachment (Experiment 5 and 6)

INSTRUCTIONS FOR THE VOICE RECORDING EXPERIMENT

For this experiment you will be asked to read a set of two simple sentences. These two sentences will be presented individually on a separate sheet of paper. You are asked to read these sentences silently at first, and then to join these sentences together to form one sentence as indicated in the example given below:

Example: someone shot the servant of the actress. The actress was on the balcony.
Joined Sentence: Someone shot the servant of the actress who was on the balcony.

After joining the sentences, you then be asked to say it aloud as many times as you wish in order to be comfortable with its meaning. Then, you will say the sentence into a voice recorder.

You will be given a few practice sentences to make sure that the equipment is functioning, that the levels are set properly, and that you feel comfortable with the procedure. When you get to the end of the practice session, pause for a moment and ask the experimenter if you have any questions.

It usually takes about 40-55 minutes to complete all sentences.

REMEMBER:

- Read the sentences as many times as you wish and focus on its meaning.
- Indicate to the experimenter that you are comfortable with the sentence and are ready to record by raising your hand.
- Try to utter the sentence naturally, as if you were speaking to someone. Try not to speak the sentence into the recorder.
- Don't worry if you stumble or for any reason or you want to start the sentence over. We can always stop the recording and do the sentence again when you are ready. Simply indicate this to the researcher.
- If you use reading glasses, you should use them for this experiment.

Appendix B4: Instructions for the Experimental Task

Instructions for the Forced Prosody Experiments (Experiment 2 and 3)

English Translation

INSTRUCTIONS TO SUBJECTS

In this folder you will find vowelized sentences to read. Each one will be typed on a separate page. For each sentence, please:

FIRST: Read the sentence with the vowelized diacritics aloud to yourself, so that you understand it, then you will be asked to say it aloud as many times as you wish in order to be comfortable with its meaning. Then, you will say the sentence into a voice recorder.

THEN: Turn the page. You will see a question about the meaning of the sentence, with two answers. Read the question silently. Then

FINALLY: Select the answer that seems logical by circling it with the pencil provided.

GO THROUGH THE FOLDER ONE SENTENCE AT A TIME. DO NOT GO BACK TO THE PREVIOUS PAGE. DO NOT SKIP SENTENCES – MAKE A CHOICE FOR EVERY SENTENCE.

The whole task takes no more than approximately 40 minutes.

PRACTICE SESSION: You will be given a few practice sentences to make sure that the equipment is functioning, that the levels are set properly, and that you feel comfortable with the procedure. When you get to the end of the practice session, pause for a moment and ask the experimenter if you have any questions.

Before the experiment begins, there will be three sentences for you to practice on. After trying out these sentences, you may ask the experimenter any questions you have about the procedure.

Once the experiment begins, it is best to go through it without interruption.

Relax and try to enjoy yourself. This is not a test.

The experiment isn't difficult, and we don't score answers as right or wrong.

We are interested in your intuitions about what the sentences mean. It will help us best if you read naturally, at whatever is your comfortable pace, and answer the questions spontaneously without thinking too long or hard. You may begin the practice session now. Stop when you get to the blue page.

Appendix C: Randomization Ordering List of materials across experiments

Expts 1 ,2,5 and 6								
PRESENTATION ORDER	A	B	C	D	E	F	G	H
1st	LRC	LRC	SRC	LRC	LRC	LRC	LRC	LRC
2nd	SRC	SRC	SA	SRC	SA	SRC	SA	SA
3rd	SA	SA	LA	SA	SRC	SA	SRC	SRC
4th	LA	LA	LRC	LA	LA	LA	LA	LA

Expts 1,2,5 and 6								
	A	B	C	D	E	F	G	H
Long RC	1	2	28	4	6	11	14	16
Short RC	5	7	3	10	19	17	27	29
Long Adj	18	20	13	30	26	24	31	32
Short Adj	12	9	8	21	15	22	23	25

Items A, B, D and F:	RC-Long < RC-Short < AP-Short < AP-Long
Items E, G, H:	RC-Long < AP-Short < RC-Short < AP-Long
Item C:	RC-Short < AP-Short < AP-Long < RC-Long

Expts 3 & 4								
PRESENTATION ORDER	A	B	C	D	E	F	G	H
1st	SRC	LRC	LA	LRC	LRC	SA	LRC	SRC
2nd	LRC	LA	LRC	SA	SA	LA	SRC	LA
3rd	SA	SA	SRC	SRC	LA	LRC	SA	LRC
4th	LA	LA	SA	LA	SRC	SRC	LA	SA

Expts 3 and 4								
	A	B	C	D	E	F	G	H
Long RC	1	2	4	6	11	14	16	28
Short RC	3	5	7	10	17	19	27	29
Long Adj	13	18	20	24	26	30	31	32
Short Adj	8	9	12	15	21	22	23	25

Appendix D: Summary Tables for Analyses of Variance

Appendix D-1: Silent Perception experiment

Experiment 1: Mean % High Attachment

Subject-based: Modifier Type (Adj/RC) x Length(Lng/Sht)

NO. OF CASES: 30
 NO. OF LEVELS OF FACTOR A: 2
 NO. OF LEVELS OF FACTOR B: 2
 NO. OF LEVELS OF FACTOR C: 1

NON-REPEATED FACTORS:

AB	MATRIX			
	39.58	23.33	52.50	36.67
A	MATRIX			
	31.46	44.5		
B	MATRIX			
	46.04	30.00		

2 WAY ANOVA: %High Attachment, Subject-based: Modifier Type (Adj/RC) x Length (Lng/Sht)

SV	SS	DF	MSS	F	P
S	33600.26	29	1158.63		
A	5167.97	1	5167.97	32.88	.334E-05
S*A	4558.59	29	157.19		
B	7720.05	1	7720.05	28.75	.924E-05
S*B	7787.76	29	268.54		
AB	1.30	1	1.30	.01	0.944
S*AB	7537.76	29	259.9		

%High Attachment

Item-based: Modifier Type (Adj/RC) x Length (Lng/Sht)

NO. OF CASES: 8
NO. OF LEVELS OF FACTOR A: 2
NO. OF LEVELS OF FACTOR B: 2
NO. OF LEVELS OF FACTOR C: 1

NON-REPEATED FACTORS:

AB MATRIX
39.58 23.33 52.50 36.67

A MATRIX
31.46 44.58

B MATRIX
46.04 30.00

2 WAY ANOVA: EXP 1 %High Attachment, Item-based: Modifier Type (Adj/RC) x Length (Lng/Sht).

SV	SS	DF	MSS	F	P
S	1021.52	7	145.93		
A	1378.13	1	1378.13	17.64	0.00404
S*A	546.96	7	78.14		
B	2058.89	1	2058.89	15.45	0.00568
S*B	933.12	7	133.30		
AB	.34	1	.34	.00	1.000
S*AB	1325.04	7	189.29		

Appendix D-2: Overt Perception experiments

Experiment 2 & 3: % High Attachment

Subject-based: N2][RC (-/+) x Modifier (Adj/RC) x Length (Lng/Sht)

```

NO. OF CASES:      30
NO. OF LEVELS OF FACTOR A:  2
NO. OF LEVELS OF FACTOR B:  2
NO. OF LEVELS OF FACTOR C:  2
NON-REPEATED FACTORS:  a

ABC MATRIX
29.58      12.92      54.58      43.33      71.67      34.58      75.42      67.92
AB  MATRIX
      21.25      48.96      53.13      71.67
A   MATRIX
      35.10      62.40
B   MATRIX
      37.19      60.31
BC  MATRIX
      50.63      23.75      65.00      55.63
C   MATRIX
      57.81      39.69
A C MATRIX
      42.08      28.13      73.54      51.25

```

3 WAY ANOVA: EXPS 2&3 %High, Subj: N2][RC (-/+) x Modifier (Adj/RC) x Length (Lng/Sht)

SV	SS	DF	MSS	F	P
A	44690.10	1	44690.10	45.63	.596E-07
S	56809.90	58	979.48		
B	32085.94	1	32085.94	97.16	.000E+00
AB	1260.42	1	1260.42	3.82	0.0556
S*B	19153.65	58	330.24		
C	19710.94	1	19710.94	89.03	.000E+00
AC	1041.67	1	1041.67	4.7	0.0342
S*C	12841.15	58	221.40		
BC	4593.75	1	4593.75	19.92	.377E-04
ABC	2190.10	1	2190.10	9.50	0.00314
S*BC	13372.40	58	230.56		

EXPS 2 AND 3: %High Attachment
 Item: N2][RC (-/+) x Modifier (Adj/RC) x Length (Lng

NO. OF CASES: 8
 NO. OF LEVELS OF FACTOR A: 2
 NO. OF LEVELS OF FACTOR B: 2
 NO. OF LEVELS OF FACTOR C: 2

NON-REPEATED FACTORS:

ABC MATRIX
 29.58 12.92 54.58 43.33 71.67 34.58 75.42 67.92

AB MATRIX
 21.25 48.96 53.13 71.67

A MATRIX
 35.10 62.40

B MATRIX
 37.19 60.31

BC MATRIX
 50.63 23.75 65.00 55.63

C MATRIX
 57.81 39.69

A C MATRIX
 42.08 28.13 73.54 51.25

3 WAY ANOVA: EXPS 2 & 3 %High, Item: N2][RC (-/+) x Modifier (Adj/RC) x Length (Lng

SV	SS	DF	MSS	F	P
S	1094.77	7	156.40		
A	11917.00	1	11917.00	78.26	.477E-04
S*A	1065.92	7	152.27		
B	8556.25	1	8556.25	35.59	.561E-03
S*B	1682.69	7	240.38		
AB	336.08	1	336.08	1.49	0.262
S*AB	1580.54	7	225.79		
C	5256.25	1	5256.25	92.18	.279E-04
S*C	399.14	7	57.02		
AC	277.81	1	277.81	2.78	0.140
S*AC	700.38	7	100.05		
BC	1224.83	1	1224.83	2.66	0.147
S*BC	3219.05	7	459.86		
ABC	583.95	1	583.95	3.89	0.0890
SABC	1049.49	7	149.93		

Appendix D-3: Silent Production experiment

Experiment 4: Implicit Prosodic Phrasing: %Prosodic Boundary
Subject-based: Modifier Type (Adj/RC) x Length (Lng/Sht

NO. OF CASES: 30
NO. OF LEVELS OF FACTOR A: 2
NO. OF LEVELS OF FACTOR B: 2
NO. OF LEVELS OF FACTOR C: 1

NON-REPEATED FACTORS:

AB MATRIX
34.58 8.75 45.83 20.83

A MATRIX
21.67 33.33

B MATRIX
40.21 14.79

2 WAY ANOVA: Exp 4 %Boundary, Subject: Modifier Type (Adj/RC) x Length

SV	SS	DF	MSS	F	P
S	36750.00	29	1267.24		
A	4083.33	1	4083.33	36.32	.137E-05
S*A	3260.42	29	112.43		
B	19380.21	1	19380.21	39.11	.775E-06
S*B	14369.79	29	495.51		
AB	5.21	1	5.21	.04	0.839
S*AB	3588.54	29	123.74		

EXPERIMENT 4 %Boundary, Item: Modifier Type (Adj/RC) x Length

NO. OF CASES: 8
NO. OF LEVELS OF FACTOR A: 2
NO. OF LEVELS OF FACTOR B: 2
NO. OF LEVELS OF FACTOR C: 1

NON-REPEATED FACTORS:

AB MATRIX
34.58 8.75 45.83 20.83

A MATRIX
21.67 33.33

B MATRIX
40.21 14.79

2 WAY ANOVA: EXP4 %Boundary, Item-based: Modifier Type (Adj/RC) x Length

SV	SS	DF	MSS	F	P
S	544.32	7	77.76		
A	1088.81	1	1088.81	18.54	0.00354
S*A	411.16	7	58.74		
B	5168.39	1	5168.39	81.66	.415E-04
S*B	443.06	7	63.29		
AB	1.38	1	1.38	.03	0.867
S*AB	320.73	7	45.82		

Appendix D-4: Overt Production experiment

Experiment 5: Over Prosodic Phrasing

EXP5: %No-Liaison, Subject: Modifier (Adj/RC) x Length (Lng/Sht)

NO. OF CASES: 30
 NO. OF LEVELS OF FACTOR A: 2
 NO. OF LEVELS OF FACTOR B: 2
 NO. OF LEVELS OF FACTOR C: 1

NON-REPEATED FACTORS:

AB MATRIX
 27.92 12.50 34.58 25.42

A MATRIX
 20.21 30.00

B MATRIX
 31.25 18.96

2 WAY ANOVA: EXP 5, %No-Liaison, Subject: Modifier (Adj/RC) x Length (Lng/Sht)

SV	SS	DF	MSS	F	P
S	27537.76	29	949.58		
A	2876.30	1	2876.30	15.32	.504E-03
S*A	5444.01	29	187.72		
B	4532.55	1	4532.55	25.31	.232E-04
S*B	5194.01	29	179.10		
AB	292.97	1	292.97	1.73	0.198
S*AB	4902.34	29	169.05		

EXP 5: %No-Liaison, Item: Modifier (Adj/RC) x Length (Lng/Sht)

NO. OF CASES: 8
 NO. OF LEVELS OF FACTOR A: 2
 NO. OF LEVELS OF FACTOR B: 2
 NO. OF LEVELS OF FACTOR C: 1

NON-REPEATED FACTORS:

AB MATRIX

27.92 12.50 34.58 25.42

A MATRIX

20.21 30.00

B MATRIX

31.25 18.96

2 WAY ANOVA: EXP 5: %No-Liaison, Item: Modifier (Adj/RC) x Length (Lng/Sht)

SV	SS	DF	MSS	F	P
S	391.48	7	55.93		
A	766.95	1	766.95	3.89	0.0892
S*A	1380.33	7	197.19		
B	1208.84	1	1208.84	28.77	0.00105
S*B	294.08	7	42.01		
AB	78.13	1	78.13	.78	0.407
S*AB	702.42	7	100.35		

Appendix D-5: Overt Production experiment

Experiment 6: Prosodic Phrasing, Mean %No-Liaison,
Subject-based : Modifier (Adj/RC) x Length(Lng/Sht)

NO. OF CASES: 30
NO. OF LEVELS OF FACTOR A: 2
NO. OF LEVELS OF FACTOR B: 2
NO. OF LEVELS OF FACTOR C: 1

NON-REPEATED FACTORS:

AB MATRIX
46.25 25.83 62.50 56.25

A MATRIX
36.04 59.38

B MATRIX
54.38 41.04

2 WAY ANOVA: EXP 6, Mean %No-Liaison, Subject-based: Modifier (Adj/RC) x Length (Lng/Sht)

SV	SS	DF	MSS	F	P
S	45541.67	29	1570.40		
A	16333.33	1	16333.33	79.85	.000E+00
S*A	5932.29	29	204.56		
B	5333.33	1	5333.33	25.80	.203E-04
S*B	5994.79	29	206.72		
AB	1505.21	1	1505.21	5.00	0.0332
S*AB	8729.17	29	301.01		

EXPERIMENT 6: Mean %No-Liaison
Item-based : Modifier (Adj/RC) x Length (Lng/Sht)

NO. OF CASES: 8

NO. OF LEVELS OF FACTOR A: 2

NO. OF LEVELS OF FACTOR B: 2

NO. OF LEVELS OF FACTOR C: 1

NON-REPEATED FACTORS:

AB MATRIX
46.25 25.83 62.50 56.25

A MATRIX
36.04 59.38

B MATRIX
54.37 41.04

2 WAY ANOVA: Experiment 6 %, No-Liaison, Item: Modifier (Adj/RC) x Length (Lng/Sht)

SV	SS	DF	MSS	F	P
S	648.51	7	92.64		
A	4355.71	1	4355.71	17.31	0.00424
S*A	1761.46	7	251.64		
B	1421.78	1	1421.78	5.95	0.0448
S*B	1672.48	7	238.93		
AB	401.44	1	401.44	2.27	0.176
S*AB	1237.68	7	176.81		

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